

**MARINE CRANNOGS: THE ARCHAEOLOGICAL AND
PALAEOENVIRONMENTAL POTENTIAL**

**with special reference to Redcastle marine crannog, Beaully Firth,
Scotland.**

In two volumes

Volume 1

The Text

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Ph.D.

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1999



Declaration

I declare that this thesis has been composed by me and that the work contained within it has been conducted by me. Any work conducted by persons other than myself is fully acknowledged.

Abstract

Marine crannogs are archaeological remains distributed around the Scottish coastline. The two groups of sites discussed in this thesis are located in the intertidal zone of the upper reaches of the Firth of Clyde and the Beauly Firth. As a result of their wet surroundings they have been associated with freshwater crannogs although little is known of their origins, function and structural design. Evidence from early investigations has indicated that substantial remains are preserved beneath the intertidal deposits. Intertidal fieldwork techniques have been developed in this thesis to enable these sites to be surveyed, investigated and to sample some of the archaeology and palaeoenvironmental evidence preserved on them.

Evidence from previous investigations of these sites is used to re-locate them and survey was undertaken to identify additional sites. The results from the surveys of the existing marine crannogs are used to indicate the variety of locations, types of remains and other characteristics of these sites. On the basis of these results, one site was chosen for additional research. Sampling and excavation on the focus site indicates primary and subsequent structural remains and particular sedimentary and artefactual characteristics. Some of the remains sampled are subjected to multi-spectral analysis, the results of which indicate that palaeoenvironmental indicators are found in marine crannog deposits and can be used to establish conditions when the location was occupied and the site constructed. An example of the palaeoenvironmental indicators analysed was diatoms, which are helpful when investigating the position and salinity levels of contemporary water levels.

Results from the surveys and sample analysis are used to indicate that marine crannogs are a distinct sub-group of crannogs and that the two groups display a regional diversity of both structures and chronology. The identification of a distinct range of structures from Iron Age Scotland contributes to the diversity of sites from this period.

Acknowledgements

I would like to thank the following people for their help, advice and encouragement in completing this thesis. Special thanks should go to my supervisors Dr. Nick Dixon and Dr. Geraint Coles for providing invaluable advice and for offering their combined experience on matters regarding crannogs and palaeoenvironmental archaeology.

The following specialists have given invaluable help and contributed to aspects of the research herein, for which I am very grateful:

Denise Carruthers - Department of Archaeology, University of Edinburgh - for identifying the faunal remains from the 1995 fieldwork season.

Andy Haggart - School of Earth and Environmental Sciences, University of Greenwich - for processing and analysing the diatom and pollen samples and for helpful advice on sea level issues. Additional thanks for providing Figures 8.1. - 8.6.

Nicola Murray - Department of Archaeology, University of Edinburgh - for identifying the faunal remains from the 1994 fieldwork season.

Ruth Pelling - Oxford University Museum - for identifying the plant macrofossils.

Jennifer Thoms - Department of Archaeology, University of Edinburgh - for carrying out the routine soil tests.

Sarah Witcher - Department of Archaeology, University of Edinburgh - for identifying the faunal remains from the 1996 fieldwork season.

I would also like to thank the following for giving advice and their assistance with particular aspects of the research:

Patrick Ashmore - Historic Scotland, Edinburgh - for providing the funding for the radiocarbon dates.

Colleen Batey - Kelvingrove Art Gallery and Museum, Glasgow - for access to the Kelvingrove special collections.

Mike Cressey - Department of Archaeology, University of Edinburgh - for advice on palaeoenvironmental sampling.

Anne Crone - AOC Scotland Ltd, The Old Schoolhouse, Lochend Road, Edinburgh - for allowing me to read the manuscript of her forthcoming publication and for giving me a copy of her dendrochronology report from Erskine marine crannog.

Niall Gregory - Department of Archaeology, University of Edinburgh - for information on Scottish log boats.

Bill Hanson - Department of Archaeology, University of Glasgow - for allowing me to reproduce his plan of the Erskine marine crannog.

Dennis Harding - Department of Archaeology, University of Edinburgh - for helpful advice and assistance from the Abercromby Travel Fund.

Bruce Henry - Renfrewshire Local History Forum - for braving the muds of the Firth of Clyde and for providing the scaffolding tower for the Dumbuck photograph.

Kevin Hicks - Centre for Field Archaeology, University of Edinburgh - for helping with many of the illustrations.

Richard Hingley - Historic Scotland - for fieldwork funding and helpful advice.

Fraser Hunter - Royal Museum of Scotland, Edinburgh - access to the special collections.

Annette Jack - Avoch - for taking the measurements for the erosion survey and for her support and hospitality during the fieldwork seasons.

Barri Jones - Department of Archaeology, University of Manchester - for pointing me in the direction of the Beaully Firth marine crannogs with the aid of his excellent aerial photographs.

John Macdonald - ARIA - for the aerial photograph of Erskine.
Conor Newman - Department of Archaeology, University College Galway - for information regarding the wattle pits on Ballinderry 2 crannóg.
Barry Raftery - Department of Archaeology, University College Dublin - for the photographs of the Rathtinaun Crannóg 61, fire baskets.
Ian Ralston - Department of Archaeology, University of Edinburgh - for helpful comments on drafts of some of the chapters.
Rob Sands - Department of Archaeology, University of Edinburgh - for help and advice on timber species identification and all number of discussions on crannogs.
Pat Storey - Department of Archaeology, University of Edinburgh - for advice and assistance with all things administrative.
John Wood - Archaeology Section, Highland Council - for financial support and advice.
The Trustees of the Wingate Scholarship - for financial support during the course of this research.
The Society of Antiquaries of Scotland - for financial support for the surveys of the Beaully Firth and Firth of Clyde marine crannogs.
Historic Scotland - for financing aspects of the fieldwork and post-excavation analysis.

I would like to thank all those people who have assisted during the fieldwork seasons in mud, rain and some sun, and also those friends whom offered help and advice during off-site periods.

Special thanks should go to my family: Roger, Nina, Ingrid, Omi, Estelle, Martin, Milo, Nick and Pip and the Clayworths for their constant love and support.

Finally, this thesis is dedicated to Anya and Opi, to whom I owe everything.

Any mistakes, however, are my own.

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CHAPTER 1

Marine crannogs: an introduction

1.1 Introduction

Scottish crannogs are structures situated in wetland, lacustrine or marine environments. While the so called “lake dwellings” (Morrison 1985) situated in freshwater environments have been the focus of considerable, and growing, attention (Dixon 1982, Barber and Crone 1993, Crone 1993) those sites located in marine environments remain the poor relation and, as yet, have not been the subject of detailed analysis. In some ways this is surprising given the potential importance of firths as prehistoric transport routes. Such sites along firths may have acted as nodal points in postulated networks of coastal transport, exchange and trade. The paucity of research may in part therefore be explained by the relative rarity of marine crannogs (of over 400 known crannogs only 3.5 % lie in marine locations) and the apparent difficulties of researching on sites in the intertidal zone.

This thesis therefore sets out to examine the archaeological potential and palaeoenvironmental significance of the remains of marine crannogs in Scotland. From the outset three key areas of marine crannog research were identified and which would be discussed in this thesis:

- Site distribution, location and environmental change
- Site structure and function
- Site chronology

The approach taken in this thesis is to locate and investigate marine crannogs so that aspects of human interaction with the coastline during prehistory can be

reconstructed using the remains. The key issues of coastal exploitation by prehistoric populations and implied by marine crannogs, built so close to the shoreline are: Were these sites built to access and exploit certain estuarine resources? Whether the firths in which marine crannogs are built were used as communication routes? Were the places where marine crannogs were built chosen for specific purposes in the firth, perhaps where water transport could be landed and launched?

The methods used to investigate these issues are based on the following broad research aims: initial searches of documentary sources of previous research on marine crannogs, to locate the whereabouts of marine crannog sites. Field investigations of the sites identified from the documentary sources have been used to re-locate and survey the remains. By surveying the sites and their surrounding intertidal zones, evidence of the past topographies were recorded. Aspects of the remains and surrounding intertidal zones were then further investigated for archaeological and palaeoenvironmental potential, by means of sampling and excavation.

One of the initial aims of the research was to choose a site for intensive investigation, including sampling and small-scale excavation. The aims of the excavation were to understand any relationships between the structural remains and the underlying topography. Palaeoenvironmental evidence was sampled and a range of analysis techniques were employed to assess the samples for evidence of the local conditions prior to, during and after the use of the site.

The common feature to all crannogs is their situation in a wetland environment. Marine crannogs are marked out by being situated in a highly variable tidal wetland environment - the intertidal zone between high and low water marks.

The term marine crannog is therefore a purely descriptive classification and it cannot be assumed that their common location in the intertidal zone is an indication either of functional, structural or chronological similarity, or of difference from one another or possibly from freshwater examples.

1.2 Site Distribution, Location and Environmental Change

Known marine crannog sites in Scotland are located in the relatively sheltered upper reaches of estuaries on both the east and west coastlines. Two concentrations of sites have been identified, one in the Beaully Firth, Highland Region and the other in the inner Firth of Clyde, in West Dunbartonshire and Renfrewshire (Figure 1.1.). Although at least one isolated single site is known to exist from documentary sources, near the Isle of Eriska, the presence of two such clear concentrations poses several questions as to the origins, distribution and palaeoenvironmental conditions pertinent to these sites. The distribution of marine crannogs in two concentrations, in the upper reaches of tidal estuaries, may be the product of differential preservation and destruction of the archaeological record in the dynamic coastal zone. Other questions that arise from the distribution and location of marine crannogs include: Are the sites contemporary? Why were they built in such concentrations in those particular firths? Can a model be developed using the topographical characteristics of the firths where sites are known and be applied to the Scottish coastline, to identify the locations of further sites?

To assess the validity of the current distribution of marine crannogs it is important to understand how their localities have changed over time. Several factors are at work that may have affected archaeological sites in the intertidal zone: relative sea level change, both isostatic and eustatic variations (exposing and submerging sites), coastal erosion (removing sites), coastal deposition (altering and masking

sites), land reclamation (destroying sites) and modern development (obscuring sites). The latter two processes are particularly acute on land surrounding certain Scottish firths, which are concentrations of major conurbations, such as the population centres on the shores of the Firth of Forth and the Firth of Clyde.

Other examples of the factors which may have affected marine crannogs and indeed other archaeological remains in the coastal zone include the variation between the rates of glacio-isostatic uplift between the east and the west coasts (Sissons 1967). A recent coastal survey on the island of Lewis has identified aspects of a Neolithic landscape, which has been submerged by a eustatic rise in sea level (Burgess & Church 1997). Whereas coastal sites built specifically to access coastal resources, such as Mesolithic shell middens, are currently on raised sea beaches as a result of glacio-isostatic uplift at an accelerated rate over sea level rise. Coastal erosion has affected many different types of archaeological sites, including the extensive Pictish and Early Historic burial ground at Lower Largo, on the north shore of the Firth of Forth, which is currently subject to erosion especially during above average high tides (spring tides) and storm events combined with prevailing winds (Robertson 1996). Coastal deposition has partially resulted in the altered coastline surrounding the Mesolithic site at Morton in Fife, to such an extent that the site now lies over 3km inland from the contemporary shoreline (Coles 1971). Previous land reclamation and modern development have affected coastal archaeology and a marine crannog in the Firth of Clyde, discussed in Chapters 2 and 4, has been obscured by such schemes.

Evidence for prehistoric occupation of a coastal site and subsequent environmental changes may be gained from a number of on- and off-site sources. For example, coastal lowlands may contain records of local and regional variations

of the palaeoenvironment. These can be found in the sedimentary record, through pollen analysis and using indicators of water salinity levels, such as diatoms (Tooley 1978a). By sampling and analysing such palaeoenvironmental indicators aspects of the original and subsequent location of marine crannogs can be reconstructed.

Marine crannogs may also be built on the remnants of former shorelines and survey and sampling on and off-site are necessary to investigate this suggestion. Previous research in intertidal zones have identified raised features, such as shoreline peat banks on which archaeological remains have been found (Bell 1995). Survey of the surface topography of the intertidal zone in the Severn estuary in south west England has located features that can be used to identify previous water courses, such as buried palaeo-channels, which may have affected the archaeology (Bell 1992). Sub-surface geological sampling techniques, such as coring can be used to investigate the deposits surrounding and beneath sites in the intertidal zone and contribute to the reconstruction of the palaeoenvironment in which they were built (Wilkinson & Murphy 1986). Sedimentary coring allows for samples to be taken at specific levels and the analysis of those sediments allows for features buried or masked by the overlying deposits to be identified. The results of such coring projects allow for cross sections through estuaries to be depicted as stratigraphic profiles and enables sub-surface remains and previous features such as mean high and low water marks to be reconstructed (e.g. Allen 1987)

On the sites themselves evidence of environmental changes that occurred during occupation may be recovered from the structural sequence, for example, by identifying primary and subsequent phases of construction, possibly indicating changes in relative water level. Sedimentary evidence of marine incursions, sealing archaeological deposits, may also indicate periods of inundation and post-

abandonment fluctuations could be indicated by particular sequences of palaeoenvironmental indicators above archaeological levels.

Records from the early investigations of marine crannogs illustrate some of the potentials of preservation in waterlogged and anaerobic intertidal environments. The preservation of both inorganic and organic material indicates that these sites could provide evidence of specific palaeoenvironments. Whether the evidence was deposited as the result of working raw materials or has become incorporated in the sites owing to natural deposition, accidental loss, or as acts of deliberate deposition are all aspects of the potential of these sites that will be discussed. These issues and others may now be considered using some archaeological techniques that were unavailable to the early investigators of marine crannogs.

One aspect of location that will almost certainly have affected marine crannogs is where was the site originally built in relation to the contemporary water level. Were these sites built at or above mean high water mark (MHW) and was it an environmental factor such as sea level rise that led to their abandonment? These questions become more problematic when it is taken into account that sea level curves after c. 5000 BP in Scotland are difficult to determine (Ballantyne & Dawson 1997). It is therefore difficult to make accurate judgements about sea-level in either the Beauly Firth or the Firth of Clyde without further research in relation to the specific sites.

1.3 Site Structure and Function

Previous studies of freshwater crannogs have shown that they are structurally a very diverse group and attempts to define both regional and site-specific typologies have been complicated by the variety of early investigation reports and the paucity of

modern excavation results. Artifactual evidence of domestic activities and animal refuse from an excavated freshwater site confirms the suggestion that some present evidence that could be interpreted as that from a domestic dwelling (Dixon pers. comm.). Others, however, have shown both domestic assemblages combined with exotic artefacts and structural evidence to suggest additional functions and these could imply that they were high status sites, an example of this was recently excavated at Buiston in south west Scotland (Crone forthcoming).

Some limited evidence for the structure and possible uses of marine crannogs has been recovered by a small number of past investigations (see Chapter 2). Many of these sites are recorded in historical records from the sixteenth century onwards but it is not until the late nineteenth and early twentieth century that they become a focus of archaeological investigation (Bruce 1899-1900, Blundell 1909-1910). Although such investigations were of limited extent they do serve to illustrate the types of remains preserved on marine crannogs and the environments in which they are located. The observation by a number of investigators of causeway structures associated with marine crannogs is an important feature of these sites and will be investigated in the current research.

Previous research has shown that the sea was an important communication route during Prehistory (Johnstone 1980, Wright 1990). The location and specific types of evidence from marine crannogs, such as log boats indicates that some of these sites could have functioned as part of societies that built shoreline structures and developed methods of coastal transport, and may provide evidence to substantiate the suggestion that:

The key to almost all movement into and from Scotland is the sea coast. . .
Movement by water, whether on sea or lake or by river, has great advantages

for primitive or simple communities using shallow-draught vessels, especially in the transport of relatively bulky or heavy goods. . . The deeply indented coastline of Scotland, with estuaries and sea lochs penetrating deeply into the land mass, and with freshwater lochs linked by rivers strung out along Highland glens, made water communications possible from sea to sea. (Piggott, S. 1982, 7)

Scottish firths can be regarded from an anthropological point of view as both obstacles to be overcome for land travellers, and transport routes for the shipment of cargo. It is reasonable to assume that firths were similarly regarded during prehistory, as both a benefit to boat transport and an obstacle to overland routes. It is therefore possible with the presence of marine crannogs, to identify certain locations where previous populations occupied firth margins and points where boats could have been launched and landed. The exact purposes these sites played in the prehistoric occupation and exploitation of Scottish firths and why the two particular firths were chosen for the siting of marine crannogs will be discussed in this thesis.

Evidence from southern Britain that certain coastal sites developed into ports of trade or emporia clearly demonstrates locations where cross-channel trade routes began and ended. Artefactual evidence from Hengistbury Head, Dorset, not only showed evidence of those trade routes but also industrial activity on-site (Cunliffe 1978). This was evidently an important site in a maritime and hinterland trade and production network. Whether evidence of networks on similar scales are present in Scotland or whether differences can be identified will be discussed in this thesis. Perhaps the presence of groups of marine crannogs in certain firths points toward localised concentrations of populations that used those firths as local transport routes and communication networks.

Another aim of the thesis will be to assess the position of marine crannogs within the contemporary landscape and to evaluate how they relate to other sites in the region. This will aim to integrate these sites into the archaeological landscape in order that evidence of their function, from structural and artefactual evidence, may contribute to the reconstruction of past societies.

Sampling and excavation will also be used to evaluate whether marine crannogs contain evidence of the activities that took place on these sites. Artefactual comparison with evidence from contemporary sites, including freshwater crannogs, may shed light on the role of sites situated on the margins of the land and their respective firths. Structural interpretation will also be incorporated to understand the function of marine crannogs and whether specific activities, for example evidence of industrial working areas, can be identified.

1.4 Site Chronology

The third broad aim of this thesis is to ascertain whether reliable dating evidence can be acquired from marine crannogs. Evidence will be sought that can be used to place the sites into their contemporary landscapes and the chronological framework of past societies.

Evidence from freshwater crannogs has illustrated a broad range of dates that may imply multiple phases of occupation and individual building phases (Henderson 1998). Specific methods of dating, for example using axe-blade signatures and dendrochronology have been carried out on Oakbank freshwater crannog and have allowed individual phases of construction to be identified (Crone 1988, Sands 1997). Whether such techniques can be applied to marine crannogs remains to be tested. Dendrochronology may provide a reliable dating source, although it is dependent on

oak timbers with enough rings to be tied into a master chronology (Baillie 1995, 20). Radiocarbon dating, despite problems at certain periods giving wide ranges of dates (Bowman 1990, 46), could be applied to marine crannogs given the evidence of timber structures from previous investigations (see Chapter 2). The known range of radiocarbon dates from freshwater crannogs will also allow chronological comparisons for the occupation of different wetland environments (Henderson 1998). Results from dating marine crannogs will be used to develop a chronology of all sites, which when analysed may be used to identify how long the sites were occupied and whether periods of further building and re-occupation can be identified.

The resulting chronologies can be incorporated into the local and regional contemporary landscapes. With dates comparable with terrestrial sites this will help to establish whether the marine crannogs were built in locations designed as part of transport networks in firths which incorporated aspects of the landscape surrounding the firth. Without reliable dating evidence it remains problematic to establish whether such shoreline and hinterland networks existed and whether marine crannogs were part of those networks.

CHAPTER 2

Previous research on Scottish marine crannogs

2.1. Introduction

This chapter examines previous work in Scottish wetland environments and focuses on marine crannog research. It outlines the history of crannog studies and, in particular, that of marine crannog investigations. The aim is to illustrate that marine crannogs are an integral part of crannog research, which in turn is part of the wider study of Scottish archaeology and that aspects of previous marine crannog research may be used to identify distinguishing features of these sites and their surroundings.

2.2. Crannog research in Scotland: background and history

Within the context of Scottish archaeology, wetland research has a long tradition of being diverse in terms of its geography and the chronology of sites investigated (Coles & Coles 1996). For example, locations range from upland mosses and bogs, such as the platform structures recently found in the Carse of Stirling (Ellis 1998) to ship wreck sites in estuarine and off-shore environments. Sites vary from complex structural remains, such as freshwater crannogs to palaeoenvironmental sites containing records useful in archaeological interpretation, which may be disturbed by coastal erosion, e.g. the site currently under investigation at Newbie Cottages on the Solway coast (Jardine & Morrison 1976, Cressey 1999).

One factor common to many wetland sites is their high preservation record and especially the abundance of organic remains owing to the presence of anaerobic, semi or permanently waterlogged conditions. Within each site there are of course variations in the degree of preservation. Investigation into such sites allows their

reconstruction to reflect aspects of activity, structure, environment and abandonment that are often missing from terrestrial sites, owing to the loss of these vital organic remains. Freshwater crannogs are one group of wetland sites that are celebrated for their preservation of organic remains, the importance of this preservation being established by a lengthy history of investigation (Morrison 1985).

Crannog research in Scotland began as part of a Europe-wide interest in wetland sites, particularly lake-dwellings (Munro 1890). In the middle of the nineteenth century, investigations in the Swiss lakes discovered a series of lake-dwellings and unprecedented preservation of timber buildings, organic structures and small finds. Research by antiquarians such as Ferdinand Keller into the lake dwellings and his resultant publication *The Lake Dwellings of Switzerland and other parts of Europe* (Keller 1866), signifies the beginning of a period of intense interest and publication of lake-dwelling research. In Ireland and Scotland, early lake dwelling research concentrated primarily on crannog sites and resulted in the publication of three important syntheses of investigations: *The Lake Dwellings of Ireland: commonly called Crannogs* (Wood-Martin 1886), *Ancient Scottish Lake Dwellings or Crannogs* and *The Lake-Dwellings of Europe* (Munro 1882 and 1890, respectively).

Robert Munro was the pioneer of crannog research in Scotland and his investigation of sites concentrated, although not exclusively, in the south west of Scotland. However, there were others who took part in early investigations of crannogs such as John Stuart (1864-66) and the Reverend R. J. Mapleton (1870), to name but two. Some of the sites Munro investigated became obvious because of loch drainage, as a result of improvements for agriculture. His publications, including those papers in the *Proceedings of the Society of Antiquaries of Scotland*, remain a

vital part of the history of crannog studies (Munro 1882, 1890, 1893). Munro was joined in the twentieth century by the Reverend Odo Blundell. Blundell used early diving equipment to investigate Highland crannogs and was thus able to examine sites in a way that Munro had not previously managed (Blundell 1909-1910). The work by Munro and Blundell illustrated that crannogs were situated in both Lowland and Highland lochs and that their remains consisted of complex structures of timber and stone construction.

Among the reports by other early crannog researchers are a number of notices on the location and investigation of crannogs in marine locations and Munro remarked in *The Lake-Dwellings of Europe* :

The question of submarine crannogs is still obscure, and the few facts that have come to light leave the matter in doubt as to whether the structures were originally constructed in the water or on a dry land and subsequently submerged, in consequence of changes in the relative levels of sea and land. (Munro 1890, 443)

Munro's recognition of the problems of interpretation, and indeed investigation of marine crannogs, may be a contributory factor to the marginalisation of marine sites in this period of crannog research. By 1900, only two marine crannogs had been investigated in comparison with over 50 freshwater sites (Munro 1884-1885, Bruce 1899-1900).

Research into freshwater crannogs continued in the early part of the twentieth century and included the establishment of a committee by the British Association in 1910 to investigate examples of crannogs, especially in Highland lochs (Fraser 1917, 48). In the period between 1907 and 1912, Blundell managed to visit a number of freshwater sites and one marine crannog, discussed below, before he was called to

serve in the Navy (Blundell 1909-1910). Unfortunately, the outbreak of World War I greatly reduced any systematic research by the Committee.

A limited number of freshwater and no marine crannogs were researched between World War I and 1952, and these do not appear to have been under the auspices of the above mentioned Committee. The freshwater sites investigated during this period resulted in two publications: *The Crannog at Lochend, Coatbridge* and *The lake-dwelling or crannog in Eadarloch, Loch Treig: its traditions and construction* (Monteith 1937, Ritchie 1942, respectively) and this was followed by C. M. Piggott's work on Milton Loch 1 crannog, which was the first excavation of a complete floor plan of a freshwater crannog (Piggott 1952-1953). In part, the plans from these early excavations, especially Piggott's, have provided the initial information for the subsequent stereotype reconstructions of crannogs as timber roundhouses on top of timber and stone artificial islands (Morrison 1985, 18). The central issue of crannog research is: how can such a large number of sites be described structurally, functionally, chronologically and environmentally when only a handful have been investigated and none fully using modern archaeological techniques? Different attempts to begin to answer these questions, each of which contain individual issues, have begun in recent years (Dixon 1984, Morrison 1985, Barber & Crone 1993, Henderson 1998). However, without holistic approaches to crannogs and their surroundings, including a programme of extensive excavation of a variety of crannog sites, these issues remain.

Results from research-driven projects are beginning to enable further discussion on the origins of freshwater crannogs. During the 1970s and '80s survey work concentrated in Loch Awe and Loch Tay and used aerial photography and diving techniques to locate and record submerged sites (McArdle, McArdle &

Morrison 1973, Dixon 1982a). This led to the investigation of Oakbank freshwater crannog in Loch Tay, using modern archaeological methods and sub-aqua equipment, which provided archaeologists with the necessary means to remain submerged for up to six hours on-site (Dixon 1981).

The underwater excavation of Oakbank crannog, in Loch Tay illustrated the methodological adaptations necessary for fully submerged crannog research and the results reflect the excellent preservation of artefacts and structures on such sites (Dixon 1984). Dendrochronology and axe-mark signature studies have all developed from, and contributed to, the dating and structural history of the site, and illustrated the variety of research opportunities that sites with excellent preservation of organic remains can present (Dixon 1982b, Crone 1988, Sands 1997). The position of Oakbank crannog when built and used, compared with contemporary water levels, remains unclear. In the case of marine crannogs this aspect of their location is important to the understanding of prehistoric occupation and the functionality of this kind of site. Past water levels may also be important factors when understanding these sites as artefacts in the archaeological record that have undergone taphonomic processes, which have led to the current condition of the remains.

2.3. Marine crannogs: early research

Early notices and reports on marine crannog investigations can be assessed for information regarding the distribution, structure, function, chronology and environmental setting of such sites. Evidence from the records of early investigations of marine crannogs indicate that, as stated earlier, two groups of sites were located; one in the Beaully Firth and the other in the Firth of Clyde, and a further single site north of Oban, near the Isle of Eriska.

The early reports are useful when determining whether intertidal remains are marine crannogs, rather than naturally occurring geological features or other types of remains. Some of the reports include evidence of the variety of materials and structures found on these sites and lists of the small finds that were recovered. Aspects of environmental evidence were also recorded, albeit to the modern archaeological standard somewhat crudely.

Records of past investigations sometimes include the condition of the different remains when first uncovered. By re-examining the evidence of structures excavated in the past, and comparing them with the current remains, any alterations that have occurred may be recognised and tied in with factors such as erosion. Comparisons between the records of previous investigations and the current research may enable the rates of loss over a known period to be calculated. This could also help to quantify and identify the agents of destruction that may threaten these sites.

Accounts of organic remains recovered during the original investigations may be used to suggest characteristics of the environment when sites were built. Organic and inorganic deposits may also indicate palaeoenvironmental conditions and variations on or near the site. Any records of the sediments or deposits overlying the sites may contribute to an environmental history and be used as an indicator of post-depositional change, which has resulted in the current position of these sites in the intertidal zone. Surface deposits may also have acted to protect the underlying archaeology and this may vary from site to site.

Marine crannogs are referred to in a number of early works including the first *Statistical Accounts of Scotland*, the *Statistical Account of Scotland* and the *Third Statistical Account of Scotland*. Early Ordnance Survey maps and Admiralty Charts,

extracts from reports held by the Royal Commission on the Ancient and Historical Monuments of Scotland (RCAHMS), library archives and reports published in journals such as the *Proceedings of the Society of Antiquaries of Scotland* were also searched during research for notices of previous investigations. The following extracts and accounts from the above sources illustrate the early references to marine crannogs and they demonstrate the variety of interpretations for their origins and possible uses. They include examples of evidence of both structural and artefactual information and demonstrate the different approaches taken to investigate such sites.

2.3.1. Early records of marine crannogs in the Beauly Firth

In 1699, James Fraser, Minister of Kirkhill parish, near Inverness, described three marine crannogs in the Beauly Firth:

There are three great Heaps of Stones in this Lake, at considerable distance one from the other, these we call cairns in the Irish. One of a huge bigness, (in the middle of the Frith [*sic*]) at low water, is accessible; and we find it has been a Burial place by the Urns which are some times discovered. As the Sea encroaches and wears the Banks upwards, there are long oaken Beams of 20 or 30 Foot long found; some of these 8, some 12 or 14 feet under Ground. I see one of them 14 feet long, that carried the mark of the Ax on it, and had several Wimble bores in it. (Lowther 1699, 538)

Similar information was recorded a hundred years later in the *Statistical Account of Scotland* for 1799, and is of interest because it shows replication from that above. It is also interesting to note that the Beauly Firth is referred to as a lake, possibly a reflection of the author's perception of the tidal regime in the firth at the time. However, recognition that it was a tidal environment is reflected in the following account and confirms at what state of the tide the site could be visited:

There are three cairns at considerable distances, one from the other. The largest is in the middle of the frith [sic], a huge heap of stones. This cairn is accessible at low water. (Dunoon 1794, 426)

One of the most detailed accounts of the marine crannogs in the Beaully Firth was published in 1808 and describes the sites, some of their characteristics and their locations and possible uses. Discussion regarding the water levels that affected the sites is particularly interesting:

The cairns in the Beaully Firth are very singular, and merit a place among the antiquities of the county of Inverness. Two are much larger than the rest; one of these is opposite to Redcastle, and the other about two miles above the ferry of Kessack, and are said to be distinctly seen above the surface of the sea, during low water neap tides. In some of these, which are accessible, beams of wood have been found; in other, graves and human bones have been discovered occasionally; which leaves no doubt of their having been in former ages used as habitations both for the living and the dead; and consequently, of their being at that period dry ground. The most material circumstance, worthy of investigation is, why the good people of that country made choice in those days, of such inconvenient dwellings for themselves, or of such repositories to contain the bones of their departed friends? and why the sea covers this burying ground at present, which we may presume was not the case at the time, owing to the reluctance of all men at a watery grave? (Robertson 1808, 430)

Evidence of the names of marine crannogs demonstrates that authors had recognised the sites and that they were regarded as objects of antiquarian importance, even though their origins and uses were not necessarily known. The following account goes on to mention a fourth site in the Beaully Firth near the confluence of the River Ness and the firth:

There is, at some distance from the mouth of the river Ness, a considerable way within the flood mark, a large cairn of stones, the origin of which is of very remote antiquity. It is called Cairnairc, that is the cairn of the sea. (Sinclair 1981, 631)

This is the first recorded use of a name for one of the sites in the Beauly Firth and translation from the Gaelic suggests that the term 'airc' implies 'difficulty', rather than the explanation given in the account (MacIennan 1979). The site was possibly used as a warning of the tidal streams at the confluence of the River Ness and the Beauly Firth (Watson 1993). The site was also called a cairn which today implies a number of prescribed characteristics. Later references to the same site indicate that it was a large mound covered by stones and was situated above LWM at the mouth of the River Ness. It was also described as a navigation aid with a beacon situated on the top of it (Maclagan 1875, 89). Her report gave no indication of any first-hand investigation and is based on previous accounts and Maclagan's personal interpretation. The current location and conditions of the site are discussed in Chapter 4.

In 1882, Christian Maclagan visited one of the sites in the Beauly Firth and described it in some detail (Maclagan 1875). Antiquarian pursuits were not uncommon for Victorian women but Maclagan was of interest because she supported her researches by actively visiting sites and publishing her thoughts about their origins (e.g. Maclagan 1870-1871). She believed that one of the sites in the Beauly Firth was similar to a crannog in the nearby Loch of the Clans. The loch had been drained and consequently revealed two possible crannogs (Grigor 1862-1863). She described some of the remains of the Beauly Firth site thus:

Crannog in the Beauly Firth-- Nearly over against Red Castle, in the centre of the Beauly loch, stands the remains of the "Black Cairn", now only visible

at low tide. We visited it at low-water of the lowest tide of the year, and believe it to be a crannog greatly resembling one in the neighbouring "Loch of the Clans", but resting on larger stronger piles. Our boatmen declared they had often drawn out of it beams 9 or 10 feet long and 3 feet broad, fresh and fit for use. They had great difficulty in pulling them out, which they did by fixing their anchors in a log or pile. (Maclagan 1875, 89)

This account reveals the position of the site, its relationship with sea-level and describes some of the structural remains. It may have been as a result of this account and the description of extensive structures that the site became the focus of two early-twentieth century investigations, discussed below. Maclagan also calls the firth a 'loch', and contradicts that description with a reference to the tide level when it was appropriate to visit the site.

A different site was described in the first *Statistical Account of Scotland*, which gives a most accurate location and description of a site for that time, and it also included an indication of a possible structure:

To the south of Redcastle about 400 yards within the flood-mark, there is a cairn of considerable dimensions. Many of the stones, notwithstanding their collision through the violence of the tide, still bear the marks of art, and indicate the existence of a considerable building at some very remote period. (Dunoon 1794, 426)

This late-eighteenth century account is the source for some of the subsequent articles written and the similarities in some cases are unmistakable (Woodham 1954-1956, 85). It is also notable for the description of marked stones, perhaps a reference to dressed masonry. A brief account of the same site was described in vague terms by A. J. Beaton of Munloch, on the Black Isle:

At Milton village, is a heap of stones at a point considerably below high-water mark. (Beaton 1882, 480)

Later notices published about the sites in the nineteenth and early-twentieth century may have been as a result of use of the Beauly Firth as a route for boats between the village of Beauly and Inverness, particularly those carrying stone from the shoreline quarries (Baldwin 1986). The marine crannogs are reputed to have been used as navigation aids, possibly as beacon-stances in order that the shallow sandbanks were avoided (Ordnance Survey 1868). Intensive building works during this period included the construction of the Caledonian Canal, the northern end of which joins the Beauly Firth and which would have required quarried stone, possibly brought from the Beauly Firth quarries (Cameron 1972).

Robert Munro included the 'Black Cairn', in a list of Scottish crannogs in his book *Lake Dwellings of Europe* (Munro 1890). Additional to the description of the site was his earlier mentioned footnote discussing 'submarine' crannogs. This illustrated one of the questions central to marine crannog research: where in relation to contemporary water levels were they built? and also Munro's ability to identify the topographical variables that may have affected them.

In the summer of 1909, Odo Blundell visited Carn Dubh as part of his investigation of Highland crannogs, with the intention of diving to inspect the site (Blundell 1909-1910, 12). However, he discovered that the site was above low water mark and that he was able to get to it by boat and walk across the site. He described the site as standing approximately 1 metre above the surrounding sandbank and measuring 80m east to west and 60m north to south. He gave a general description of the surface cover stones weighing approximately 50kg each and recognised some smaller stones beneath the surface. A collection of unusual stones was explained as

dumps from vessels that had run-aground on the site. To him these stones were, 'Easily distinguished from the round boulders of which the island is built', (Blundell 1909-1910, 17). He also found a number of horizontal timbers beneath the surface stones and believed them to be wedged in by the overlying stones. One of the timbers was described as, 'A fine oak log, 9 feet long and two feet in diameter', (Blundell 1909-1910, 17). A second horizontal timber was sampled for further examination and it too was identified as oak. The timbers were described as, 'Running through a rubble building', (Blundell 1909-1910, 17). He also described the surface stones as part of an earlier building but did not explain why he thought the site would accommodate a stone building. His photographs published with the report provide an early record of the site and may be compared with one of those taken when the site was re-visited in 1994, as part of the current research (see Plates 2.1. and 2.2.).

Another investigation of Carn Dubh was undertaken by members of the Inverness Scientific Society and Field Club in 1936. A report and two accompanying photographs of the site visit are held by Inverness Museum and Art Gallery and are reproduced in Appendix A. The report describes the position of the site and its dimensions, though their measurements vary from Blundell's earlier calculations. This may have been because of the Field Club members noting that they had no compass accurately to fix Blundell's point of reference on-site.

The Field Club members' description of the surface remains are similar to the previous accounts. Excavation of a small trench in the south east corner of the site gives an indication of the sub-surface remains; interstitial sands and mud, and the depth to which the archaeology survived, over 0.7m below the surface of the site. A photograph taken inside the small trench shows a wooden pile *in situ* in the floor of

the trench, displaying evident cut-marks (see Appendix A). The excavated part of the pile appeared to have been cut to a tapered point. Other potential small finds discovered by the Field Club members included a possible whetstone. The stratigraphy and the location of the various finds are unclear on the basis of the report and photographs. However, the evidence from the trench does indicate usefully the depth of the archaeology preserved in 1936.

A survey of the archaeological remains of the Black Isle was carried out and published by Anthony Woodham and includes the marine crannog near Redcastle in a gazetteer of sites:

About 400 yds below high-water mark on the mud-flats to the S. E. of Milton village is a low cairn of stones of considerable size. Its position and the faint but quite definite remnants of a causeway leading to it, leave little doubt of this being a crannog. (Woodham 1954-1956, 85)

This account marks a departure from those previous ones because it associates the site with a causeway feature and Woodham classified the site as a 'crannog'. Another crannog that possessed both a stone mound and causeway leading to the shore was being investigated in another part of Scotland at the same time. In the year previous to Woodham's survey, C. M. Piggott had completed her excavation of Milton Loch crannog 1 (Piggott 1952-1953), and the publication of her report may have influenced Woodham's interpretation of the linear feature adjacent to Redcastle. Additional research into this feature was undertaken during the current research and is discussed in Chapter 7.

The documentary evidence discussed highlights the limited amount of research previously undertaken on marine crannogs in the Beaully Firth. Some of the

access issues faced by the early investigators are clearly described in their reports and indicates that most of the work was concentrated on Carn Dubh. The general position of four sites is confirmed and the relationship of two of them to the tide level suggested. The reports also reflected some details of the structural remains, the types of materials used and notably that the pile found on Carn Dubh had been cut using a metal tool. However, the results do not offer any further information regarding the function or chronology of the sites. On the basis of the reports, it would seem that the investigators were generally aware of the other sites in the firth despite the fact that only two of them were named during the investigations. The other sites have remained nameless until the current research began; Redcastle was named after the nearest shoreline settlement and the other two sites have also been named accordingly: Coulmore and Phopachy.

Finally, it should be noted that Carn Dubh was designated a Scheduled Ancient Monument in 1971, classed as a 'crannog or beacon-stance (possible)'. Despite this measure to protect the site, little is known about the origins, period of construction and use of Carn Dubh, and why it was built in such a location. Additionally, the factors that may affect a site in such a location and the archaeology are unknown.

2.3.2. Recent research on the Beaully Firth marine crannogs

Two of the marine crannogs in the Beaully Firth were the focus of the author's undergraduate dissertation, undertaken at the Department of Archaeology, University of Manchester (Hale 1992). During the course of the research, four sites were surveyed; Carn Dubh, Coulmore, Phopachy and Redcastle. Phopachy and Redcastle were the focus of sampling for datable evidence. Excavation of trial-trenches on both sites located sub-surface timbers that had been worked and

appeared to have been parts of structural remains. Two alder timbers from Redcastle and two from Phopachy were submitted to the Beta Analytic laboratory for radiocarbon assay and the resultant dates from Phopachy were: 1940 ± 60 BP (Beta-48765) and 2030 ± 60 BP (Beta-48766). The Redcastle dates were: 1750 ± 90 BP (Beta-48764) and 2150 ± 60 BP (Beta-48763) (Hale 1992, 1994), (see Figure 2.1. and Appendix E for calibrations). More recently Coulmore, Phopachy and Redcastle have been scheduled as protected ancient monuments, as 'crannogs' (Hingley R. pers. comm.).

2.4. Marine crannogs in the Firth of Clyde

A second group of marine crannogs is located in the Firth of Clyde. They were the focus for investigations at the end of the nineteenth century and beginning of the twentieth century. The sites are referred to here by any names given by their investigators and those that are un-named have been assigned a name, again, according to the nearest shoreline place-name or habitation.

Investigations in the River Clyde, near Glasgow Green in the early 1880s located the remains of an intertidal structure, during the excavation of a log boat. The following is an excerpt from the report and describes the location and remains found:

It [Point Island] is very small in extent, its extreme length being only some twenty-four yards, while it is fourteen yards broad. The eastern or upper portion of it consists mainly of a mass of stones superimposed upon a framework of piles and stakes, at one part of which traces of wattling are perceptible. At first it was thought that this framework extended under the whole islet, but our excavations in course of removing the canoe showed that this was not the case and that the larger portion of it consisted of an accumulation of ordinary clayey soil in which the canoe rested.

(Duncan 1883, 128)

This account indicates that a timber framework structure was found associated with a log boat, which may suggest the remains of a structure, possibly a marine crannog. The site was very close to Glasgow Green and much further upstream than any of those sites discussed below. Subsequently, as the river became canalised and dredged, the island disappeared and so too did the structures (Riddell 1979). This form of construction on tidal promontories or islands is illustrated in accounts of other early investigations of marine crannogs in the Firth of Clyde.

2.4.1. Dumbuck

Dumbuck was one of the first marine crannogs in Scotland to be investigated extensively. The various records of the investigations contain details of the location of the site, many of the structural features, and suggestions as to the possible functions of various structures and small finds. There are also records of the variety of small finds recovered during the excavation.

Dumbuck was discovered in 1898 by William Donnelly, a local artist from Dumbarton. The excavations of the site took place between July and October of the same year and were supervised by John Bruce, who later became President of the Society of Antiquaries of Scotland. During the excavations, the general public were encouraged to visit the site and visitors included notable academics of the period such as Robert Munro. Water-colour paintings by Donnelly, not only of the structure but also of the visitors and some of the small finds, give an additional insight into what it must have been like to visit the site while the excavations were in progress and what remains were discovered (NMRS box file 'Dumbuck') (Plate 2.3.).

Excavations on Dumbuck revealed a central circular, timber platform, which was approximately 15m in diameter (Figure 2.2.). This timber 'flooring' was covered by 30-45cm of estuarine sands and silts (Bruce 1899-1900, 437). According to Bruce, the flooring consisted of three layers of horizontals, the upper and lower layers had been laid radially from a central point, whereas the middle layer had been laid across those above and below it. In the middle of the circular structure was a 2m diameter wattle-lined pit. It was wattled on the sides and bottom with hazel rods and sails and had been infilled with stones (Donnelly 1898, 372).

According to a local geologist, John Campbell, who reported on a joint visit to the site by the Geological and Philosophical Societies of Glasgow, the clay within the wattle-lined pit was approximately 0.3m thick and was 'still watertight' (Campbell 1899, 269). Around the top of the pit were a number of stones which formed a coarse paving and protruding above the upper layer of horizontal timber and surrounding the paving was an indeterminate number of piles, the function of which is not indicated (Donnelly 1898, 372). Examples of jointing, mortise holes and piles in the circular timber platform were interpreted as representing methods of fitting vertical piles to the platform to form an upstanding building, the remains of which had disappeared.

Surrounding the timber platform was a ring of 27 piles spaced 2-3m apart which were identified as oak. Four to five metres beyond the circular timber structure was a stone and timber 'breakwater', which surrounded the site apart from on the north side. Bruce's account of the excavation describes the breakwater as consisting of horizontal timbers forming an inner lining which were held in position with piles. The core and outer edge of the feature was made up of large stones

(Bruce 1899-1900, 438) and it measured approximately 7m wide, although it was not recorded on the north part of the site.

From the centre of the site, leading westwards, was a 2m wide linear stone feature, possibly a causeway, laid on top of the horizontal platform timbers. Bruce claims that this feature was a 'rough but systematically laid pavement' (Bruce 1899-1900, 439) and from the plans broadened away from the site. A second all-timber causeway was described as having been positioned between the centre of the site and a dock feature.

The dock feature, in which a log boat was found *in situ*, was approximately 15m north east from the centre of the site (see Figure 2.3.). The dock consisted of an open-ended linear structure with piles and horizontal timbers that formed shuttered sides. The shuttering was found and recorded on three sides and the fourth was open, towards the south east and the main channel of the Firth. The dock was 15m long and 2m wide (Neilson 1905, 283) and accommodated a 10.84m long oak log boat (Mowat 1996, 26). The log boat was damaged during excavation, however, the remaining 10.1m was presented to the Glasgow Art Gallery and Museum, where it remains today (accession number GAGM 98-217a).

To the north west of the centre of the site, between the timber platform and the external breakwater, was a large worked timber (Plate 2.4.). This 'mortised log' (Bruce 1899-1900, 439) or 'ladder' (Munro 1905, 142) was 4.6m long, 0.4m wide and 0.1m deep. Along its length were six bevelled mortise holes, the first of which was 0.3m from the end. The six holes, spaced approximately 0.1m apart, measured 0.25m long and 0.2m wide and the final hole was 2m from the end of the timber. The purpose of this timber is unclear. Munro suggested in *Archaeology and False*

Antiquities (Munro 1905) that the timber could have been used as a ladder possibly between the outer breakwater and the inner timber platform.

The construction techniques used on the site were described by both Bruce and Munro. For example, the central wattle-lined pit which is a feature recurrent on other marine and freshwater crannog sites, both in Scotland and Ireland, was described in detail (see Chapters 7 and 10). Further interpretation of the structural remains found on Dumbuck are discussed in Chapter 11.

Some of the descriptions of Dumbuck and the surroundings include records of two streams on either side of the site. Drawings by Donnelly effectively show the site on the end of a short promontory formed by the two streams (Neilson 1905, drawing 1) . Evidence of this feature will be discussed further in Chapter 11 with additional information gathered from the current research.

Evidence from the site of palaeoenvironmental conditions is sparse from the previous investigations, although a number of indicators can be inferred. The horizontal timbers were covered by approximately 0.3-0.4m of estuarine sediments, consisting of sands and silts. It must be assumed that this surface deposit did not completely cover the site when first found by Donnelly, because Bruce described the site when first discovered:

When first discovered a few of the tops of the ring of oak pile stumps were just protruding from the sand and abraded to a point by the action of water and age. (Bruce 1899-1900, 437)

There also appears to have been a very fine layer of estuarine mud on top of the sands and silts. This was probably a highly mobile deposit which is characteristic

of the surface of shallow sedimentary bodies in intertidal environments and could have been deposited at various times, such as during each high tide. Surface estuarine sediments high in the tidal range, are regularly deposited and re-transported at each tidal flow and ebb (Evans 1965, 228).

Underneath the horizontal timbers were organic deposits of heather, bracken and brushwood (Munro 1905, 136). These remains may have been a deliberate deposit within the structure, placed by the builders possibly to level the underlying surface. Whether they mark a primary construction deposit is unclear from the report. The sediments beneath the organics were, 'Mud, loam, sands and gravel', (Munro 1905, 136). These sediments were noted when one of the piles was excavated. The pile was 1.2 m long and its cut-marked sharpened point penetrated an underlying deposit of clay.

The small finds from Dumbuck are one of the most remarkable aspects of the site. They can be divided into two categories; those believed to be genuine artefacts and a group of carved and inscribed stones and shells. This second group of finds led to a long-running and sometimes vitriolic debate between the excavators and a number of antiquarians. The objects were the subject of two publications; one book is about forgeries from many different aspects of archaeology, *Archaeology and False Antiquities* (Munro 1905), and the other dealt specifically with the objects found on Dumbuck and other marine crannogs in the Firth of Clyde, *The Clyde Mystery* (Lang 1905). The surviving small finds are held in store by the National Museums of Scotland in Edinburgh.

The contested finds are small carved stones and shells depicting various abstract designs and figurines (Bruce 1899-1900). These 'spurious antiquities'

(Morrison 1985, 70) which reflect the artistic talent of their perpetrators and include one piece that strongly resembles William Donnelly, have been identified as forged artefacts. However, re-examination of these finds indicates that although the carving and incision marks that form the elaborate features appear to have been added later, the un-marked stones could have been original to the site. Some of the pieces are perforated cannel coal which suggests that they may have been wasters from attempts to make bracelets, rings or other objects. Some of the less well marked pieces could potentially have been parts of rough stone tools, as recorded by Donnelly and others.

Whoever was responsible for the carving has yet to be established and may never be known. The identity of the forgers is complicated by the claims by the various investigators to have found different pieces at different times and all in context. For example, John Bruce found one of the largest disputed objects beneath the mortised timber (Bruce 1899-1900, 443). One possible explanation for the re-worked small finds was that the local press encouraged people to visit the site during the excavations and perhaps they were 'found' during visits by members of the public and academics. Nonetheless, the disputed objects remain interesting artefacts from the excavation and as a record of an important archaeological controversy. Similar finds uncovered on another early investigation on a Firth of Clyde marine crannog are discussed below.

Some of the other Dumbuck small finds had also been re-worked and included a long bone, possibly a cattle femur, which had a small worked stone inserted into its broken end. Another similar composite find was of an antler tine with a stone wedged into the cut end. Other animal bones were recorded during the excavations and included cattle, sheep/goat, pig, red or roe deer antlers and tines, and

a large incisor. The animal bones and remains were found mostly in the 'midden' deposit outside the platform piles. The cattle and sheep/goat remains consisted mainly of the long bones which had been split or broken and John Bruce suggested that they had been shaped to form sharp, possibly chisel points (Bruce 1899-1900, 440). Other long bone fragments had signs of wear and may indeed have been used as tools. Inspection of the finds recently found that one small fragment of rib bone had simple linear striations across the width of the bone and may have been genuine markings, possibly as a result of butchery practices.

Three flint scrapers and a 0.5m diameter rotary quern were also discovered during excavations on Dumbuck. Beneath the quern were a number of ground and whole acorns and hazelnuts, some of which were recorded as being burnt (Campbell 1899, 270). Adjacent to the quern was a wooden object described by Donnelly as a 'driving bar', it was 0.8m long, 0.07m wide and 0.01m thick (Donnelly 1898, 369). Unfortunately, it did not survive the excavation and its purpose remains unclear. A saddle quern and rubber were also noted by John Campbell, who recorded six wooden objects, described as:

Of an oval shape, like an almond, all sizes, from 19 inches in diameter and 4 inches thick. (Campbell 1899, 270)

The purpose for which these wooden objects were designed is unclear and from the description it is possible that they may have been rounded by prolonged movement in water. Other organic small finds held in the collection included a worked limpet shell, a pair of oak apples and some charcoal fragments.

2.4.2. Langbank

The position of two sites on the southern shore appear to have been confused since the excavation of one of them at the beginning of this century. One site investigated was called Langbank, and a report published by John Bruce who had earlier investigated Dumbuck, referred to the site as being:

About 50 yards from high water mark, in a line due north from the West Lodge of Erskine House. (Bruce 1908, 44)

Unfortunately, the West Lodge of Erskine House no longer exists. The exact location of the site is, as a result, unclear. Bruce's account of the investigation and records of later work by John Hunter of Paisley Museum in 1977 (C. Batey pers. comm.) has enabled the following description of the remains of the site to be compiled. Recent fieldwalking and discussions with members of the Renfrewshire Local History Forum has identified the site excavated by Bruce as that on the southern shore opposite Dumbarton rock (see Chapter 4 for the exact location).

Excavation of the site took place over two fieldwork seasons, starting in October 1901 and continuing between September and October 1902 (Bruce 1908). Bruce recorded that the site was located on an island, known as the Baby Island, which was severely eroded and only the remnants of turf were found. A committee of eight was appointed to oversee the investigation on Langbank, probably to ensure any small finds were genuine to the site and to prevent a situation similar to that when the re-worked objects were found on Dumbuck occurring.

Records of Bruce's excavation reveal that he found an oval structure of horizontal timbers surrounded by a ring of piles, spaced approximately 1-1.5m apart and similar to that of Dumbuck (Figure 2.4.). The wooden structure was

approximately 15m in diameter and consisted of cross-timbers which were covered by estuarine sand and silts. Although the outer piles were protruding above the surrounding sandbank on the northern side of the site, on the western edge they could only be located by excavation. The surrounding piles were all identified as oak and the horizontal pieces were a mixture of:

Beech, mountain ash, alder, fir, and birch, also hazel. (Bruce 1908, 45)

The timber construction techniques were recorded during the early excavations and included the piles fixed to horizontal timbers by means of forked features and mortise holes. Between each pile, tree trunks were placed horizontally forming an oval surround, roundwood pieces apparently chosen for their natural curve formed the margin of the platform. A semi-circular feature, 1-2m to the east of the site consisted of piles driven into the underlying clay and fixed with pegs was tentatively compared with the Dumbuck dock structure. However, no conclusion was reached about this structure. Bruce recorded that the structural remains were found during the first season of excavations in 1901 and that other structures, such as the piles mentioned above and further small finds, were discovered in the second season.

To the east of the wooden platform was a midden feature, which contained a large quantity of animal bones, broken shells and a number of other objects. The majority of small finds were recorded as coming from this area (Bruce 1908, 45). The bones are mainly of cattle, red deer, roe deer, pig and sheep/goat, including both burnt and unburnt examples. Specific bones of all the species were identified and a number are of particular relevance. Approximately 60 fragments of cattle mandibles and many broken long bones were analysed by Thomas Bryce (in Bruce 1908, 49-51). He suggested that the animals had ranged in age from immature to mature examples. A skull fragment of a hornless animal was found and eight others still

showed their horn cores, reflecting the presence of young animals. Bruce suggested that some of the long bones had been used as tools. Other bones included red deer skull fragments, roe deer bones, pig mandibles and other remains. There was also a collection of sheep/goat limb bones, consisting mainly of metacarpals and metatarsals. The use and interpretation of the faunal remains from this and other marine crannogs are discussed in Chapter 11.

John Bruce also recorded four pieces of stone, two of which showed engravings similar to those on the questionable pieces from Dumbuck (Bruce 1908). Two other pieces of cannel coal had also been worked and had perforation depressions on their edges (Bruce 1908). Re-examination of the finds held by the National Museums of Scotland in Edinburgh, suggests that two pieces of cannel coal with no evidence of engraving are genuine artefacts and are again wasters from stone working similar to those pieces from Dumbuck. The two engraved pieces may also be wasters that were re-worked at some time later. It is interesting to note that the two engraved pieces were found by John Bruce during the first season of fieldwork when none of the committee members were on-site. From the recurrence of similar objects it would appear that some of those people involved in engraving the Dumbuck objects may also have been involved during the Langbank excavations.

The only diagnostic finds, an inscribed bone comb and a bronze penannular brooch, were found in the 'refuse mound' (Plates 2.5. and 2.6.). The comb has been compared with a similar one found at Ghegan Rock near Seacliff, East Lothian, which was dated in association with late Roman objects (Bruce 1908, 46). More recently the comb has been dated on stylistic grounds to the first century AD and classed as a single-sided A1 design, after MacGregor (Foster 1990). The brooch was dated to the Early Roman period by C. M. Piggott (1952-1953, 150) and the design

is similar to Fowler's type A, Aa or A1, also attributed to the first or second century AD (Fowler 1960).

Other small finds recently re-examined, included three pieces of worked stone that had engraved linear marks, a perforated and engraved oyster shell, and three antler tines, which showed signs of both wear and cut-marks. A collection of finds said to be associated with the site included a fragment of burnt bone, a gastropod shell, broken mussels and small fragments of wood. A small piece of burnt rope was also recorded as being associated with the site (MacGregor 1976).

2.4.3. Old Kilpatrick

A third site in the Firth of Clyde was discovered on the northern shore close to Old Kilpatrick. The site is located just before the river begins to broaden and flow in a westerly direction. It is marked on a map entitled 'Plan of River Clyde near Erskine Ferry at 1840', Glasgow City archive accession number T-CN 14/459/3 (Figure 2.5.). The map was produced in 1906, after an intensive period of canalisation of that part of the river and enabled the general position of the site to be re-located prior to further land reclamation on the shoreline, which has since obscured the site (Riddell 1979).

Excavation of the site occurred prior to the construction of Napier and Miller's shipyard, in 1906. No written records exist of the excavation but there are a number of photographs held by the RCAHMS in the NMRS of the site, during excavation and Glasgow City archive library holds a series of maps and plans of the site. They include hand-painted plans and sections of the site and its surroundings, executed before and during the excavation. The following descriptions are derived from re-examination of those documents.

From a plan held by Glasgow City archive the site was calculated to be approximately 25m long and 20m at the widest points (Figure 2.6.). The site was roughly oval in plan with the long axis aligned north to south and parallel with the flow of the river. One of the plans, dated 1840, indicated that although the site was within the flood plain of the River Clyde it was approximately 15m inland from mean high water mark (MHWM) and approximately 40m from mean low water mark (MLWM). The large scale plan shows the site situated between the 1-2m contour lines and the southern edge sloping to below 1m above Ordnance Datum.

In June 1906, excavations on the site and a section drawing show that it was situated between high and low water marks (Figure 2.7.). Whether the change in position of the site over 67 years, since the first plan was in account of survey inaccuracies or a change in tidal extent because of the substantial changes and dredging of the inner Firth of Clyde is unclear. Alterations at the same time to the main channel of the inner Firth of Clyde between Dumbarton Rock and Glasgow could have accounted for a localised change in the extent of the area affected by the tide (Riddell 1979). In the case of the Old Kilpatrick site, the building of training walls on the shores of the firth may indeed have led to the area of low-lying land in which the site was built to become inundated.

Reconstructing the physical remains of the site is complemented by photographic evidence available from the NMRS. The photographs were taken while the land was being cleared, during the construction of the shipyard. One photograph shows the upper 1m of two vertical piles with large mortise holes cut approximately 30cm below their tops (Plate 2.7.). Next to the piles are two horizontal trunks with their ends shaped to points and showing cut-marks. These may originally have been

fallen piles, suggested by their pointed ends. Between the shore and the River Clyde, on either side of the mortised piles, was a straight line of piles and a number of very large trunks (Plate 2.8., in background). The trunks show little signs of working, with the exception of their ends, which may have been cut or eroded flat. The exact relationship between the piles and the large trunks remains unclear from the photographs.

One of the Glasgow City archive accessions is a plan of the excavated structural remains of the site at 2¹/₂ inches to 10 feet scale (Figure 2.8.). It is a hand-painted plan showing the horizontal timbers and piles with careful detail of the grain direction, knot-work and construction features. Large scale sections were included on the plan and this is the most complete record of the structural remains.

Evidence from the plans and photographs of the site indicates that the remains were distinct from previously excavated freshwater crannogs, such as the Buiston site (Munro 1882). The remains appear to form a curvilinear structure with parallel rows of vertical piles between worked, horizontal timbers, branches and trunks. Adjacent to some of the timbers are lines of stones, suggesting that they were integral to the wooden structure. Occasionally a timber was located lying between the parallel rows, which may have acted as a bracing timber. There was an accumulation of brushwood towards the north west of the site. The plan of the site was incomplete because a number of areas have been disrupted by dredging, to the extent that the timbers were removed.

Particular aspects of the construction techniques can be identified from the plans, sections and photographs, especially those shown in Figure 2.8. Four of the horizontal timbers contained mortise holes, cut near their ends and three further

horizontals showed the remains of mortise holes. Through the complete mortise holes, which were placed one above the other, was a vertical pile. The pile appears to secure both the upper and lower horizontals together. The same section drawing also showed the use of external retaining piles. They appear to have been used to help maintain the position of the horizontal timbers. The same figure shows a section excavated through the site approximately east west. The plan part of the figure displays a number of timber remains including the largest oak trunks nearest the River Clyde with a number of horizontal trunks inland.

A brief report on some of the small finds was included in Graham Callander's article on the vessels and associated remains found on the Culbin Sands. The report specifically referred to some of the organic finds from the site:

Carbonised, unthreshed ears of barley and many other seeds were recovered from the crannog or pile structure at Erskine ferry, Old Kilpatrick, in 1906. (Callander 1911, 164)

These organic remains were part of a larger sample of grains, stalks, charcoal, pips and other plant macrofossils and small finds which were also mentioned in the 'Palace of History: catalogue of exhibits', from the Glasgow exhibition in 1911 (Scottish Exhibition of National History, Art and Industry 1911). A sample of the organic remains was re-located in the Kelvingrove Museum, Glasgow, and recently analysed by Camilla Dickson of the Department of Botany, University of Glasgow. Her unpublished report is reproduced in Appendix B. The exact location of where the sample was taken from is unclear, however, from the report it is clear that the remains were well-preserved and identifiable. A sample of the charcoal from the organic remains was submitted for radiocarbon dating and the resultant date was 2390 ± 50 BP (GU-2154) (C. Batey pers. comm.). Recent

radiocarbon dating of a fig pip found amongst the sample showed that it was a modern intrusive find (Dickson & Dickson 1996, 631).

Other remains from the Palace of History exhibition list included; stone polishers, hammers and rubbers, a number of wood-chips, pegs and piles. Also amongst the collection were the remains of some wattle fragments and a sherd of Roman Samian pottery (Scottish Exhibition of National History, Art and Industry 1911, 864). The fragment was from an unidentified context and its position and association with the construction and use of the site are limited. The close proximity to the Roman fort at Old Kilpatrick and the western end of the Antonine Wall may indicate use of the site during the 2nd century AD. The difference between the radiocarbon date of the charcoal fragments and the Roman sherd may thus indicate a primary phase and later re-use. The use of the site and the chronologies of the Firth of Clyde marine crannogs is discussed further in Chapter 11.

2.4.4. Erskine

Erskine was investigated by Dr. Bill Hanson of the Department of Archaeology, University of Glasgow and John Macdonald of the Association of Certificated Field Archaeologists, Glasgow University (Hanson & Macdonald 1985). The investigation of the site focused on assessing whether Erskine marine crannog was associated with the end of the Antonine Wall and the Roman presence in the area. The site is situated 150m north of MHWL, adjacent to MLWL on the edge of the main river channel. The investigations by Hanson and Macdonald consisted of clearing surface stones and sediments to expose the upper timber components of the site. These were planned using photogrammetry and the resultant plan reflects a number of structures (Plate 2.9. and Figure 2.9.).

The oval plan of the site is approximately 40m long and 27m wide. The long axis is aligned east west, parallel to the river flow. The site is covered with stones overlying smaller pebbles and cobbles. Among the stones are both horizontal and vertical timbers. From Hanson's plan, the site appears to consist of timbers surrounding the south, east and northern peripheries with a concentration of radially aligned timbers in the north and east. The radial timbers were laid horizontally and some of the external piles are tilted with their tops towards the centre of the site. Perpendicular timbers have been planned between a few of the radials. Some of these showed signs of working; two had been cut into half-checks and two had been held together with mortise holes at their ends, with a vertical post through the hole. The only small find recovered was a fragment of a rotary quern found on the surface of the site.

The investigations by Hanson and Macdonald suggest that aspects of the surviving structural remains on Erskine may be compared with those found on Dumbuck and Langbank. However, variations within the three sites can also be recognised. For example, they all possessed circumferential piling enclosing horizontal timber platform areas, but the piling around the Erskine site appears to mark the limits of the remains, whereas Dumbuck's platform was surrounded by the stone breakwater, outside the ring of piles. The rotary quern suggests that processing may have been an activity that took place on Erskine, however, without further excavation the conclusions that can be reached about the site and its function are limited.

The wooden remains on Erskine were sampled during the 1985 survey to apply both dendrochronology and radiocarbon dating techniques (Hanson W. pers. comm.). However, after species identification of the samples by Dr. Anne Crone,

had been carried out, the samples proved to be unsuccessful for dendronchronological analysis (Crone A. pers. comm.). Four samples were submitted for radiocarbon dating to the Scottish Universities Radiocarbon Research Centre (SURRC) and the results were: 1950 ± 50 BP (GU-2328), 1970 ± 50 BP (GU-2187), 2170 ± 60 BP (GU-2383) and 2210 ± 50 BP (GU-2186) (Barber & Crone 1993, Hanson W. pers. comm. and see Figure 2.1.). Despite the lack of suitable material for dendrochronology it is interesting to note that all of the horizontal timbers sampled were identified as alder (*Alnus* sp.) and the five piles sampled were all identified as oak (*Quercus* sp.) (Crone A. pers. comm.).

2.5. West coast marine crannogs: An Dòirlinn

This site is the earliest marine crannog to have been investigated in Scotland, in 1884 and demonstrates that other sites which are not necessarily located in groups may be on the west coast of Scotland. It should be noted however, that this thesis is primarily concerned with the two groups of sites in the Firth of Clyde and the Beaully Firth and that further investigation of the potential of the west coast for single sites is envisaged for the future.

The excavation of An Dòirlinn seems to be one of the first instances of archaeological research in the intertidal zone in Scotland. In September 1884, Robert Munro visited Eriska, 20 miles north of Oban, with the intention of assessing whether the site was an artificial island (Munro 1884-1885). He had been alerted to the presence of the site by J. Meliss Stuart, who was about to build a bridge on to the Isle of Eriska and had dug some small trenches into the site and recovered burnt bones, charcoal and large timbers (Munro 1884-85, 192) Munro re-excavated one of Meliss Stuart's trenches and extended it in a north south direction from one side of the site to the other and published his findings in the *Proceedings of the Society of*

Antiquaries of Scotland. The following is an interpretation of his investigation and analysis of the structure and origins of the site based on his report.

The site lies on a sandflat in a sheltered bay on the north shore of the narrow firth called An Dòirlinn, which separates Loch Creran from the Firth of Lorn. The site will hereafter be referred to after the name of the firth. It lies approximately 45m from the southern shore of the Isle of Eriska and 90m from the shore of the mainland. Munro's description of the location suggests that the site was situated on the edge of a raised sandbank:

On its west side, after the tide retreated, there remained some stagnant water, and on the south and east side the water-bed is somewhat lower than that which intervenes between it and then north shore of the island.
(Munro 1884-1885, 192)

The surface morphology of the site is similar to some of the other known marine crannogs described above and consists of an oval mound covered by stones and estuarine sediments. Records of the first excavation describe worked and unworked structural timbers positioned towards the centre and around the edge of the site. When Munro visited the site the trench edges had been eroded by tidal action but the same trench was re-excavated and continued through the site from one side to the other.

In the centre of the site were layers of timber mixed with brushwood and the margin timbers were sometimes laid in pairs. The timber remains in the centre were approximately 1m below the surface estuarine sediments and stones, and overlying fragments of timber and brushwood. The timbers on the margin were only one layer deep and Munro noted cut-marks on some of the pieces and what appeared to be a

saw-cut on one. The absence of any peripheral piles is noticeable from the early descriptions and indicates the limited value of structural interpretation from a single trench. Excavation beneath the timber remains uncovered estuarine sediments and he described them as follows:

A soft clayey substance was turned up similar to that of the surrounding seabed. (Munro 1884-1885, 194)

Unfortunately, little can be concluded from this description of the underlying sediments and the type of foundation on which the site had been built.

Fragments of burnt bone, ashes and charcoal were uncovered in the trench approximately 0.1m below the surface. The association of these finds with the horizontal wooden structure 0.8m further down is unclear from Munro's account. A further concentration of animal bones was found outside the timber remains on the western margin of the site, 0.6m below the surface deposits. The bones were from both sheep and cattle and some had been broken. They were found in association with a scatter of ashes, just outside the timber remains of the site.

Munro's succinct description of the site reflects the brevity of the investigation and the inferences that can be drawn are, as a result, limited. Peripheral piles that were noted on the two Firth of Clyde sites were not found during the excavations on An Dòirlinn and may therefore indicate different structural components and further investigations would be necessary to develop Munro's interpretation that:

A stagnant marsh existed here in former times, sufficient to afford protection for a fort or crannog, before the sea encroached upon it to the extent it now does. (Munro 1884-1885, 195)

Part of Munro's article was developed from an oral report by G. McKenzie, who also helped during the excavations and gives one explanation as to the origins of the site. Munro recounts MacKenzie's letter in which a thief called 'Thick Sandy' had stolen cattle from the island of Eriska (Munro 1884-85, 195). He was shot on the site of the cairn and had been buried there. McKenzie also mentioned that the firth was fordable 18m to the east of the site, during low tide. This suggests that a local, natural event or events have led to the submergence of the site since it was constructed and evidence of geomorphological changes affecting the location of marine crannogs are discussed in Chapter 11. Finally, the name An Dòirlinn translates from Gaelic as 'the place of the fist' (MacIennan 1979). This may be a reference to the size of the stones that cover parts of the firth, were found on the surface of the site and the surrounding shorelines.

2.6. Conclusion

The previous investigations of marine crannogs discussed illustrate that the diversity of remains preserved in the intertidal environment on the east and west coasts is extensive, despite the apparent destructive nature of the tidal environment. The location of the marine crannogs have posed different environmental constraints on the investigators, such as the limitations of time on-site and the methods by which the sites were accessed. However, as Odo Blundell discovered on Carn Dubh these sites can be reached during low water periods.

Notices and reports of previous investigations illustrate the continuing problem with marine crannogs; that there have been too few excavations and that some of them took place too long ago to be of conclusive use in making definitive statements about these sites. However, common factors in the structural remains on some of the Firth of Clyde sites illustrate that possible similarities within that group

exist. The lack of detail with regard to structural remains of the Beaully Firth group means that structural comparisons cannot be drawn conclusively at this stage.

Given the proximity of the sites to one another in the two groups, the implications of their chronologies are an important aspect for the current research. The preliminary radiocarbon dates from Erskine and the diagnostic finds from Langbank East, in the Firth of Clyde and radiocarbon dates from Phopachy and Redcastle in the Beaully Firth, indicate a general period for their use, during the later Iron Age. On the basis of the early report it would appear that An Dòirlinn was not part of a group.

The imbalance between the information on the two groups of sites is a result of the focus of previous investigations on the Firth of Clyde sites. They were the focus for a series of investigations in the later part of the nineteenth and early twentieth century, whereas the Beaully Firth sites have only been reported infrequently and very little intrusive fieldwork was carried out on them. The imbalance shows a relative paucity of evidence from the Beaully Firth sites and a variety of evidence on structural form, associated artefacts and chronological indicators from the Firth of Clyde group. This suggests that further research into the Beaully Firth group could result in evidence that has been disturbed by fewer previous investigations.

Finally, despite Munro's early statement regarding water levels and the original position of marine crannogs, this aspect of the origins of these sites does not seem to have been a major aspect to the previous investigations. Results of the initial investigations of Old Kilpatrick, with the help of the surveys of the River Clyde, enabled past shorelines to be reconstructed, but the original relationship between

marine crannogs and contemporary water level when they were built remains unresolved.

CHAPTER 3

Marine crannog survey methods and fieldwork adaptations

3.1. Introduction

This chapter describes the methods developed and used to locate or re-locate, and survey existing marine crannogs. The sites in the Beauly Firth, the Firth of Clyde and An Dòrlinn, Eriska have all been surveyed individually. The methods used and adaptations necessary for survey in the intertidal zone are presented in this chapter. Access times to each site were, for example, very much dependent on the tide level relative to the height of the individual sites. The transportation of survey equipment across mudflats, sandbanks or tidal channels required practical solutions that will be outlined below. The photography and recording of the marine crannogs also needed adaptation to the intertidal environment.

3.2 Methods and techniques: documentary searches

Records of previous surveys in the Firth of Clyde included plans of Dumbuck (Bruce 1899-1900, Munro 1905) and Erskine (Hanson & Macdonald 1985), which showed structural remains and other surface features, as outlined in Chapter 2. The first aim, therefore was to re-locate all sites previously recorded on maps, Admiralty Charts or from the past investigations in the Beauly Firth and the Firth of Clyde. Each site would then be visited either on foot by walking across the intertidal zone or by boat. Fieldwork on the individual sites would include surveying the location of the remains into the National Grid and levelling them to shoreline Bench Marks (BM), in order to obtain their position relative to Ordnance Datum (OD). Individual

surveys were carried out to record the surface remains of each site at a common scale, and to record the intertidal and supratidal topography surrounding them.

Maps and aerial photographs held by the Royal Commission on the Ancient and Historical Monuments of Scotland, National Monuments Record of Scotland (RCAHMS, NMRS) were consulted prior to the fieldwalking to ascertain if marine crannogs had been recorded in the past and, if so, where they were situated in their respective firths. Ordnance Survey maps of the Beauly Firth showed that over the past 200 years only two of the five sites; Carn Dubh and Redcastle, had been recorded. Currently, only the site near Redcastle, on the northern shoreline is marked and indicated as *Crannog* on the Ordnance Survey 1:25,000 scale map, sheet NH44/54. Carn Dubh is also recorded on the Admiralty Charts of the Inner Moray Firth, number 1452, possibly because it could represent a hazard to boats using the Firth. In the Firth of Clyde, none of the sites were recorded on the past or current Ordnance Survey maps. However, Langbank West and Dumbuck were documented on an Admiralty Chart (1995, sheet 2007 A). An Dòirlinn is recorded on the current 1:25,000 scale Ordnance Survey map and is marked as a *Crannog* (OS map sheet NM 84/94).

In the Beauly Firth the dimensions of Carn Dubh had been recorded by Odo Blundell in 1909 and subsequently by James Fraser in 1936. Their respective measurements of the long and short axis of the site differed and may have suggested possible alteration to the surface deposits between the two dates or that the dimensions may not have been wholly accurate, as stated in Chapter 2 by Fraser in his letter (see Appendix A). In the Firth of Clyde, Dumbuck crannog was recorded and drawn by William Donnelly during the initial excavations in 1898, and later by Robert Munro in his book *Archaeology and False Antiquities* (Munro 1905, 143).

During the current research the sites were re-surveyed to record any changes to their surface morphologies that may have occurred during the past 100 years and to provide a contemporary record. Comparison between the previous and current surveys may also allow changes to the sites to be recognised over a given period of time.

3.3. Aerial Photography

Aerial photographic survey is an excellent tool for locating sites in the intertidal zone (Strachan 1995). However, it is necessary to combine low tide, available daylight and favourable weather conditions which, of course, may not all coincide on the same day. This therefore can reduce the amount of days and time of the year when aerial photography can take place successfully in the intertidal environment. Problems may also be caused by prevailing weather systems and atmospheric conditions which can ensure that tides do not fall to their predicted level and consequently the sites and their surrounding topographies may remain submerged. Despite the large number of aerial photographs of the Scottish coastline, for example, the Fairey Coastal Strip Survey, begun in 1975 (RCAHMS NMRS), few photographs were taken of the Beauly and Clyde Firths during low tide periods.

Prior to the current research, the marine crannog sites that were photographed included those in the Beauly Firth by Professor Barri Jones of Manchester University (Hale 1992) and as the previous chapter noted the Erskine site, in the Firth of Clyde. Those aerial photography surveys that did capture marine crannogs included the Ordnance Survey photographic survey between 1966 to 1967, which include the four sites in the Beauly Firth (NMRS Aerial Photographic collection, catalogue number 2654/704, frame number 002 1967). Part of an aerial photograph of the Beauly Firth,

showing the Redcastle site is included as a plate in Volume II, to illustrate the value of such records when conditions are favourable (Plate 3.1.).

Public aerial photographic coverage of part of the inner Firth of Clyde is incomplete owing to a possible military installation on the shoreline adjacent to Dumbuck. However, colour aerial photographs are available of the rest of the Firth from the Fairey Coastal Strip Survey taken in 1975. The survey was designed to record all of the Scottish mainland coast at 1:10,000 scale and Langbank East, Langbank West and Erskine were recorded during the survey (NMRS Aerial Photographic collection, catalogue number 7343, frames 30368-70 and 30375-78). An Dòirlinn was recorded during the All Scotland Survey (1967), on catalogue number 63688, frames 047 and 048, in the NMRS aerial photographic archive.

3.4. Survey methods

Each site was surveyed at 1:100 scale to provide comparable plans. As well as recording the visible margins, the surveys also recorded all surface deposits, features, such as timbers and any other adjacent remains. The results of the surveys were then used as part of the marine crannog database (Table 3.1.). Surveys of the sites at 1:100 were carried out by setting up a theodolite or electronic distance measurer (EDM) off-site. In the Beaully Firth, none of the sites could be surveyed at 1:100 scale from a shoreline survey station position owing to the distances between the sites and the adjacent shorelines, and the instruments were therefore located off-site in the intertidal zone. However, in the Firth of Clyde all but Dumbuck, were surveyed from MHW. The survey station for Dumbuck was again located between the site and the adjacent shoreline. An Dòirlinn was surveyed from a point between the site and the MHW and the EDM was placed on firm intertidal sands and gravels.



The intertidal zone often appears as a flat, homogeneous surface that slopes from MHWL towards MLWL and any changes in the micro-relief are difficult to recognise by eye alone. Further inspection of the surface deposits of the intertidal zone may reflect underlying geological variations which cannot be detected without employing survey techniques that record any changes in the topography. A survey with the aim of recording the micro-relief surrounding each marine crannog was carried out using an EDM total station (Leica TC 1000 and 1010). The instrument was programmed to record northing, easting and height co-ordinates (X, Y, Z) for each survey point chosen. The data was entered into the computer software programme Penmap, which was used to plot a two dimensional image of the sites from the three co-ordinate data. The programme was used to produce a data-terrain image of each site within its surrounding intertidal zone. The images also depict any variations of micro-relief by showing contour lines at chosen intervals. The absolute height of the sites and the contours were all adjusted to OD. The margins of the sites and features on the surrounding sandbanks or mudflats, such as drainage channels, streams and palaeo-channels were surveyed. One of the advantages of using the Penmap programme was that the contour increment could be altered to enhance any distinctive features such as breaks of slope. It also allows large quantities of survey data to be entered directly in the field to a computer and a composite picture built up as the survey progresses. This allows any alterations or areas that required additional detail to be re-surveyed during a single low tide.

Given the nature of the intertidal environment and the diurnal as well as seasonal changes in water level, adaptations to terrestrial survey methods and specific types of equipment are necessary for marine crannog research. Initially it was thought that they could be surveyed using underwater techniques, such as those

described by the Nautical Archaeology Society in their guide to underwater archaeology (Dean *et al.* 1992). Snorkel survey around Redcastle during high tide indicated that large quantities of sediment are disturbed by the tide and the visibility is reduced to less than 0.5m. This is due to the mobile sediments on the surface of the mudflats and sandbanks that became suspended during periods of submergence. Subsequently survey took place during low water periods that posed a different problem, which was site-dependent. In the Beaully Firth, Redcastle can be reached by walking across mudflats, however, Carn Dubh, Coulmore and Phopachy can only be reached by boat. In the Firth of Clyde all of the sites can be reached on foot as can An Dòirlinn.

Low water survey in the intertidal zone is dependent on three main factors; the height and position of the site and the area being surveyed, the height of the tide and the direction of the prevailing wind. These delimit the amount of exposure and therefore work-time on the individual sites, which are given alongside the results of each site survey in Chapter 4 and in the marine crannog database in Table 3.1.

3.4.1. Ordnance Datum

All the sites re-located were surveyed into OD; a level originally defined between 1916 and 1921, during which time the mean sea level was calculated from the average of hourly observations at Newlyn in Cornwall. The levels were connected with a number of shoreline bench marks and can therefore be calculated for the whole country. Mean sea level (MSL) cannot be regarded as unchanging over a long period of time (>100 years) (Dyer 1979). It is widely accepted that isostatic uplift and sea-level adjustment is a continuing process in Scotland (Sissons 1967) and therefore the absolute level of the bench marks surrounding the Beaully Firth and the Firth of Clyde may have altered since they were first positioned. However, the

accuracy of the marine crannog surveys was checked over three years. All of the sites were surveyed into two shoreline bench marks and, if possible, three were used to ensure accuracy. During the surveys discrepancies of the registered height of the bench marks were noticed and subsequently an error bar of $\pm 0.1\text{m}$ is incorporated into all levels. The reason for the discrepancies of the levels between the bench marks was probably because of the settling of walls and the re-building of some features in which the marks were incorporated. A global positioning system (GPS) was used to check the theodolite references although it could only guarantee accuracy to within 50m and was not accurate enough for heights relative to Ordnance Datum.

3.5. Photography

General photographs of marine crannogs are best achieved from aerial positions, as stated earlier. Photography from any position above the site is therefore impossible without the aid of specialist equipment. A photographic tower is one solution and this method was applied to Dumbuck with some resultant problems, for example, independent foot-plates were needed to prevent the tower from sinking into the intertidal sediments. This method of photography and additional supports was appropriate for photographing Dumbuck which was close to the shoreline and surrounded by relatively firm sands (the results are shown in Plate 4.5.). However, a photographic tower would require more substantial foundations at a site such as Redcastle, which is surrounded by deep and unconsolidated muds and can be penetrated to about 1m in depth if pressure is applied.

Another consideration when photographing marine crannogs, or other sites in the intertidal zone, is the problem of foot-prints in the surrounding sediments. These can disturb intertidal sediments and draw attention away from the archaeology,

especially when site remains are partially covered by mud and are difficult to distinguish from intertidal surfaces. A precise route for all photographers should be planned and all general photographs of the site in its local context should be taken before other fieldworkers are on site. This method ensures that the photographs of intertidal surfaces are not disturbed by foot prints. A permanent off-site platform, designed to be raised above the high water mark, to provide room for researchers and equipment, could also be used for photographing parts of the site from an elevated position, in future projects.

On-site photography of the surface remains and any sampled areas can be practised similarly to terrestrial archaeological photography. However, owing to the grey colour of much of the intertidal and on-site sediments colour photography is useful in recording the different remains to ensure contrast and definition is captured. Colour photography is also an important medium with which to record organic remains that may discolour once exposed to light and air. Black and white photography remains a standard method when recording larger areas, structures and finds.

3.6. Tides

Tidal differences can affect site access for fieldwork, both diurnally and seasonally. The March and September tidal equinoxes are two periods of the year during which the lowest and highest astronomical tides (LAT and HAT) are recorded, and in areas with shallow gradients much more of the intertidal zone may therefore be exposed or submerged. During the lunar cycle, spring tides are recorded after the new and full moons and the tidal amplitude increases. During neap tides, the minimum tidal amplitude is experienced (Hardisty 1990). Consequently intertidal fieldwork timetables are dictated by the coincidence of low water periods and

daylight hours and enhanced in account of additional exposure times during spring and low astronomical tides. The spring tides allow for the longest exposure time of intertidal sites and especially those located towards mean low water mark. The fieldwork seasons conducted during the course of this research were mainly programmed to coincide with the longest daylight hours during June, July and August. However, during other periods of the year fieldwork was also carried out, during which time the access variations became apparent.

The movement of the tide over each site has an affect on the standing remains, which is reflected in the results of the surveys and the erosion survey of one particular site (see Appendix D). Tidal currents are generally at their highest velocities during mid-tide, this means that any sites in contact for a prolonged period with mid-tide streams could be subjected to greater rates of erosion (Hardisty 1990, 75). Sites that are well away from the tidal streams, i.e. nearer MHW and surrounded by extensive tidal flats could therefore contain larger quantities of archaeology given the reduced contact with the erosion forces of the ebbing and flowing tides. Conversely, sites close to tidal streams, especially those located close to MLW, which may also be in contact with flowing water at all times and could be subject to greater rates of erosion.

In the Beaulieu Firth the tidal amplitude is approximately 4m between MHW and MLW (Admiralty Tide Tables 1994). Within the firth are a number of tidal streams which concentrate in two main west to east channels. The greatest tidal currents are recorded at the eastern extent of the firth between the Kessock narrows. Upstream the firth broadens and shallows and the low tide period is marked by the exposure of extensive sand and mudflats. Casual observation from the shoreline

during low tide periods can give the impression of an almost dry system with only one channel flowing from the River Beaully towards the Inner Moray Firth.

The tidal regime in the Beaully Firth is overall a natural event which has not been greatly affected by canalisation. In the Firth of Clyde where the group of marine crannogs are located the tidal range is in the region of 4.5m (Admiralty Tide Tables 1997) The inner Firth of Clyde shoreline has been greatly canalised and the channel section modified, since the late eighteenth century (Riddell 1979), and the affects of building training walls and reclaiming land alters the extent of the area which is covered by tidal flood waters. One result of canalisation is the increased tidal stream by reducing the cross-section of a channel and forcing the same volume of water into a narrower channel (Tivy 1986, 16) . The reclamation projects on the Firth of Clyde therefore may have altered the tidal regime, which in turn could affect the marine crannogs. The areas that were previously affected by the tides have been turned into development land behind training walls and those locations could have included sites of marine crannogs, for example, the location of the Old Kilpatrick site, as discussed in Chapter 2.

3.7. Health and Safety

Health and safety considerations for field personnel during survey in intertidal environments is paramount and a risk assessment was completed of the environment and conditions in which the fieldwork was carried out during this research (see Appendix C). Additional safety measures for fieldwork teams included; informing the local coastguard of timetables and locations of individuals. The teams were equipped with mobile telephones and inshore safety flares and any personnel using boats during the research were also equipped with buoyancy aids and two-way radio equipment.

3.8. Equipment

Specific types of equipment included footwear that was insulating and protective but did not get stuck when walking across mudflats. The most appropriate solution was to wear neoprene wet-suit boots, which could be changed for walking boots or other footwear once on the relatively consolidated sediments on some of the sites. Transportation of equipment to and samples from the sites that could be accessed on foot was overcome by using lightweight plastic sledges. These provided large carrying capacities and allowed fieldworkers to walk through the mud, which was sometimes knee deep. The sledges were pulled across the surface of the intertidal mudflats and were an excellent method of transportation. Further specific pieces of equipment that were used during the research are discussed with the results in the relevant chapters.

CHAPTER 4

Marine crannog survey results

4.1. Introduction

This chapter describes the results of the survey work carried out on the two groups of marine crannogs and An Dòirlinn, the single site near Eriska. Using the methods outlined in Chapter 3, surface geological remains, archaeological features such as timber or stone work were recorded and the survey results include the local intertidal landscapes surrounding each site. One of the aims of the survey was to identify a site that would be the focus for additional research, including sampling and excavation.

At present both groups of marine crannogs in the Beaully Firth and the Firth of Clyde are made up of four sites each. In the Firth of Clyde, three additional sites are recorded in the RCAHMS, NMRS, although during the current fieldwork two could not be located and the third is a small mound of quarried stone and not a marine crannog. Additionally, An Dòirlinn was surveyed so that a record of an isolated marine crannog, which had been previously investigated, was included in the current research and database.

4.2. Marine crannogs in the Beaully Firth (Figure 4.1.)

In the Beaully Firth, four sites; Carn Dubh, Coulmore, Phopachy and Redcastle were re-located using shoreline preliminary survey. Carn Dubh and Coulmore are in the middle of the Firth, Phopachy is close to the southern shore and Redcastle is adjacent to the northern shoreline and the most westerly of the group.

4.2.1. Carn Dubh (NGR: NH 61755 47423) (Figure 4.2.)

The 1:100 scale survey of Carn Dubh recorded the surface morphology of the site and a number of internal features. The site is an oval mound 62m east west and 45m north south, and has a maximum exposure time of approximately 4 hours during mean low water (MLW). There is a very distinctive built-up eastern margin and an almost indistinguishable western side (Plate 4.1.). The eastern side of the site forms a crescent feature, steeply sloping to the east and a more gentle gradient to the west. The surface of the site is covered with large Old Red Sandstone (ORS) stones, colonised by large quantities of seaweed, beneath which are smaller ORS pebbles and gravel. The surface stones are well rounded and also well sorted in size.

Among the smaller pebbles and gravel, and protruding from between the surface stones were three timbers. One is a pile near the highest part of the site, the second, a near horizontal timber, protruding about 0.4m from the interstitial sediments and the third is a very large horizontal timber. The largest timber was identified as the same one photographed by Odo Blundell during his visit to the site (Blundell 1909-1910, 18 and see Plates 2.1. and 2.2.). During the survey this timber was sampled and identified as oak (*Quercus* sp.) and a sub-sample was sent for radiocarbon dating. The pile was also sampled and was identified as pine (*Pinus* sp.) and sub-sampled for radiocarbon dating. The resultant dates are: 2530 ± 50 BP (GU-4540) for the horizontal oak timber and 280 ± 50 BP (GU-4539) for the pine pile (Hale 1996) (see Appendix E for calibration results).

By contour surveying Carn Dubh the crescent nature of the eastern part of the site was determined and the western margin and interior features defined more clearly. Beyond the margins, the contour survey indicated that the site is situated on a linear, east west sandbank. The eastern end of the site stands 0.8m above the

surrounding sandbank and was levelled to $-0.9\text{m} \pm 0.1\text{m}$ OD. In contrast, the western margin of the site is only delineated by individual stones. The surrounding sandbank slopes steeply away towards the north and east of the site, unlike those to the south and west. This may be because of the underlying geology, the position of the main east to west tidal channel in the firth or to the predominant direction of the tides. These topographical features may demonstrate localised sediment movement in that part of the firth, causing erosion on the western side and accretion on the east. The linear sandbank on which the site is built appears to have been formed by the dominant east to west movement of the tide.

4.2.2 Coulmore (NGR: NH 61021 47642) (Figure 4.3.)

The 1:100 plan of Coulmore shows a small, almost oval site consisting of an upstanding mound covered with stones and estuarine sediments. The surface stones are large well-rounded ORS stones overlying smaller less well-sorted ORS pebbles and gravel. The surface stones are colonised by seaweed which covers the entire site (Plate 4.2.). The upstanding mound is 20m east west and 25m north south. It has steeply sloping margins on the north, east and south sides and the western margin is a more gentle gradient. The highest part of the site is the south east side at a level of $-1.6\text{m} \pm 0.1\text{m}$ OD and in the centre was a shallow depression. During the survey, the maximum time on-site was less than 2 hours total exposure, after which the margins became submerged.

The steepest part of the site indicated by the contour survey is the northern margin. This side of the site is adjacent to the main tidal channel of the firth and therefore undergoes almost continuous contact with the water and possibly increased erosion. The site is situated on the northern edge of the east west linear sandbank, which is the continuation of the same feature on which Carn Dubh is built, 800m to

the east. The more prominent eastern side of the site stands 0.5m above the sandbank, whereas the western sloping edge is only 0.2m above it.

4.2.3 Phopachy (NGR: NH 60221 46601) (Figure 4.4.)

Phopachy is also situated on part of an east west linear sandbank, located 500m from MHWL beyond the southern shore of the firth. Similarly to Carn Dubh and Coulmore, Phopachy is separated from the shoreline by a tidal channel. The position of the site adjacent to the tidal channel allows for approximately 3 hours of total exposure during low water periods. The edges of the site are situated at MLWL but during mean low water neap tides (MLWNT) the edges remain submerged. During mean low water spring tides (MLWST), the southern tidal channel is dry and the site can be accessed on foot. The surface of the site consists of seaweed covered ORS stones and estuarine sediments and beneath the large surface stones are smaller stones of similar geology. On the eastern margin some areas are covered by sand rather than surface stones (Plate 4.3.). The highest part of the site is $-1.1\text{m} \pm 0.1\text{m}$ OD, near to the centre.

The contour survey indicates that the site is an upstanding oval mound with irregularly sloping margins. The steepest edges are the northern and southern slopes. The survey also indicates that the site is situated on a distinct linear, east west sandbank that may be the remains of a former raised feature on which the site was originally built. Previous research had exposed sub-surface timbers on the south side of the site and two of the timbers were re-sampled and radiocarbon dated, the results were: 1990 ± 50 BP (GU-4099) and 2060 ± 50 BP (GU-4098) (Hale 1995 and see Appendix E).

4.2.4. Redcastle (NGR: NH 58582 48953) (Figure 4.5. and Plate 4.4.)

The Redcastle site is exposed for approximately 6 hours at each low tide. This relatively long exposure time, compared with the other sites in the firth allowed a more extensive survey to be carried out.

Large well rounded ORS stones cover the surface of the site and other stones are present on the surface which are quartz rich and metamorphic in origin. However, the majority of the stones are ORS. Among and beneath the large stones are smaller ones of ORS origin. The origin of these ORS stones on this site and the others in the Beaully Firth appears to be a local source because they are similar to those found on the current shorelines and scattered over the intertidal features in the firth. The mudflats immediately surrounding the site are devoid of stones and this may represent a zone of clearance from which the stones on-site were collected. The stones range between sub-angular to well-rounded and are well sorted.

The 1:100 survey recorded the position of three large stone mounds near the centre of the site. Two are oval mounds 5m in diameter and less than 1m high. The third and smaller stone mound is a crescent shape 3m in diameter and 0.5m high. The crescent shape is formed by an open side to the north and a hollowed centre.

A past notice of the site recorded a curvilinear stone feature next to the site and it was examined in the current survey (Woodham 1954-1956, 85). Contrary to Anthony Woodham's suggestion, this feature does not appear to represent the remains of a causeway. It was observed that this feature prevented the rising tide on the western side of the site from covering the site for a considerable amount of time each tide (c. 1/2 hour). It also appears to prevent the surface drainage runnel and

continuation of the Redcastle Burn from encroaching on the site, from the north and west. The feature therefore seems to act as a breakwater delaying tidal submergence, rather than allowing access to the site. Whether the structure is contemporary with the original use of the site is discussed in Chapter 7.

The contour survey of Redcastle covered a rectangular area centred on the site and encompassed the intertidal zone from the present MHW to MLW. Specific topographical variations and features are identified in the survey area. These include a very distinct break in slope on the south west edge of the site. North of the site is a raised linear feature running in a north north east direction. Two hundred metres north north east of the site the raised feature becomes absorbed into the north west to south east contours. The survey results suggest that the contours to the north of the site could be the remains of a palaeo-shoreline with associated drainage channels, and that the site is located on the end of a raised promontory, which protrudes from the main palaeo-shoreline.

4.3. Marine crannogs in the Firth of Clyde (Figure 4.6.)

As indicated above, eight sites were previously recorded in the Firth of Clyde, although not all of their positions were confirmed. In the current survey, the north shoreline between Dumbarton Rock and beyond Erskine Bridge was fieldwalked to identify sites. On the southern shore between Langbank village and Erskine Bridge the shoreline was also fieldwalked during MLWST periods and in total four sites were identified: Dumbuck, Erskine, Langbank East and Langbank West. Surveys were conducted during low tide periods and the following observations were made about the individual sites.

4.3.1. Dumbuck (NGR: NS 41672 73928) (Figure 4.7.)

Situated on the northern shore of the Firth of Clyde, to the east of Dumbarton rock, Dumbuck is surrounded by mudflats and lies 80m from MHW and 30m from MLW. The site is fully exposed for approximately 6 hours during each low tide. The remains do not form a large upstanding, consolidated mass of estuarine sediments, stones and organics like the sites in the Beaulieu Firth, but consist of distinctive features, such as timber and stone structures protruding through the estuarine muds (Plate 4.5.). Some of these features appear to have been exposed by previous investigators, which were discussed in Chapter 2.

During the survey, surface remains consisting of stones and timbers over an area measuring approximately 100m² were identified. Various specific features can be identified and are comparable with the previous plans of the site (Figure 2.2.). The centre of the site is marked by a circular stone feature around which are 10 radially projecting horizontal timbers. These form part of the timber 'flooring', approximately 15m in diameter (Munro 1905, 142). The edge of the horizontal timber structure is marked by 22 piles and in one place a single timber was found between two of the piles. Surrounding the timber structure at a distance of between 1m and 8m is a scattering of stones, which forms a 'breakwater'. The stones are sub-rounded to rounded and their geology originates from the olivine-rich basalt of the area (Cameron & Stephenson 1985). This breakwater was previously described as, 'Having the open side to the north or landside' (Munro 1905, 138), this suggests that the 'breakwater' was never built around the north of the site and the current survey indicated that the area concerned was used for the location of a spoil heap from previous excavations. Two of the piles and two intersecting horizontal timbers were sampled for submission for radiocarbon dating and the resultant dates are: 1910 ± 50

BP (GU-7471), 2040 ± 50 (GU-7472), 2060 ± 50 (GU-7473), 2090 ± 50 (GU-7470) (Hale 1999 and see Appendix E). The sampled piles were identified as oak and the adjacent horizontal timbers were alder.

One feature not re-located in the survey was the stone and timber causeway that led from the centre of the site to the western edge, shown on one of the original plans (Figure 2.2.). This causeway may be buried beneath estuarine sediments. An area free of stones to the north east of the timber platform, outside the stone breakwater, appears to be the remains of the dock structure. The previous reports note that the dock was excavated and this could have resulted in the remains becoming disturbed and further intrusive investigation would be necessary to confirm the location.

Results from the contour survey of the site and surrounding intertidal zone indicates that the site forms a short, raised promontory, which projects southwards from the present MHW. The edge nearest MLW of this feature is indicated by the change in frequency of the contours, particularly visible to the west of the site and marks a small slope. The site itself forms a low raised feature, projecting 30m southwards, from the edge of the gently sloping intertidal sandbank.

Comparisons between the current survey results and the plan made by the Clyde Navigation Trust (Figure 2.2.) during the primary investigations shows that the main circle of piles are still present. The current survey only identified 22 piles surrounding the timber platform, five fewer than originally noted and this may be as a result of their excavation or re-burial (Munro 1905). Other features still present include the central 'pit' and the general location of the dock. However, variations

exist when comparing the extent of the surrounding stones and the absence of the western causeway.

4.3.2. Erskine (NGR: NS 45553 72888) (Figure 4.8.)

Fieldwalking indicated the presence of surface timbers, associated with an extensive scatter of stones (Plate 4.6.). As mentioned previously, Erskine was surveyed in 1984 and during that exercise a high pressure hose was used to clear the surface timbers of estuarine sediments (Hanson W. pers. comm.). The aims of the current survey were to produce a site plan and a contour survey of the surrounding intertidal zone, in order to compare the previous results and assess any changes to the surface remains over the past 14 years (Figure 4.9.). The site is exposed for approximately four hours during low tide, however, owing to its position directly adjacent to the main river channel submergence is rapid during tidal flow.

Results of the re-survey of the site showed that the upstanding remains consist of a mass of timbers and stones on the edge of a large sandbank, 100m from the southern shore of the Firth. It does not form an upstanding mound, like those sites in the Beaully Firth, rather the remains protrude from the estuarine sediments and are exposed on the steep slope at the edge of the river channel. The survey identified both horizontal and vertical timber remains which form a distinctive curved structure adjacent to MLWM on the northern part of the site. On the southern part of the site, the structural remains may be obscured by the accumulation of sediment forming a raised sandbank. The geology of the surface stones are a mixture of sedimentary sandstones and igneous basalt.

Large quantities of timber remain exposed predominantly on the north and eastern sides of the site. Some of these timbers form a sloping side to the site, at

approximately 40° from the horizontal and appear to have slumped towards the tidal channel, possibly in account of increased erosion in that area, which has caused undercutting and localised slumping. Surrounding the margins on the north and east sides were seven piles. Towards the highest part of the site are five very substantial horizontal timbers, two of which showed wood-working marks on their sides, which may have been caused by sampling during previous investigations, for species identification and analysis.

The variations between the two plans demonstrates the vulnerability of exposed timber remains in intertidal environments. Since the initial plan 14 years ago, a number of the timbers, especially on the north and north east side of the site have disappeared, probably as a result of tidal scour. Timbers and stones on the south and south east of the site have also disappeared. However, on that side of the site they seem to have been re-buried by sediments, also as a result of the tidal regime. Sediment levels around marine crannogs is discussed further in the following chapters and an erosion monitoring and sediment movement project around a marine crannog is discussed in Appendix D.

The overall condition of the exposed timbers on Erskine indicates that they have been attacked by wood-boring animals. The most common threat to waterlogged wood is the attack by a boring mollusc, such as the *Teredinidae* family, the 'shipworm' (Pearson 1987). The pitted surfaces of the timbers also showed evidence of biological damage from algal growth.

4.3.3 Langbank East (NGR: NS 40501 73363) (Figure 4.10.)

Langbank East is 95m offshore from the southern MHW, surrounded by intertidal mudflats, which are strewn with sub-rounded basalt stones similar to those

on-site. It is over 300m from MLWM and the distance allows an extended exposure period of over 6 hours during each low tide.

The site is 45m, east west and 30m north south at the widest point and forms an irregular shaped raised mound of stones and estuarine sediments (Plate 4.7.). The raised central area of the site is characterised by a rectangular stone structure, one course high, 20m long and 15m wide (Figure 4.10.). The steepest part of the site is on the southern margin, adjacent to the rectangular feature. The western flank is more gently sloping and where the edge of the site ends and the surrounding mudflat begins is not clearly visible. No evidence of the timber remains formerly identified were found during the survey.

Between the site and the shoreline are two parallel lines of stone. These have previously been identified as a causeway in the RCAHMS, NMRS. The results of the contour survey suggest that these features may have been demarcating an area between the present shoreline and the site. This type of feature is unique to this site and may be the result of re-use. Prior to the dredging and canalisation of the river, a ford was documented in the area between Dumbuck and the Langbank East site (Riddell 1979). It is suggested that the site and associated features could have been used during this period and that the stone lines and other stone features on the site are evidence of re-use.

Contour survey also identified an area of level mudflat between the site and the current shoreline. Elsewhere surrounding the site, the mudflats form gently sloping gradients from MHW to MLWM. The possibility that a buried promontory between the site and the shoreline, similar to that found at the Redcastle site in the Beaulieu Firth was investigated when assessing the contour survey. The results

indicate that the site is situated on a relatively flat part of the southern shore. The results from the survey show that the site is located on a break of slope, which is possibly the remnants of a buried palaeo-shoreline, parallel to the current MHW, rather than it being located on a promontory.

4.3.4. Langbank West (NGR: NS 38226 73652) (Figure 4.11.)

Langbank West is situated on the southern shore, north of the village of Langbank. Maximum exposure time of the site is approximately 5 hours during low tide. The site is a raised oval mound of stones and estuarine sediments, 30m long and 20m wide (Plate 4.8.). The surface stones on the site are well rounded sandstones and are colonised by seaweed. Beneath them are smaller, well-rounded pebbles and gravel. One metre outside the western margin of the site are three small piles protruding from the intertidal sediments. The margins of the site are clearly discernible from the surrounding stone-strewn, gravel foreshore.

Contour survey of the site and its surroundings shows the remains of a short promontory from the modern shoreline towards the site. This low feature is only 20m long and does not continue beyond the northern visible edge of the site. The northern edge of the promontory is marked by a relatively steep slope on to the surrounding mudflat. Recent land reclamation on the current shoreline because of the construction of the M8 motorway has unfortunately obscured the previous shoreline. These alterations may have affected the sedimentary regime around the site and caused a build-up of sediment between the site and the shoreline. Further assessment of this feature would be necessary to establish whether this was the case or if it was part of a natural promontory, on which the site was built.

4.3.5. Old Kilpatrick (NGR: NS 4656 7211)

Fieldwalking in the vicinity of this site, identified from map sources and a number of photographs in the NMRS (see Plates 2.7. and 2.8.), shows that the site was disturbed or possibly destroyed during the construction of a shipyard and by later land reclamation. The total destruction of the remains is not documented and a single timber was found protruding from the estuarine sediments in the intertidal zone in the vicinity of the approximate location of the site, during fieldwalking in 1997. Future examination of the area where the timber was found may reveal more evidence of the site.

4.4. An Dòirlinn, Eriska (NGR: NM90100 42400) (Figure 4.12.)

An Dòirlinn is an apparently isolated site, south of the Isle of Eriska, 70m off-shore in a narrow firth. During the current research, a maximum period of 4 hours exposure time was recorded on-site. The site is less than 20m from MLWM. It consists of a distinct raised mound of seaweed covered stones, ranging in size from large stones to smaller pebbles and some gravel (Plate 4.9.). The stones are well rounded and igneous in origin. Estuarine sediments were also seen beneath the larger stones. The site is almost circular and the diameter is 22m. The southern edge is steep with a shallower gradient on the northern, eastern and western slopes. A depression creating a pool of standing water during low water, clear of all stones, lies just to the north east of the mound.

On the north side at the bottom of the slope, there is a single course of walling running east west, approximately 5m long. Where the walling ends, at the eastern end a linear depression is clearly seen running north south through the middle of the site. This appears to be the remnants of the trench mentioned earlier which was excavated by Robert Munro (Munro 1884-1885). It is approximately 1m

wide and runs through the centre of the site. Spoil on either side of the trench consists of small piles of stones and pebbles, particularly concentrated on the very top of the site. The sides of the trench are now gentle slopes and the bottom has become filled with large amounts of broken shells.

Between the MHWL and the site, the intertidal zone consists of a mixture of gravel, mud and sand. There are a number of larger stones and some very large boulders, which appear to be ice-borne erratics (Peacock 1992, 154). To the east of the site, the intertidal area is clear of stones in an arc, approximately 500m wide. This may be the clearance zone from which the stones were taken to build the site. During low water part of the site is adjacent to a pool of water on the southern side and the rest of the site edge is dry. The narrow firth between the mainland and the shore is only covered by some shallow pools of water during low tide and it can easily be forded on foot.

The results of the contour survey indicated that the site is 1.1m upstanding above the surrounding mudflats, although 0.3m of that is probably Munro's spoil heap and the highest point on-site is $1.4\text{m} \pm 0.1\text{m}$ OD. The survey of the surrounding mudflats clearly distinguished a low promontory running from near MHWL, on which the site is located. However, unlike Redcastle, An Dòrlinn is not on the very end of the promontory, which continues towards MLWL for over 10m beyond the south edge of the site.

4.5. Conclusions

On the basis of all the surveys of these sites, it is clear that their positions in the intertidal zone is a factor that affects the shape of the remains and the survival of structural detail. Results from the surveys also allow observations about the different

intertidal sediments that surround and cover the sites to be made. Different sediments in the intertidal zone can be used to indicate variations of tidal energy and the erosive nature of the environment. Results of the contour surveys provide evidence of the micro-relief surrounding and beneath marine crannogs, which could indicate the position of promontories, palaeo-channels and former shorelines.

Using the current MHWm as a baseline the location of marine crannogs can be divided into three categories; shoreline, near-shore and off-shore sites. Shoreline sites are those located within 50m of the MHWm, near-shore sites are those between 50m and 400m from MHWm and off-shore sites are those located beyond 400m from MHWm. Langbank West is the only shoreline site, but perhaps only as a result of the construction of the modern M8 road. This alteration of the shoreline by modern road building means that it too will be considered with An Dòirlinn, Dumbuck, Erskine, Langbank East, Old Kilpatrick and Redcastle as near-shore sites. Carn Dubh, Coulmore and Phopachy are all over 400m from MHWm and will be grouped together as off-shore sites.

Those sites situated in near-shore locations are sheltered by shoreline features such as the embayment surrounding Redcastle. Their positions between MLWM and MHWm ensure that they are only subjected to the erosive swash zone of the passing tide for a relatively short period of time. Although Erskine and the probable remains of Old Kilpatrick are near-shore sites, they are located closer to MLWM than most of the sites. Their location ensures that they are in contact for longer periods with the tidal channel and flowing water where prolonged erosion can occur. Dumbuck, Langbank East, Langbank West, Redcastle and An Dòirlinn are located between the MHWm and the MLWM and experience reduced contact with constantly flowing water.

Carn Dubh, Coulmore and Phopachy are all situated in the central part of the Beaully Firth. Because of their exposed positions they are subject to longer periods of submergence and extended periods in contact with flowing water. Compared with the near-shore sites, the depth of water during submergence is increased. The maximum wave fetch in the Beaully Firth is 11km long. The potential for wave erosion on those sites exposed to the maximum fetch is thus higher than for Redcastle. Coulmore is located at MLWM and some part of it often remains submerged throughout the tidal cycle and this may be one of the results why it is one of the smallest of all marine crannogs. Erskine is another site where continued erosion of the exposed timber work is increased, probably owing to its location adjacent to MLWM and as a result of their exposure for the previous survey. However, unlike Coulmore, a sandbank is accumulating over the southern part of Erskine, which is covering previously exposed timbers and possibly protecting them from continued tidal erosion.

Erosion and the accretion rates on marine crannogs may also be affected not only by the location of the site but also by the deposits that cover the sites. The large stones covering the majority of sites appear to protect some of the underlying remains. It is only when delicate organic deposits or sub-surface timbers become exposed, for example on Dumbuck and Erskine, that the remains become subject to tidal erosion and biological damage. On the survey results alone the protection and survival of surface structural and other delicate remains appears to be greater on those sites located away from tidal channels, in near-shore environments that are protected by the shoreline and not in exposed off-shore environments, for example the Dumbuck remains which can be quantified over the past 100 years. However, the

potential for the survival of sub-surface features remain uncertain without excavation.

Further evidence of the type of environment in which a marine crannog is situated can be inferred from the surrounding sediments. Within estuarine systems, the different types of sediment present can indicate the amount of energy in the environment (Dyer 1979). This was illustrated in the Firth of Tay and showed that pebbles, sands and gravels indicated high energy environments such as those prevalent on beaches (Buller & McManus 1975). Lower energy environments were indicated by sands and muds and the mudflats around Redcastle indicate that it is surrounded by a relatively low-energy environment. The same is true for Erskine, Dumbuck and Langbank East, although Langbank West is surrounded by sandy gravels. In the Beaully Firth, Carn Dubh, Coulmore and Phopachy are surrounded by sandbanks, which signify a higher energy environment than around Redcastle.

The contour surveys revealed some sub-surface features, possibly indicating aspects of the topography when the sites were originally built and which have subsequently been masked by intertidal deposits. An Dòirlinn is situated on a very distinct sub-surface feature that appears to be a short promontory. Langbank East was also on the edge of a flat shelf adjacent to a break of slope. At Dumbuck, the remains of the site form a small promontory and a break of slope was recorded on the south side of the stone 'breakwater' close to MLWM. Contour survey results from Redcastle are interesting because they show the site clearly on the edge of a distinct break of slope, and it is also situated on the end of a promontory extending from a possible palaeo-shoreline, 200m south of the current MHWL.

The apparent absence of causeway structures from the surveys may indicate that such structures were not necessary to access these sites. The contour surveys from some of the sites showed that they were either built on low promontories or that the sites themselves formed such features. This form of landscape feature may indicate that these sites were originally built not off-shore, but rather on former shorelines, possibly on the edges of raised promontories and have subsequently become submerged as a result of changes in the tidal regime or perhaps small and localised fluctuations of sea-level.

CHAPTER 5

Redcastle marine crannog: choosing the focus site and identifying sea level change

5.1. Introduction

As a result of the fieldwalking and site surveys, Redcastle was chosen as the focus site for further investigation. The aim was to examine a site in greater detail for evidence of structural remains and palaeoenvironmental indicators. Reports from previous investigations, outlined in Chapter 2, indicated that Redcastle could provide evidence that had not been disturbed by previous investigations and large-scale excavation. The results of the current surveys also contributed to choosing a site with a suitable length of exposure time to allow for on-site time over 5 hours during each low tide. Dumbuck and Redcastle were both considered, however, previous excavations on Dumbuck indicated that greater undisturbed archaeology might be found on Redcastle. Additionally, the results from a previous survey on Redcastle had highlighted that an area on the south west part of the site was prone to erosion which had exposed a number of timber and stone features (Hale 1992). It was believed that some of the archaeology could consequently be threatened to continued damage, a fact underlined by the erosion survey undertaken during the current research (see Appendix D).

In the wider context of the two firths, the Beaully Firth was chosen because there have been fewer shoreline protection and reclamation schemes compared with the dredging, reclamation and canalisation in the inner Firth of Clyde over the past 250 years. One of the effects of the engineering works on the channel of the Clyde has been the altered tidal regime in the firth. According to John Riddell, the delay

between high tide at Greenock and Broomielaw, a distance of over 30km, was approximately 3 hours in 1770, 1 1/2 hours in 1837 and less than 30 minutes in 1980 (Riddell 1979). This increase in tidal change reflects the reduction and alteration of the cross-section of intertidal and subtidal area submerged and has contributed to the scouring of the navigable channel. The building works have deepened the single navigable channel at the expense of any other channels that were previously present, some of which are shown on Pont's sixteenth century map of the area and show the inner Firth of Clyde as a braided river with mid-channel islands (copies of which are held in the National Library of Scotland, Edinburgh). Therefore by concentrating the flow into one channel, the horizontal extent of the intertidal area has been reduced, while increasing the vertical depth, especially in the channel where it is needed to keep large boats afloat. This has altered the speed at which the tidal change occurs in the inner Firth of Clyde and could have affected the archaeological remains.

Conversely, the Beaully Firth is surrounded by agricultural land and the shoreline is relatively sparsely populated. This has maintained a lower rate of the construction of coastal defences, which can alter tidal processes and affect erosion patterns. However, land reclamation has taken place at the head of the firth on both sides since the eighteenth century (Omand 1984). This reclamation has restricted the confluence of the river Beaully and the firth and may have altered sediment regimes. The bay surrounding the Redcastle site appears heavily silted and this may be as a result of the reclamation at the head of the firth. At the other end of the Beaully Firth, either side of the Kessock road bridge, recent land reclamation has included the building of a land-fill site and a football stadium. These more recent works may have altered the tidal currents and sedimentary regimes at the mouth of the Firth. The possible affects of these recent changes could include channel migration with resultant erosion and accretion to the marine crannogs, especially those in the centre

of the Firth. Redcastle was therefore chosen because it is situated away from the main channel and the extent of the surrounding sediments indicate that parts of the site have been buried and aspects of the archaeology exposed by tidal action.

5.2. Redcastle marine crannog and sea level change in the Beauly Firth

The Moray Firth, and specifically the Beauly Firth, is one area of Scotland that has a history of, and has been subject to, recent intensive sea-level research (Synge & Smith 1980, Haggart 1982, 1986, Firth & Haggart 1989). The current sea level curves are based on the analysis of radiocarbon-dated deposits, associated with the analysis of sediments containing diatoms (for water salinity levels) and pollen (for local vegetation and environment type) remains. This methodology was pioneered by Ian Shennan and developed and applied to the Beauly Firth by Andrew Haggart (Haggart 1987). Haggart's results show that sea level positions and movement, and the timings of those changes can be identified using the evidence from sedimentary analysis (lithostratigraphic analysis) and the identification of diatoms and pollen remains (biostratigraphic analysis) that enabled past environmental conditions to be reconstructed.

This recent research has developed a history of the sea-level since the last glaciation in the Beauly Firth region by the identification of a series of shorelines. The following is a synopsis of the changes identified by Firth and Haggart (1989). The Main Lateglacial Shoreline, indicating that MHWm, pre 10,000 years BP was identified and located at *circa* 2 m OD (current MHWm at Beauly is at the same level today). The sea level rose rapidly to a variable maximum level of c. 8m OD at c. 10,000 BP (6m above current MHWm). The sea level then fell and rose to a comparable level by c. 6,500 BP. Since that time the sea level has attained its current position by falling owing to continued isostatic uplift and eustatic factors. Within

this general fall, there are a series of small rises (transgressions), falls (regressions) or stillstands (stasis) in relative sea level which probably signifies that sea-level was affected by local factors. This can be seen clearly in the series of low shorelines identified by Firth and Haggart at the head of the firth (Firth & Haggart 1989, 44).

Minor variations in sea-level after c. 6,500 BP have been suggested for other parts of the east coast of Scotland (Haggart 1987). These variations are problematic because they indicate periods during which the sea level of this part of Scotland is unclear. It is therefore difficult to define whether or not the marine crannogs in the Beaully Firth were originally built at or above MHWL without further investigation of the water level variation associated with their radiocarbon dates. However, by applying the methodology discussed above to the structures and deposits on a marine crannog, chronologically controlled structures can be identified and associated with deposits sampled and analysed for biostratigraphic and lithostratigraphic sea level indicators.

Analysis to establish previous water level has been applied to Redcastle marine crannog partly because the site's radiocarbon dates place it into a period after which relative sea level positions for the Beaully Firth are unknown. Given the proximity of Redcastle away from the main tidal channel and the possibility that evidence of past water level changes may be preserved in the surrounding sediments, combined with the possibility of on-site structural remains, the site will be investigated to test whether the methodology used by Haggart and others can be applied successfully to a marine crannog.

Redcastle is accessible across 350m of intertidal mudflat and in contrast to the other sites in the Beaully Firth, access is by foot. The following example of the

depth of water covering Redcastle during high tide illustrates the position of the site and the length of exposure time when the site was available for fieldwork. An on-site temporary bench mark (TBM) was levelled to $1.3\text{m} \pm 0.1\text{m}$ OD for survey during the sampling and excavation. The height of the tide, for example on 1st July 1996 was 4.8m above local datum (local datum is -2.25m below OD) and the TBM was covered by $1.2\text{m} \pm 0.1\text{m}$ of water at high tide (13.17 hrs). At low tide on the same day the water height was 0.6m above local datum and the TBM was $2.95\text{m} \pm 0.1\text{m}$ above low water at 19.17 hrs. The depth of water coverage during a high tide period is therefore relatively small and could possibly be accounted for by local water level change since the site was built. Additionally, the change could be the result of a combination of factors including tidal range alteration and channel migration. These and other indications of water level change are discussed in Chapters 8 and 9.

5.3. Redcastle 1:20 survey methods and results (Figure 5.1.)

It has been suggested that the stones that cover some freshwater crannogs were integral material of both the foundation and superstructures or that they were later additions (Morrison 1985, 39). Planning of the surface stones of Redcastle at 1:20 scale was therefore undertaken before intrusive research began in order that their extent and characteristics were recorded. The site was divided into a north south, east west grid system, which was positioned using a theodolite in order that the individual grid points were accurately located. Each 10m grid square was marked by stainless steel planning pins and joined by nylon twine. The grid squares were surveyed using horizontal, double-strung planning frames, positioned using tapes and spirit levels.

As stated above, a temporary bench mark (TBM) was set up on-site to enable more detailed levelling. This was also helpful during the excavations and sampling

projects which required all structures, deposits and samples to be tied into OD. The TBM was levelled from three shoreline Bench Marks and the point chosen was cemented in place to create a permanent on-site bench mark. At the start of each fieldwork season the TBM was re-levelled for error, although none was found during the fieldwork seasons.

The detailed survey of Redcastle was carried out to test the hypothesis that the surface stones on the site were not a random scatter but had some form and if studied in detail could indicate specific features and associations with other remains. The plan helps to identify the different parts of the site where the stone cover densities varied. It also delineates the site-surface margins and when viewed in conjunction with the contour survey, highlights concentrations of stone that have moved possibly as a result of tidal or human action. During the course of the survey, it became clear that a lower limit of stone size should be chosen. Stones less than 0.05m long-axis were chosen as the lower limit to be drawn. Observation of the site had previously established that the stones below that size limit were regularly moved due to tidal currents around the site.

Results from the 1:20 survey indicate that the surface stones were, in places, related to specific structural remains. Two particular areas were found to confirm that the surface stones were not only part of underlying structures but also formed features themselves. The first area is near the south west margin, where a number of sub-surface stones are positioned in roughly north to south lines and the second on the south east edge, where a north east to south west linear form of stone coursing is clear. Both areas were the focus of excavations, see Chapters 7, 8 and 9. The association of the surface stones with other sub-surface remains will be discussed in Chapter 10. The 1:20 survey identified areas where surface erosion had exposed sub-

surface timbers, wooden piles and other organic deposits on the south west margin of the site.

The three stone mounds identified from the 1:100 scale plan of the site were more closely investigated during the 1:20 scale survey. Clearance zones of large stones over 0.2m long axis around the bases of the mounds suggests that those areas were cleared to provide stones for the mounds. The zones of clearance were characterised by concentrations of much smaller stones and interstitial estuarine sediments.

The 1:20 plan also suggested that the visible remains of the margin of the site may not represent the actual edge of the archaeological deposits. The edges are composed of concentrations of stones of a particular size. The northern margin of the site is dominated by consolidated stones of varying diameters and intertidal mud. This gives a distinct margin between the stones and the estuarine sediments which also does not change in elevation and suggests that the stones may continue beneath the sediments, a point investigated during the excavations. The south eastern margin is characterised by a more dispersed scatter of surface stones in a depression, surrounded by a mudflat. The south west edge of the site has a distinct break in slope with two main concentrations of scattered stones; one at the northern end of the margin and the other at the southern edge. The area in between is sparsely covered by stones that appeared to have moved, probably as a result of tidal action, downslope into a small depression. This variation in angle of the margins of the site was confirmed from the contour survey. Around the margins of the site the surface stones are colonised by seaweed identified as *Fucus vesiculosus* (bladder wrack), *Fucus serratus* (toothed wrack) and *Aria esculenta* (dabberlocks) (Fish & Fish 1989).

5.4. Conclusion

The results from the Redcastle 1:20 survey show evidence of increased erosion on the south west area of the site. The identification of stone mounds and linear arrangements shows that particular features are present on the surface of the site and their further investigation could suggest construction phases and episodes of surface disturbance. The conclusion from the survey was that sub-surface timber and stone remains were exposed on the south west edge of the site possibly as a result of preferential erosion in that area, which is the first part of the site to become submerged by the rising tide. Therefore small scale excavation in that area could reveal archaeology that had already been subject to erosion, without the extensive removal of surface cover deposits.

CHAPTER 6

A methodology for excavating the focus site: Redcastle marine crannog.

6.1. Introduction

Records of past investigations on the marine crannogs in the Beaully Firth and the Firth of Clyde have indicated some of the potential archaeological features and deposits that may be preserved and subsequently sampled. For example, as previously mentioned the investigators of Dumbuck found structural evidence overlying brushwood deposits (Bruce 1899-1900). The reported condition of the structural remains discovered 100 years ago shows that the preservation quality could be good and that any surface sediments have acted as a protective layer to the underlying remains. Small finds from Dumbuck and Langbank East also suggest that despite, the re-worked objects, genuine material culture does survive and coincide with the recent radiocarbon dates obtained from structural samples from both Dumbuck and Erskine. With modern techniques available, the marine crannogs therefore represent a potentially excellent resource for evidence of the palaeoenvironmental conditions prevalent on certain estuarine margins. This chapter outlines the excavation and sampling strategy developed to assess what types of structural, palaeoenvironmental and sedimentary remains exist on Redcastle and what methods will be used to access and analyse those remains.

The sampling programme on Redcastle aimed to assess the types of structures present, to take samples from any structures for dating purposes and sample different sediments for evidence of the local palaeoenvironmental and

topographical conditions before and during the occupation of the site. To achieve these aims part of the exposed structures on the south west edge of the site were excavated, during which suitable dating material was sampled. Additional sampling was undertaken to identify variations of sediment off-site, especially associated with the promontory recognised from the contour survey. Comparative sediment samples were also taken at locations off-site and from some of the other marine crannogs in the Beaulieu Firth.

6.2. European wetland archaeology research; previous methodologies

Research on wetland sites in different parts of north west Europe have employed a variety of methodological approaches which are designed to cope with the particular conditions presented by the sites and their environments. Some of these may be adapted to the investigation of Redcastle and other marine crannogs. For example, the excavation of timber trackways in Ireland, England and Germany have required linear trenches following the directions of the features and the exposed timbers required spraying with water to prevent drying and desiccation (e.g. Coles & Coles 1986, 44). Marine crannogs, similarly may require adaptations specific to the individual structures and the environmental conditions in the intertidal zone. Despite the differences in sites the exposure of organic remains on marine crannogs requires similar consideration given the potential for drying of such remains during low tide periods and the protection of the exposed areas during tidal submergence.

On the basis of the previous research on marine crannogs already documented in this thesis it was clear that Redcastle contained an unknown depth of stratified and delicate organic remains and structures. Excavation techniques specifically for marine crannogs are under-developed and the methods applicable to Redcastle are largely unknown. Approaches to stratified organic structures and

deposits in intertidal environments, however, have been developed during the research in the Severn Estuary (see Severn Estuary Levels Research Committee publications 1992-1998). In contrast to the evidence from previous investigations of marine crannogs the majority of sites encountered in the Severn Estuary intertidal zone did not present very deep stratigraphies. For example, the rectangular structures at Goldcliff were examined by survey of the upstanding remains, small-scale trenches were excavated to establish any sub-surface features and sections were sampled for sedimentary analysis (Bell 1992). This small-scale approach was ideal for the conditions presented by the intertidal environment and may be applicable to Redcastle marine crannog for recording and sampling purposes.

One possible approach to adapt for the Redcastle research was the multi-spectral archaeological and palaeoenvironmental sampling strategy used during the Assendelver Polders Project in the Netherlands (Brandt *et al* 1987). Although this project was on a much larger scale than the current research, it analysed raised mound or terp sites with varying amounts of organic remains, built on former estuarine levees by applying multi-spectral sampling and analysis techniques to the different sites. The approach taken on the Assendelver Polders sites was to identify traces of occupation (not necessary for the known marine crannog sites), trial trench to define the nature of the sites and excavate chosen sites. During the excavations the sites were sampled for ecological analysis, including bone, pollen, seeds, diatoms, parasites, insects and wood remains. This project demonstrated one approach to investigating sites built in wetland environments and some of which were situated in tidal situations.

It could be suggested that marine crannogs should be methodologically approached in a similar manner to that of Netherlands terp research, insofar as

marine crannogs may have been built on former estuarine shorelines and contain stratified organic remains. However, post-depositional changes have led to marine crannogs becoming submerged and this has ensured that the protected organics could still be present, unlike some terp sites which have remained above sea level, partially waterlogged but exposed to drying and desiccation processes. The approach taken was to test the hypothesis that Redcastle marine crannog had been built directly on to a former land surface, possibly in a shoreline situation and had been submerged owing to post-depositional changes in the Beauly Firth. Therefore by applying a multi-spectral sampling approach the origins of the site and palaeoenvironmental aspects of its location could be assessed for evidence of such a location and history.

6.3. Methodological problems and their solutions

This section outlines the measures necessary to adapt to archaeological investigation in the intertidal zone, specific to the fieldwork on Redcastle. They include the limited exposure time of Redcastle, access restrictions to the sites in the Beauly Firth, trench protection between tides, transportation of samples and small finds from the site and trench waterlogging problems.

In the course of the fieldwork in the Beauly Firth adaptations to sampling and excavation techniques were developed to prevent damage to any features exposed, especially during high tide periods. Access limitations experienced during the sampling and excavation were similar to those encountered during the survey part of the fieldwork, as outlined in Chapter 3 and were adapted by using a rolling timetable for teams of fieldworkers and ensuring that excavations were limited in size and for the amount of time the trenches were kept open.

Apart from the access limitations imposed by the intertidal mudflats and sandbanks and the tidal changes, potential problems with regard to sedimentary sampling in the intertidal zone are caused by the active re-working of sediments by fluvial and marine processes. This is exemplified by the disturbance and re-deposition of the surface muds during each ebb and flow tide. Not only do the surface sediments become disturbed by each tidal cycle, but also groundwater level varies in the intertidal sediments and this stimulates movement of both water and fine particles within the pore spaces between the larger grain sizes (Evans 1965). This can lead to the alteration of sedimentary compositions and may be reflected in the statistical signatures of the sediments sampled from the Beaulieu Firth.

The use of bulk sampling for sediments was restricted by a number of factors; the limited extent of the exposed areas and sections excavated, mainly on the south west side of Redcastle and the limited depth to which excavation and sampling could occur prior to trench waterlogging. In intertidal archaeology, waterlogging is a constant challenge because, even at low tide periods, the water-table is very close to the surface (Murphy & Wilkinson 1991, 12). This approach was preferred because of the paucity of information regarding the sedimentary foundations of these sites. The sampling and analysis methods adopted were those that could provide results defining the different characteristics of the sediments and consequently their potential for indicating the environmental conditions when they were deposited. The possible buried shoreline on which Redcastle was built was identified from the contour survey of the area surrounding the site (Figure 4.5.). The identification of differences between fluvial and marine sediments may enable the foundation origins of Redcastle to be understood. However, their deposition may also have been affected by anthropogenic activities. For example, later human disturbance of some of the surface stones on Redcastle illustrate that defining 'natural' process from

anthropogenic actions is not always distinguishable from artefactual evidence alone in such energetic environments.

The methods employed to investigate the archaeological remains on Redcastle were similar to those used on terrestrial sites although there were some particular adjustments designed to adapt to the intertidal environment. These included the rapid recording of every find, feature, deposit, context or structure on discovery. This method was essential because if the nature of a feature was not recorded upon exposure there was a possibility that it could be affected during the intermediate tide, before the excavators returned to the site to record the exposed remains. This method significantly increased the amount of recording time and thus limited the extent of the excavation during each low tide and over the total number of fieldwork seasons. Additionally, the complexity and large number of structures, deposits and small finds recovered that required on-site conservation, storage and subsequent post-excavation analysis, ensured that the extent of excavation was restricted. Many of the small finds were wooden and these required speedy recovery and conservation in order that they were protected for post-excavation recording and analysis. Larger structural remains, such as worked timbers were not removed but were recorded *in situ*, sampled for dating or identification purposes if wooden and re-buried. Greater provision would be necessary in the future for the lifting, transportation and conservation of the larger timbers found during the excavations on the south west of the site or on another marine crannog.

Excavated areas were temporarily covered between each high tide to protect the exposed archaeology, if a trench was to be left open for more than one low tide. This method was adopted to prevent sediment disturbance by erosion that could potentially alter the exposed features. Large sheets of plastic were placed over the

excavated areas and weighted down with stones removed in the course of the work. Additional sand bags and weights were used to hold down the larger sheets (Plate 6.1.). The sheeting used was chosen specifically because it had holes, 0.01m in diameter across it, which allowed water to pass through it but prevented it from acting like a billowing blanket and creating a micro-current beneath it when the site was submerged. The sand bags were used to protect particularly delicate features and to create small breakwaters around the trenches that dissipated any limited wave energy on-site as the tide ebbed and flowed.

Given the potentially destructive nature of the intertidal environment and the processes that have caused the timber structures to become exposed on Redcastle, it was necessary to limit the excavations. It was decided that the area excavated would concentrate, although not exclusively, on the features exposed by erosion on the south west edge of the site. This would ensure that limited areas would be investigated but that stratigraphic control could be maintained by concentrating mainly on the features of the south west of the site. Evidence from previous investigations on marine crannogs has shown the potentially destructive nature of archaeological research on the organic remains. The removal of the estuarine muds from the surface of Erskine exposed the structural timbers, which subsequently have become damaged or removed by tidal erosion and attacked by biological organisms. In order to minimise the damage to the Redcastle remains only small areas were examined during the fieldwork seasons.

6.4. Excavation methods

All excavation and sampling was carried out on Redcastle during low tide periods and aspects of the excavation methodology are outlined below. They include the trench locations and size, the reasons why they were positioned in particular

places on the site and what the excavations aimed to achieve. The trenches were located over semi-exposed features and positioned as a result of the 1:20 scale survey. Although the area on the south west side of the site was the location for the largest trenches, other parts of the site were also excavated especially where surface features showed that further investigation could reveal sub-surface structural remains.

Five small trenches were excavated on the Redcastle site during the fieldwork seasons (Figure 6.1.). The two largest (Trenches 1 and 2) were situated on the south west side of the site, the third (Trench 3) was located to the south of the centre and the fourth and fifth trenches (Trenches 4 and 5) were on the eastern margin of the site. Trench 1 was excavated after the preliminary site research had located surface timbers (Hale 1992). The trench was opened directly above the visible timber remains and was 5m by 4m. Trench 2 was positioned in order to investigate further exposed surface timbers on the south west of the site, to the north of Trench 1 and was 4m by 2m.

Trench 3 was 1m² and situated in an area dominated by large surface stones and in the area identified from the 1:20 scale survey of the site as containing a linear stone feature (Plate 6.2.). Stone walling has previously been documented on freshwater crannogs and had been identified as later re-use phases on earlier dated foundation structures (Holley & Ralston 1995). Previously the stone remains on marine crannogs have been suggested as being additional features such as breakwaters or causeways rather than the remains of integral structures (Munro 1905). Trenches 1 and 2 were excavated to record and sample the sub-surface wooden remains and to understand the relationship between the surface stones and the underlying timber structures. Trench 3 was excavated to assess whether the linear

stone walling was a later addition and whether it was associated with or later than the timber phases found in Trenches 1 and 2.

Trenches 4 and 5 were excavated on the margins of the surface stone cover and the surrounding mudflat. These trenches were situated in order to investigate the relationship between the surface stones, any underlying remains and the mudflat deposits. They were also designed to discover whether any sub-surface remains continued beneath the mudflats, indicating sediment encroachment and a possible change of depositional environment since the site was built and used. They were approximately 0.5m² and penetrated to 0.5m below the surface deposits. The amount and variation of different deposits and archaeological remains preserved show that this form of sampling and excavation is favourable in such conditions.

For the excavation of the trenches and other remains all surface features were recorded prior to the removal of the upper surface large stones. The underlying pebbles and gravels were then photographed and that deposit removed. Further recording would take place during this removal in account of the presence of the upper parts of timbers and other organic remains. The excavation followed a horizontal extent method, removing stratigraphic blocks equally throughout the small trenches. The spoil was sieved for small finds and the trenches were excavated using small tools such as trowels and brushes. As wooden remains were encountered the metal tools were replaced with wooden ones, in order to minimise the damage to the soft timbers. All the small finds were recorded and protective measures taken on-site to preserve them such as storing objects in water in sealed boxes with bubble-wrap linings to maintain the object's form and moisture content. When vertical sections were necessary for recording horizontal stratigraphy or for sampling purposes test sections were excavated, where appropriate.

As mentioned above parts of large wooden structures were uncovered during the excavations and these remains were sampled *in situ*. This was the chosen option rather than their removal by controlled lifting and transporting these extensive composite remains for laboratory conservation, which would involve additional fieldwork methods and post-excavation considerations. In order to minimise damage to the Redcastle framework timbers, only their upper surfaces were exposed during the excavation. Small test pits were excavated in order to understand the depth of the timbers in section, for species identification and to sample them for dating purposes.

Prevention of increased erosion during the Redcastle excavations was an important factor. This was considered important if the timbers were to be investigated for their age, extent and evidence of taphonomic processes, thus providing a record of the timbers which could in future be used if the site were to be re-investigated. Results from the erosion survey show that areas disturbed during the excavations underwent increased erosion which could potentially accelerate the deterioration of the exposed timbers (Appendix D).

The 60m linear stone feature to the west of the site was also investigated, to ascertain whether it was contemporary with the site, what type of materials it was built from, to what depth it survived and whether it was a causeway (Woodham 1954-1956). The large stone mounds near the centre of the site were also investigated. The largest mound was half-sectioned by dismantling the unconsolidated stones until the consolidated site surface was reached and any surface finds recorded. The aims of the excavation of this feature were to understand the relationship of these mounds with the surface stones, the excavated structures and what was their function.

6.5. Sampling of dateable material

One of the aims of the sampling strategy during the excavation was to provide samples for radiocarbon dating and if suitable tree-ring counts were found samples could be taken for dendrochronology. The samples were taken from various parts of the structural remains. During the excavation horizontal and vertical wooden remains, complete roundwood pieces, worked timbers and smaller fragments of wood and other organic remains were all encountered and sampled. Structural members that intersected, joined or were associated with others and could be used to show relative chronologies to other features, were also sampled.

The samples for radiocarbon assay were taken from the heartwood-sapwood boundary, if present, and were analysed for species identification prior to being submitted for dating. They were stored wet and identified by taking tangential, transverse and radial thin sections and then mounting the sections on microscope glass slides. The identifications were made using a binocular microscope with optics ranging from x10 and x100 magnification. The species thin section keys of Schweingruber (1990) were used, with additional reference to thin section material held in the Department of Archaeology, University of Edinburgh.

Dating of the radiocarbon samples was funded by Historic Scotland and once the timber species had been identified they were submitted to the Scottish Universities Reactor and Research Centre (SURRC) at East Kilbride, Glasgow. A sample of leather was also submitted for dating by the Accelerated Mass Spectrometry (AMS) process and was sent by SURRC to Beta Analytic laboratory in Florida, USA.

Radiocarbon dating was used because some of the selected samples were identified as alder (*Alnus* sp.), which cannot currently be matched to an absolute date using dendrochronology in Scotland (Crone A. pers. comm.). Sampling on Erskine marine crannog in 1985, provided oak and alder samples for dendrochronology and analysis of them showed that unfortunately the samples could not be tied into relative or absolute master chronologies (Crone A. pers. comm.). Any oak structural remains found during excavation were assessed for their suitability for dendrochronology by counting the numbers of tree-rings present in the sample. The minimum number of tree-rings suitable for dendrochronology that can be matched to a master chronology is generally accepted to be more than 40. The other possible restriction which may be encountered during dendrochronology to date the marine crannogs discussed in this thesis, is the absence of a reliable master chronology for the Scottish Iron Age. Although recent excavations have produced dendrochronology dates for a Late Iron Age, south west Scottish freshwater crannog (Crone forthcoming), they are more recent than the dates from Redcastle, implied by the radiocarbon results.

6.6. Palaeoenvironmental sampling methods

Specific to the investigations on Redcastle was the taking of samples from particular deposits and features in order that they could be assessed for their suitability for containing palaeoenvironmental remains. The deposits were sampled as both loose bulk samples in plastic bags and using Kubiena, metal monolith tins, which were hammered into sections exposed during the excavations.

Sub-sampling was undertaken for a variety of palaeoenvironmental indicators. Analysis of the sub-samples may also show post-depositional taphonomic processes that have affected the remains. Because marine crannogs are situated in

environments that are subjected to constant variations of water level, vertical and horizontal translocation of palaeoenvironmental indicators such as pollen grains may take place. The analysis procedures of the samples were therefore designed to provide a range of results that could be interpreted for palaeoenvironmental, topographic and taphonomic conditions.

6.6.1 Plant macrofossils; a methodology

Previous research on freshwater crannogs has demonstrated that well-preserved plant macrofossil remains can be found within stratified deposits (Miller 1997). Evidence from the records of the early excavations of Dumbuck also suggested that plant remains could be preserved on a marine crannog.

Plant macrofossil remains were found on Redcastle associated with different parts of the site, including the wooden structural remains and also in an off-site sedimentary core that could be used to interpret aspects of the topography of the area surrounding the site. Analysis of the plant macrofossils in these deposits was undertaken to assess their nature, contents and the environmental conditions prevalent when the deposits were laid down. It also aimed to establish whether the organics sampled on the south west edge of the site were similar, and possibly part of the same deposit, as that found in the core sample. Basal organic deposits containing plant macrofossils in Trenches 1 and 2 were present beneath the construction of the primary phase structures and could therefore be used as a relative environmental marker horizon. Samples were taken from; on-site within the structural remains, on-site below all structures and from an off-site location in a core transect.

Before the remains could be identified each sample was prepared for analysis. They were weighed and processed by hand, by washing through a series of stackable sieves, with mesh sizes 710 micrometers (μm , where $1\mu\text{m} = 0.001\text{mm}$), 355 μm and 180 μm . The remaining plant debris was then examined wet under a binocular microscope, at a magnification of x10 and x20 by Ruth Pelling of Oxford Museum. The identifications were made from morphological characteristics and by comparison with modern reference material held at Oxford University Museum. The interpretation and an assessment of the use of plant macrofossil evidence from Redcastle marine crannog are included in Chapter 8

6.6.2. Pollen sampling and analysis

Evidence of the survival of pollen taxa in a crannog environment was established by the excavations at Oakbank crannog, in Loch Tay (Clapham & Scaife 1988). A core sample from the site was analysed and the evidence indicated that regional vegetation types could be identified. Samples suitable for pollen analysis were taken on Redcastle to try to provide evidence of local and regional vegetation conditions prior to and during the occupation of the site. They were sampled during the excavation on the south west side of the site and were stratigraphically and chronologically controlled using the dated timber features.

A sample for pollen analysis was taken using a Kubiena monolith tin and hammering it into the exposed section inside a pit on Redcastle. The top of the 25cm long Kubiena tin was levelled to $0.41\text{m} \pm 0.1\text{m}$ OD. The resultant sediment sample (sample RDC95.29) was then removed from the section, wrapped in protective film and stored in a fridge until analysis was carried out. A second monolith sample was also taken adjacent to the first (sample RDC95. 50). It was positioned lower than the first, its top was $0.38\text{m} \pm 0.1\text{m}$ OD. This overlap was included in order that any

discrepancies could be identified and to verify the results from the first monolith sample.

Sub-sampling for pollen remains was carried out every 2cm down the length of both of the monoliths. The sub-samples were pre-treated and microscope slides were prepared using similar techniques to those described in Moore & Webb (1978). Essentially, the samples were treated in order that the non-pollen constituents were removed, using chemical concentration techniques. The remaining pollen grains were mounted in silicone oil on glass microscope slides and counted using a binocular microscope by Andy Haggart of the School of Earth and Environmental Sciences, University of Greenwich. The results are discussed in Chapter 8.

6.6.3. Diatom sampling and analysis

When attempting to reconstruct the water levels around Redcastle that were contemporary with the occupation of the site, it was important to sample evidence which could suggest tidal position and water type. Diatom analysis is a tool that indicates variations of salinity levels by identifying species that are characteristic of particular ecological niches. Individual species correspond with marine, brackish and freshwater conditions and can be used to demonstrate that those circumstances were prevalent. Sampling to test whether diatom analysis could be used successfully to indicate environmental conditions prior to and during the occupation of Redcastle was carried out and the results are discussed in Chapter 8.

A recent research paper on Scottish Holocene sea-levels used diatoms to identify particular positions of water levels in an intertidal estuarine environment (Dawson *et al* 1998). Two marker species within the diatom cores from Loch Gruinart on Islay were identified as marking ecological change from mudflats to

developing salt marshes, thereby indicating a specific tidal position; mean high water spring tides (MHWST), and these were confirmed by the current diatom species in the area. The diatoms analysed from samples taken on and near Redcastle were also identified for similar boundaries of palaeo-tide levels and the results are used indicatively in conjunction with the marker boundaries identified by Dawson *et al.*

Two samples were taken for diatom analysis during the excavations on Redcastle. One sample was a sedimentary core taken near the centre of the site to provide evidence of water conditions above the structural sequence found on the south west margin. The core was 0.33m long and the top was levelled to $1\text{m} \pm 0.1\text{m}$ OD. The other sample taken for diatoms was analysed to provide a comparative record of the water conditions and without the possibility of the anthropogenic disturbance identified in the sample taken on-site. That sample was taken using a Kubiena monolith tin from a test pit dug 15m beyond the south west edge of the site (Figure 4.5.). The top of the sample tin was levelled to $0\text{m} \pm 0.1\text{m}$ OD and was taken from a section excavated from 0.05m below the intertidal ground surface. It was tied into the geological profile from the core transect, see below and was taken from the fine grained, grey sand above the intercalated organics, which were sampled for evidence of plant macrofossils. It should therefore be representative of the sediments on the south west margin of the sand mound, corresponding to those into which the above mentioned timber structures were located. It would be analysed to provide any evidence of water levels in that part of the site.

Analysis of the Redcastle diatom samples by Andy Haggart divided them into the salinity classes as described by Denys (1991/2) where: *polyhalobous* species tolerate an optimal salinity of greater than 30‰ and represent marine conditions; *mesohalobous* species (salinity 0.2-30‰) are representative of brackish estuarine

conditions and *oligohalobous indifferent* species (salinity tolerant of less than 0.2 ‰) indicate freshwater environments. The results are presented in Chapter 8 and discussed in Chapter 10.

6.6.4. Insect sampling and analysis

Waterlogged sites offer the potential for the survival and preservation of insect remains, particularly beetles (*Coleoptera*) (Girling 1982). The presence of specific species of beetles can indicate palaeoecological characteristics of the site and surroundings and can also contribute to the interpretation of the function of the structures excavated on Redcastle. Bulk samples were taken from the sediments associated with the structural sequence on the south west edge of the site, and submitted for analysis to ascertain whether beetle remains were present and had been preserved to a degree that would allow their identification. Samples were prepared for analysis by diluting in a mixture of paraffin and water. As the heavier sediments settled to the bottom of the container, the paraffin separated from the water and collected on the surface containing floating organic and other macrofossil remains. The remains were then sorted and any beetle fragments were identified using modern reference material from the Royal Museum of Scotland in Edinburgh by Clive Warsop of the Department of Archaeology, University of Edinburgh. The results of the sampling and analysis are discussed in Chapter 8.

6.6.5. Charcoal sampling and analysis

The presence of charcoal in archaeological deposits may indicate burning, although not necessarily from a source on-site. Charcoal fragments similarly to pollen grains can travel distances from their source, whilst being carried as air particles, before coming to rest. Sampling for charcoal on Redcastle was undertaken in association with the remains on the south west edge of the site. Analysis of the

charcoal remains aimed to establish post-depositional movement within the waterlogged sediments, which could be indicated by the varying size range through the monolith. The results of the analysis are present in Chapter 8 and discussed in Chapter 10.

6.6.6. Routine soil tests; pH and phosphate spot test sampling and analysis.

Soil tests were used to indicate variations of sediment types and conditions on-site and were compared with an off-site control sample. The individual tests were carried out by Jennifer Thoms in the Department of Archaeology, University of Edinburgh. The pH of the soils was determined using a hand-held pH meter, calibrated with two standard solutions of pH 4 and pH 7. Each 20g soil sample was suspended in 50ml of distilled water. The solutions were left for twenty minutes and stirred occasionally. The meter electrode was immersed in the soil solution and the pH value was recorded after sixty seconds. Phosphate content of the samples was determined using the spot-test method (Hamond 1983). This method relies on the speed of reaction between the phosphate contained in the soil and two reagents; ammonium molybdate with hydrochloric acid and a solution of ascorbic acid. Chapter 8 discusses the results of the application of routine soil tests on sediment samples from Redcastle.

6.6.7. Using faunal remains as palaeoenvironmental indicators

Animal bones from archaeological deposits can be used as palaeoenvironmental and economic indicators of a site and surroundings. The bones excavated from Redcastle would be used in this manner because they were the most abundant small find from which palaeoenvironmental evidence could be reconstructed. They were analysed for identification of their species type and other

characteristics. Apart from the bones being found during the excavations they were also noticed during the erosion monitoring survey, especially around Trench 1.

All bones found were cleaned, dried and identified by Denise Carruthers, Nicola Murray and Sarah Witcher using the reference collection at the Department of Archaeology, University of Edinburgh. Results of the identifications were used separately to indicate the percentages of types of species found on-site and in conjunction with the other palaeoenvironmental evidence, to contextualize the site in its surroundings. The possible functions that involved the use of animals and the deposition of their remains were also considered. It is of interest to note the contrast between poorly-preserved bone remains found during the Oakbank crannog excavations and the well-preserved examples from Redcastle (Dixon 1981). The reasons for the variation between the freshwater and estuarine conditions may be because of the increased presence of salts in the water in the Redcastle deposits. It has been suggested that the bone preservation on Oakbank crannog was poor owing to the high acidity levels in the peat rich waters (Dixon 1981, 19), although other environmental factors could also have affected the taphonomy of the site and the animal bone preservation.

6.7. Sediment sampling aims and methods

Sediment sampling on Redcastle aimed to provide evidence of vertical and horizontal variations beneath and associated with any structural remains. Changes within sediments can potentially indicate differences in the depositional environment. As already described, sampling on the south west of Redcastle was undertaken using both bulk and Kubiena monolith tin sampling techniques. Each sediment sample was levelled to the TBM and also relatively to the structural sequences and to any elements that had been radiocarbon dated. The aims of the

sampling of sediments on-site were to understand whether changes of sediment could be compared with specific structural phases and whether they could be identified as being related to sea-level events in the Firth or more local changes in the topography and water level.

The contour survey established that Redcastle is situated on the edge of a sub-surface geological feature. On the end of the feature is a steep slope, which forms the south west edge of the site and is possibly a shoreline or edge of a palaeo-channel. Sedimentary sampling and analysis of this feature was undertaken to assess the remains and to integrate them with the evidence from the contour survey. One particular sample was taken 15m off-site in order that the sediments beneath the intertidal surface muds could be analysed. This location was chosen because it could provide sediments that could be tied relatively into the structures and sediments on-site and which would not be directly disturbed by anthropogenic activity. The results are discussed in Chapter 9.

The method used to prepare the sediment samples for analysis was that outlined by Buller and McManus in Dyer (1979). Each sample was initially oven dried at 110° C over a twelve hour period and then passed through a 2mm (-1.0 Phi, ϕ , after Krumbein 1934) gauge sieve to remove all particles above fine gravel size. The Phi scale was developed to replace imperial or metric measurements of sediments. It uses a logarithmic scale of size classes and expresses the particle size as the negative logarithm, to the base of 2 of the diameter in millimeters: ϕ (Phi) = $-\log_2 d$, where d is the diameter of the particle in millimeters. For example, $1.0\phi = 500\mu\text{m}$ and $2.0\phi = 250\mu\text{m}$ (see page 250 for conversion tables).

Two of the samples were also subjected to Loss on Ignition analysis, which assess the amount of organic content in a sediment by drying, weighing, igniting and re-weighing the remaining sample (Manheim, Meade & Bond 1970). The sieved samples were passed through a stack of sieves from 0 to 4 Phi, with the coarsest sieve at the top and the finest grade at the bottom. Each sample was mechanically shaken for twenty minutes and the retained amount on the sieves was weighed and recorded as a percentage of the total sample weight. The results of each sample were recorded as cumulative frequency curves. This allows the data to be analysed in comparison with the log-normal distribution of a sediment. The samples taken were analysed for their particle size characteristics, namely the proportions of different grain sizes (Krumbein 1941, Doeglas 1968). Particle size analysis would enable the environments of transport and deposition of a given sediment to be evaluated.

Some of the samples were also submitted for analysis of the fines percentage; clay sized particles below 0.002mm diameter, when the amount retained on the smallest sieve mesh was greater than 20 % of the total weight. The aim of this type of analysis was to establish the percentage content of clay sized particles that could show that the depositional situation was a very low energy environment, such as standing water. The sample locations were chosen to correspond with the two monoliths; the first sample RDC96.6 was taken from 0.1m below the surface of the site and above the monolith tins, discussed above. The second sample, RDC96.8, was taken from 0.5m below the ground surface and below both of the monolith tins. The samples were initially prepared similarly to those outlined above by being sieved to the same Phi size sieve (4 ϕ) and the retained material was then subject to a fines counting procedure.

The instrument used to measure the percentages of the fines was a Micrometrics 5000ET SediGraph Particle Size Analysis System. The apparatus uses a fixed x-ray and detector to measure the gravity-induced travel rates of different sized particles, held in a liquid of known property. The x-ray passes through a cell containing the sample, which in this case was distilled water. The individual particles of the sediment are measured according to Stokes' Law, which states that particles fall at different rates; the largest fall fastest and the smallest at the slowest rate (Hsü 1989). See Chapter 9 for the analysis results.

6.7.1. Core sampling

Coring for sediments was used to provide a stratigraphic profile on either side of the site. This would allow a profile to be reconstructed of the sediments towards MHWL and MLWL. The aims of coring either side of the site were to establish if and where buried geological features such as palaeo-channels and previous shorelines were located. If such features were found they would enable aspects of the former topography surrounding the site to be reconstructed.

Cores were taken along a north east to south west transect from the current shoreline across the site and towards MLWL, in addition to the evidence of the sub-surface features highlighted by the contour survey. The coring aimed to sample the sediments in the upper layers of the sub-surface deposits in order to understand the geology masked by the intertidal sediments. The coring was carried out using a Russian-type borer and 22 cores were taken; 16 between the shoreline and the site and 6 from the south west edge of the site towards MLWL. The cores were taken from the upper 1m of sediments because they represent the more recent Late Holocene deposits and can be stratigraphically related to those on-site. The head of each core was levelled using the $1.3\text{m} \pm 0.1\text{m}$ OD TBM on-site and the 3.6m OD

BM on-shore. Each core was photographed and a field record form completed for the sedimentary types, colours, vertical changes and intercalated deposits, such as organic banding.

6.7.2. Sediment sampling in other parts of the Beaully Firth.

Samples were taken to assess whether the position of the different marine crannogs affects the type of surface and sub-surface sediments present. If variations between the sites were found they could be indicative of their original positions and the processes that may have affected the archaeology. Random sampling of the surface and immediate sub-surface (0.1-0.5m) sediments on Carn Dubh and Phopachy was carried out to provide comparative samples from two other marine crannogs in the Beaully Firth.

Samples were taken from the surface of Carn Dubh and at 0.1m depth intervals (CD94.1-CD94.4). The surface sample (CD94.1) was levelled to $-0.9\text{m} \pm 0.1\text{m}$ O D. The samples were processed in the manner described above. Five samples were taken on Phopachy; at the surface (P94.1, -1.5m O D.) and at every 0.1m intervals to 0.5m depth (P94.2-P94.5). Additional samples were taken at the current MHW (RDC96.14) and MLWM (RFT95.6) near Redcastle to provide comparative material from those environments. All samples were analysed for particle size characteristics using the methods described above and the results are discussed in Chapter 9.

6.8. Summary

Overall the excavation and sampling represents a relatively small sample of the total area of the site (less than 5 %). However, as will be shown below the results

of the limited excavations have provided large quantities of remains on which multi-spectral analysis techniques are applied.

The excavation and sampling strategy was designed to highlight the methods that can be developed and the potential of marine crannog investigation. The problems of restricted access time experienced during this research may be largely overcome by applying small-scale trenching techniques, combined with careful protection of the trenches during high tide periods. In contrast to terrestrial excavation, intertidal excavation requires rapid and sometimes sequential recording, sampling and re-burial or protection during each low tide period on-site. This method of excavation requires some additional fieldwork team organisation and can be very successful within the limited time on-site.

The variety of the remains preserved on Redcastle and the techniques available for their analysis shows that marine crannogs contain well-preserved palaeoenvironmental indicators. By combining the sampling aims and sub-sampling for separate analysis techniques the use of multi-spectral analysis will be assessed. The results in the next chapters illustrate the applicability of the techniques used to understand some of the characteristics and changes to the location, form, function and chronology of Redcastle.

CHAPTER 7

Redcastle marine crannog excavation, Part 1: excavation results.

7.1 Introduction

This chapter will describe the results of the excavations on Redcastle and in particular it will discuss the areas excavated, the structural remains recovered, the small finds associated with the structures and the radiocarbon dates that were taken as a result of sampling from the individual features and small finds.

As mentioned previously Redcastle is located in a wide bay on the north shore of the Beaully Firth. During low tide, the entire bay becomes exposed and the site is surrounded by extensive mudflats (Plate 7.1.). On the surface of the mudflats are drainage runnels and the site occupies a point on the end of a sub-surface promontory. The promontory, identified by the contour survey, may be the remains of a former shoreline feature and was examined during the excavation. The site itself is an irregular shaped mound, covered by an uneven scatter of large stones. Some parts of the surface have been eroded to reveal sub-surface timbers and other organic deposits and it was these exposed features on the south west edge of the site that were the location for the largest two trenches (Figure 6.1.).

The excavations aimed to assess whether small-scale trenches, strategically placed, could be used to gain information as to aspects of the construction of the site, given the limited time available on-site during each low tide. During the course of the excavations the type of procedures outlined in Chapter 6 were developed and tested. The trenches were designed to understand the structural development on

particular parts of the margins of the site, where survey had shown that timber features were exposed by tidal erosion. Trenches were also placed to ascertain the extent of some other stone features and to understand the sequence of remains in specific parts of the site, and will be outlined below.

The excavations on the site revealed that there were three major building phases; Phase One consisted of a series of shallow, wattle-sided pits that had been dug into the short slope on the south west edge of the site. Phase Two lay directly on top of the first and was made up of a large wooden framework built in a curvi-linear plan to reflect the curved form of the slope on the south west edge of the site. The third phase was made up of further deposits on top of the Phase Two framework, especially noticeable towards the centre of the site. Other features which could have been part of Phases Two and Three are also discussed below. The results of the radiocarbon dates from the particular features excavated are included in this chapter as uncalibrated dates BP (see Appendix E for the calibration of all the dates).

7.2. Trench 1: results

Trench 1 was positioned where previous survey had identified an area of erosion that had resulted in the exposure of large horizontal timbers. The method of excavation employed required the initial removal of all surface stones and seaweed. Beneath the large surface stones a sandy gravel deposit was found that contained the upper remains of various wooden features. The sandy gravel deposit was removed and found to be between 0.005m and 0.02m deep. Beneath this deposit was a fine-grained grey sand and in places areas of intercalated sandy silt. All contexts from the trenches excavated are included in a Harris matrix diagram (Figure 7.1.), showing the stratigraphic relationships between the various features excavated in the different trenches.

7.2.1. Phase One: Pit One (Figure 7.2. and Plate 7.2.)

Two shallow wattle-sided pits were found next to one another dug into the sand ground surface. The upper limits of Pit One were in contact with and covered by the pebble and gravel deposit which had been recorded during the 1:20 scale survey in most parts of the site underneath the large ORS surface stones. Pit One consists of thirteen vertical wooden sails that delineate a near-circular plan, 1.2m in diameter. The sails are complete roundwood pieces, identified as alder (*Alnus* sp.) and their diameters vary from 0.05m to 0.076m, with between 6 and 10 annual rings (see Table 7.1. for details of worked wood excavated on Redcastle). Sail 5 was chosen to be fully excavated so that it could be fully examined (Figure 7.3.). It was chosen because there was no wattling around its top and it was in an area that had appeared to have undergone additional erosion. Excavation of sail 5 indicated that the tip had been cut to a form described as 'chisel-ended' (Sands 1997).

Around the sails thin willow (*Salix* sp.) branches form the wattle border to a maximum depth of 0.2m (Figure 7.4.). The wattle branches, or 'rods', are long thin pieces wound around the sails and any off-shoots had been removed by trimming to leave a single rod. The bark on some of the rods appeared blackened and there were charcoal flecks in the surrounding sediment. A sample for radiocarbon assay was taken from sail 12 and the resultant date was 2310 ± 50 BP (GU-4094).

The interior of Pit One consists of three main deposits and a number of discrete remains (Figure 7.5.). The surface of the feature was covered by ORS stones and pebbly gravel matrix. At the lower level of this deposit and in the upper levels of the underlying silty sand were a large number of animal bones. Underneath the surface stones was an deposit of silty sand in which there were some large ORS

stones. These stones may have been placed deliberately inside the pit because they respected the wattling and no stones were found at this level outside of the pits. These internal stones were only one layer deep and across their tops were four split alder branches. The remains of a grey clay deposit was present around some of the wattle rods. Beneath the level of the wattling was a grey fine sand, into which the points of the sails had been driven. Beneath the packing stones and the interstitial silty sand was the fine grained, grey sand, which continued to a depth of at least 0.6m below the tops of the sails. Before that level was reached the excavation of a test section became difficult because of increased waterlogging and the collapse of the sides of the section. However, it was noted that the tips of the sails penetrated a compacted layer of leafy organic remains, approximately 0.3m below their tops. This deposit was sampled and analysed for plant macrofossil remains (see Chapter 8).

Small finds from inside Pit One included oak and alder woodchips (Plate 7.3.). Although they were not represented in very large quantities, their presence may be useful during the interpretation of the structure and the possible activities that took place on-site (see Table 7.2.).

Five small fragments of leather were recovered from inside Pit One, beneath the large internal stones (Plate 7.4.). Yellow and brown staining of the sand indicated where further remains of the leather may have been present beneath the stones. The fragments were submitted for identification and analysis and one piece was sent for radiocarbon assay. Using the accelerator mass spectrometry (AMS) technique the resultant date of one of the leather fragments was 2220 ± 70 BP (AA-21249).

7.2.2. Phase One: Pit Two (Figure 7.2.)

Pit Two was an oval wattle-sided pit, which consisted of 10 oak roundwood sails. They ranged from 0.042m to 0.095m in diameter and when sampled the ring-count varied between 6 and 13. The structure was 2.1m across the long axis and abuts Pit One to the south. The species of the wattle rods wound around the sails have been identified as willow with a single piece of hazel (*Corylus*). The upper two wattle rods were sampled and their diameters varied between 0.002m and 0.028m, with 6 and 10 rings respectively. The wattling was intact between sails 1-5 and between sails 5-10 it was absent, which may have been caused by preferential erosion on that part of the structure. To the south west of Pit Two, adjacent to sail 9, were some horizontal wattle rods, which appear to have been part of the wattling from the pit and have subsequently become disturbed from their original position, similarly, this may be owing to erosion in that area. Sail 5 was sampled for radiocarbon assay and the resultant date was 2330 ± 50 BP (GU-4095).

Sampling inside Pit Two took place in the area between sails 7 and 8 where erosion had exposed the lower deposits and similar fill types were found to those in Pit One. On top of a single layer of 12 large ORS stones was the continuation of the thin layer of gravel and pebble matrix seen in Pit One. Beneath the stones was the interstitial silty sand that surrounded the ORS stones and around the wattling between sails 4 and 5 were traces of grey clay. Beneath the interstitial deposit was the upper surface of the fine grained, grey sand and into which the sails of both pits had been driven. A number of animal bones were found scattered over the pit, they were mainly in the upper sandy gravel deposit.

7.2.3. Phase Two structures (Figure 7.6.)

The structural remains of Phase Two in Trench 1 are situated directly on top of Pit Two (Phase One) and adjacent to Pit One (Plate 7.5.). The remains uncovered in Trench 1 seem to be part of a more extensive framework, some of which were found between Trenches 1 and 2 on the surface of the site (see Plate 7.6.).

The feature uncovered in Trench 1 consists of three timbers, the largest of which (RDC94.T.6) measured 0.5m wide, was over 3m long and was noted to continue beyond the north edge of the trench. A large square mortise hole, 0.25m square and 0.1m deep, had been cut 1.2m from the south end of the timber. The hole was cut completely through the timber and was filled with silt and woodchips. The cut-marks inside the mortise hole had been made from both sides of the timber (Plate 7.7.). Most of the upper surface of the timber was flat and at the south end it appeared to have been broken across the grain. At that point the heartwood was distorted and raised, indicating possible desiccation because of wetting and drying periods. A sample of this timber was taken for radiocarbon dating and the result was 2480 ± 50 BP (GU-4097).

Timber RDC94.T.7, was exposed for over 2.5m in length and continued beneath the surface deposits beyond the edge of the trench. To minimise the threat of damage to the timber by erosion, it was only exposed within the trench. The timber is 0.5m wide and although flat on the upper surface it too showed similar signs of deformity of the heartwood at the western end. The flat upper side indicates that it could have been cut or split from a complete trunk, possibly using the tangentially faced method (Allen 1994, 4). The timber abuts RDC94.T.6 where the mortise hole is positioned. The third timber of the cross feature, RDC94.T.5, is 0.7m long and 0.45m wide and is deformed along its entire length, resulting in longitudinal raising

and complete splitting of the heartwood. The west end also appears damaged and eroded. A sample from this timber was radiocarbon dated to 2550 ± 50 BP (GU-4543). This short member of the cross feature also abuts timber RDC94.T.6 adjacent to the mortise hole. All of the horizontal timbers discovered from Phase Two in Trench 1 had their bark present.

Three small vertical oak piles are adjacent to the Phase Two timbers. Two of the piles are on the west side of RDC94.T.6 and the third is north of RDC94.T.7 (see Figure 7.6.). The top of the third pile had been damaged and is severely flattened. The exact cause of the damage was unclear but may have occurred during the driving of this pile or it may be evidence of post-deposition action caused by movement of the large surface stones. All three retaining piles seem to be associated with the horizontal timbers, rather than the underlying wattle pits. One of the retaining piles was sampled for radiocarbon assay and the resultant date was 2510 ± 50 BP (GU-4541).

Small finds associated with the second construction phase included a large quantity of animal bones found in the surface deposit of gravel, scattered over and adjacent to the horizontal timbers (Figures 7.7.-7.9. and Table 7.3.). It should be noted that the distorted parts of the timbers were those that had been exposed prior to excavation and had been noted as early as 1991 (Hale 1992). Other parts of the timbers that were excavated during the current research were found to have been cut flat, although no signs of wood-working, such as cut-marks were found on their exposed, upper surfaces.

7.3. Trench 2: results (Plate 7.8. and Figure 7.10.)

The north east to south west trench was 2m wide and 4m long and was divided into quadrants; the north west and south east were excavated. The excavation of opposite quadrants aimed to provide contrasting views within the same trench; the upper included part of the framework structure and the lower focused on the natural slope of the site margin and contained no visible structural remains. In this trench a structural sequence similar to that in Trench 1 was identified. The trench was positioned on the steep slope of the site with the upper, north east quadrant overlying part of the exposed timber framework. The location was chosen in order that part of the framework and the very margin of the site could be excavated, which would enable the association between the framework and the margin slope of the site to be established.

Two construction phases were found in the north west quadrant; the lower, Phase One, consists of a shallow, wattle-sided pit and Phase Two is two horizontal timbers laid across the middle of the underlying wattle pit. In the lower quadrant no structural remains were found although the sediments revealed a number of stained features and some small finds were recovered.

7.3.1. Phase One: Pit Three

Pit Three was an oval, partially wattle-sided pit similar to the two found in Trench 1. It is 1.3 m wide across the north east to south west axis and has 9 circumferential sails, three of which have wattling wound around them. Six of the sails were alder and the other three were oak. The tops of two further sails were discovered outside the excavated area near the north east section amongst the surface pebbles and gravel and appear to be part of the same structure. The diameter of the

roundwood sails is between 0.03m and 0.036m and they show an age range of between 4 and 8 growth rings (Table 7.1.).

The wattling around the sails was identified as hazel rods wound around their upper 0.15m. The tops of the sails showed signs of damage causing them to be split or bent. The wattling was only preserved *in situ* at the north east end of the trench. On the other side of the timber towards the lower part of the trench it was absent apart from a few splayed fragments. These splayed rods may be the remains of the wattling which became dislodged from around the sails by erosion on the edge of the site. The six wattle rods range in diameter from 0.013m to 0.029m and they were branches with between 3 and 9 growth rings.

The upper surface of Pit Three was covered with the gravel and pebble matrix, similar to those deposits found in Trench 1. Inside the sails and wattling were thirteen large ORS stones, positioned to respect both the remaining wattling and the overlying horizontal timbers (Plate 7.9.). The stones were only one layer deep and surrounded by an interstitial silty sand. On parts of the wattling were traces of grey clay, similarly to that found in Pit One. Beneath the interstitial silty sand and ORS stones was a fine grained grey sand which extended beyond 0.8m in depth below the tops of the sails, discovered whilst excavating a small test section in the quadrant. This deposit was intercalated with a horizontal layer of compacted organic fragments, into which the tip of sail six had penetrated. This was at a similar level and in appearance to the organic deposit found beneath the sails in Pit One. The small finds recovered in the north west quadrant of Trench 2 include six wood-chips and six wood fragments (Table 7.2.).

7.3.2. Phase Two structures (Figure 7.10.)

Overlying the wattle pit in a north south orientation were two large horizontal alder timbers (RDC94.T.4 and RDC94.T.2). These timbers were surrounded by the interstitial silty sand deposit and their upper surfaces were covered by the gravel and pebble matrix. Excavation found the northern end of timber RDC94.T.2 protruding beneath RDC94.T.4 and they were positioned with 0.3m of their ends overlapping one another. Square mortise holes, 0.1m by 0.1m had been cut 0.25m from the ends of each of the timbers and the holes were located above one another. An oak pile was positioned through both mortise holes, effectively fixing the timbers in place. This pile was sampled for radiocarbon assay and the resultant date was 2570 ± 50 BP (GU-4542). Inside the mortise hole were wood-chips, again suggesting on-site wood-working and a wooden wedge. This method of fixing the framework timbers in place was also evident outside the trench in an area of the framework that had become exposed, at the junction of timbers RDC94.T.1 and at the other end of RDC94.T.2.

The upper surface of RDC94.T.4 was flat and smooth and similar to those timbers in Trench 1, which had not been previously exposed. The timber plank still retains its bark on both edges and appeared to have been cut or split from a complete trunk. Adjacent to the timbers and driven into the underlying pit was a pile that did not appear to be part of the wattled structure. This feature was similar to those found associated with the horizontal timbers in Trench 1 and may to have been a retaining pile. The small finds from the upper levels of the north east quadrant of Trench 2 include two bone fragments (Table 7.3.).

Additional timbers, probably part of the same framework, were noticed in other parts of the site, during the fieldwork seasons. These timbers were recorded

beneath the surface stones and the plan of their positions extends the curvi-linear form of the framework (Figure 6.1. and Plate 7.6.).

7.3.3. South east quadrant (Figure 7.10.)

The south east quadrant was cleared of all large surface stones and the thin deposit of estuarine mud. The surface stone, gravel and pebble matrix were removed to reveal a sloping surface of fine grained grey sand. The surface of this sloping deposit was mottled with orange and brown stains and included a concentration of broken shell fragments. Some of the stains were rounded and seemed to resemble animal footprints, possibly from cattle hooves (Plate 7.10.).

At the south west end of the trench, at the lowest part of the slope, a number of wood fragments were found just below the modern estuarine mud. There were no cut-marks on these small finds and it would appear that they could be fragments that had been rolled and smoothed in moving water and were subsequently deposited at the bottom of the slope of the site. The edge of the trench in this quadrant was extended towards the south west and sectioned in order that the sediments could be sampled and recorded in section (Figure 7.11., Plate 7.11.).

7.4. Trench 3: results(Figure 7.12., Plate 7.12.)

This trench was positioned to establish the form of the linear stone feature found on the south part of the site, during the 1:20 survey. Two phases of construction were found in this trench, the first corresponded with the wattle pits found in Trenches 1 and 2, however, the second had not been previously recorded in the other trenches.

To investigate the first phase the surface stones were removed from the south east part of the trench, which abutted the linear stone feature. Three layers of loose ORS stones were removed before a surface of estuarine mud was encountered. Beneath that was fine grained, grey sand from which the tops of five small, roundwood alder piles protruded, which were positioned around a 0.3m diameter alder pile. The exposed top of this larger pile was completely flat, as if it had been cut, rather than it forming an erosion cone through natural processes. An erosion cone can form when the top of a pile is exposed above surrounding sediments and the outer, softer sapwood becomes eroded. Despite there being no visible wattling present around the smaller piles on the surface of the trench the feature resembled those wattle pits found in Trenches 1 and 2.

The second phase of construction consisted of the stone walling, which was positioned across the underlying piles (Figure 7.13.). The drystone walling was three courses deep and based on the 1:20 survey results continued outside the trench for over 10m, in a north east to south west direction (Plate 6.2.). The lowest course of the walling was in contact with the pebbly gravel deposit found on other parts of the site, which is mixed with numerous organic remains, unworked wood fragments, twigs and leaves in this trench. Despite there being no evidence in this trench of the horizontal framework, the stone walling forms a specific feature above the Phase One feature and is therefore included as a Phase Two structure, although from the excavation it cannot necessarily be directly associated with the framework.

7.5. Trench 4: results (Figure 7.14., Plate 7.13.)

Trench 4 was located on the eastern margin of the site where the surface stones are covered by the surrounding mudflat sediments. The surface sediment was removed and beneath it the large stones continued. The trench contained the badly

eroded and damaged remains of the top of a vertical wooden pile. Clearance of the large stones revealed a void between two parallel courses of stones and the pile was surrounded by fine grained, grey sand deposit, between the two stone courses. The small finds from the trench were two wood fragments that had been smoothed, probably by movement in water and a small fragment of an animal bone (see Tables 7.2 and 7.3, respectively).

7.6 Trench 5: results (Figure 7.15., Plate 7.14.)

Trench 5 was excavated farther east from Trench 4, beyond the visible site margin, on the surrounding mudflats. Beneath the surface estuarine mud was a layer of stones similar to those on the surface of the site, 0.1m below the current surface. Beneath the layer of stones is an intercalated and well preserved organic deposit, that contains shell fragments and a piece of oak roundwood lying horizontally across the trench. Below the sub-surface stones a fine grained, grey sand was encountered similar again to that found in other parts of the site. No structurally coherent remains were identified but the continuation of the stones beneath the surface sediments and the small finds suggests that stones from the surface of the site do continue beyond the visible margin at least in that area.

7.7. Stone mound excavation (Plate 7.15.)

During the course of the excavation seasons the largest of the stone mounds near the centre of the site was examined. It was dismantled by half section to investigate its relationship with the phases found on other parts of the site (Figure 7.16.).

No coherent structure was found during the dismantling of the mound and the stones lie directly on top of the consolidated surface of the site. The small finds found on that surface suggested both the age and use of the mound. Among the stones and pebbles were the remains of bird bones (Table 7.3.) and also a number of shot-gun cartridges. The significance of these small finds and the interpretation of the stone mounds on the surface of the site are discussed in Chapter 10.

7.8. Off-site linear stone feature

Inspection of parts of the 60m linear stone feature to the west of the site, identified no sub-surface remains. The absence of any remains, such as timbers shows that this feature was probably not built as a causeway. The feature consists of one or in places two layers of large ORS stones, which are similar in size and shape to those on the surface of the Redcastle site. The feature is curvilinear and forms an arc that curves away from the site towards MHW. However, it stops over 200m short of the current MHW. Whether this distance from the current MHW is significant is unclear from the investigation. It may indicate that MHW has shifted landward and that the feature did once reach the shoreline, or that it was built for an altogether different purpose. As mentioned above, observation of the rising tide around the site showed that this feature acted to delay tidal incursion and perhaps this was the original purpose.

7.9. Summary

Excavation of Trenches 1-5, part of the surface stone mound and the off-site curvilinear stone feature enable a number of points to be made about the structural development of Redcastle. Trench 1 excavations revealed two phases of building near the south west edge of the site; the initial wattle pit phase followed by the

overlying framework. The phasing of the initial pits, which were subsequently replaced with the framework, indicate a change of use of that part of the site. The reasons for the change of building are unclear and may be as a result of both social and environmental factors. Disturbance and absence of the wattling on the south west part of the pits in Trench 1 indicates that that area was, and may still be, prone to erosion, compared with other parts of the pits, which showed the wattling still intact.

Trench 2 confirmed aspects of the structural development found in Trench 1 on another part of the south west side of the site. The primary wattle pits were superseded by the horizontal framework and similar evidence of erosion was recorded on the wattle near the margin of the site. Excavation of the upper and lower quadrants provided evidence of built remains and other activities that occurred in that part of the site. The possible animal hoof prints in the lower quadrant show that live animals could have been present on-site. This evidence complements that from the faunal remains (see Chapter 8).

Trench 3, showed two structural phases, however, the primary pit showed no signs of wattle-work, although this may be owing to erosion. Phase Two in this trench was not an extension of the wooden framework, but a stone wall. This may indicate that in that part of the site conditions were different to those on the south west edge and that the timber framework was replaced by a stronger and more robust stone wall.

Evidence from Trenches 4 and 5 show that in that part of the site the surface stones continue beneath the estuarine muds. The absence of stones in the middle of Trench 4 and the remaining vertical pile may suggest that structural features still

exist in that part of the site. In Trench 5 the horizontal oak roundwood may also have been a structural timber.

The stone mounds on the surface of the site appear to be the remains of later disturbance. This may indicate that any stone features on the upper parts of the site may have been largely destroyed by the later construction of the stone mounds. The construction of the off-site curvilinear stone feature may also point to later disturbance of the surface stones. The variety of stone features and the composition of stone and wooden materials indicates that at least on Redcastle marine crannog stone was an important component in the building phases and that small-scale trenches have been able to define some of those phases.

The small finds from all of the trenches were largely wooden pieces, both waste in the form of chips from wood-working, and stray twigs and broken pieces. Some of the fragmentary pieces may have been remnants of wattle rods that had become dislodged as a result of erosion. Additional to the wood small finds were the relatively large quantity of animal bones, especially in Trench 1. The significance and conclusions that can be drawn from the faunal remains and the wooden small finds will be discussed in Chapter 10.

The results show that the methods applied, using small-scale trenches, designed to expose specific features and located with care, can be excavated during low tide periods in intertidal locations. The excavations revealed that a variety of well preserved structural remains and small finds were preserved and could be examined, recorded and sampled in the limited time that was available.

CHAPTER 8

Redcastle marine crannog excavation, Part 2: palaeoenvironmental results.

8.1. Introduction

This chapter discusses the results of the sub-sampling for specific palaeoenvironmental indicators on selected samples, acquired during the excavations on Redcastle. The sub-sampling was designed to apply a wide spectrum of palaeoenvironmental analysis techniques in order to answer specific questions about the site and to provide reference results for research on other marine crannogs. The aims of the analyses were to test which techniques were suitable and this chapter describes the results from the individual techniques applied. The chapter describes the results in the same order as the individual analysis techniques were outlined in Chapter 6, apart from the sedimentary analysis results which are discussed separately in Chapter 9.

8.2. Plant macrofossils

Samples were taken from various parts of the site and from off-site locations for plant macrofossil analysis. As noted in the previous chapter an intercalated deposit of compacted organic remains was discovered in Trenches 1 and 2, which was penetrated by the tips of the sails of the wattle pits (sample number RDC97.3). A similar deposit had also been found in some of the sediments sampled from the off-site core transect (sample RDC97.core 7). Other samples taken for plant macrofossil analysis were taken in contexts associated with the upper levels of the pits (RDC96.17 and RDC95.36) and associated with the timber framework on the

south west edge of the site (RDC96.5). A sample from Trench 5 was also analysed owing to the large amount of well preserved organic fragments (RDC95.76).

8.2.1 Pre-construction plant macrofossils (Table 8.1.)

One sample taken off-site from a sedimentary core (RDC97.core 7) and one from on-site beneath the structural remains on the south west edge of the site (RDC97.3) were analysed for plant macrofossils. The species found in RDC97.core 7, were from an organic rich sand deposit that was levelled to between -0.1m to -0.3m $\pm$ 0.1m OD. The sample contained occasional leaf fragments, which could not be identified. However, seeds from alder trees and seeds from catkin scales of birch (*Betula* sp.) were identified from the sample, which contained mainly broken and unidentifiable fragmentary remains.

Sample RDC97.3, was levelled to 0.13m $\pm$ 0.1m OD. The sample was very compacted and less than 3cm in depth and excavation had showed that it was present along the south west edge of the site. Analysis of the sample indicated that the deposit was dominated by fragments of deciduous leaves, although the majority of which could not be identified. The presence of certain species could be derived from associated remains. Leaves of alder were identified by the presence of the gall mite (*Eriophyes laevis-inangulis*) which is associated exclusively with the species. There were also bracken fronds (*Pteridium aquilinum*) preserved in the sample.

The above two samples are derived from similar deposits of leaf litter predominantly consisting of alder and birch woodland remains. With bracken fronds present this suggests that the deposits were from woodland floor cover. Bracken is not tolerant of deep shade, suggesting therefore that the tree cover was not very

dense and its presence in the deposit is indicative of a light acid soil (Pelling R. pers. comm.).

8.2.2. Plant macrofossils associated with the structural remains (Table 8.2.)

Evidence of disturbed or cultivated ground is suggested in sample RDC95.36 by the presence of, for example, fat hen/goosefoot (*Chenopodium* sp.) and chickweed (*Stellaria Media* type). Chickweed is a plant which grows in waterside environments (Clapham *et al* 1987). The presence of these two species and the absence of plant macrofossils which show cultivated ground indicates that the remains could be derived from disturbed ground in a waterside location. Sample RDC96.17 contained quantities of alder seeds and was taken from close to the timber framework. The presence of alder on-site is also confirmed by the identification of the species of some of the primary pit sails and the horizontal framework timbers.

Analysis of the plant macrofossils in sample RDC95.76, indicate that this deposit was derived from a number of locations and could represent a secondary deposit and a period of disturbance. The fat hen/goosefoot indicates the presence of disturbed ground and the buttercup (*Ranunculus acris/repens/bulbosus*) represents wet and marshy conditions. The alder seeds may also be used to infer wet ground conditions, although the seeds may have been brought on to the site by humans, perhaps during a construction phase when the trees were being converted into the various timber features.

Sampling from an organic rich deposit found adjacent to the timber framework yielded results representing a distinct assemblage. The sample (RDC96.5) was taken from inside the framework and has plant remains representing two specific environmental conditions some of which are similar to those identified

above. Similar species that represent disturbed and cultivated land are again present but in lower quantities than previously. The other species identified are largely characteristic of wet or marshy ground. Crowfoot (*Ranunculus* subgenus *Batrachium*) is a group characteristic of aquatic or semi-terrestrial conditions and has been found in wetland environments. Common spike rush (*Eleocharis palustris*) requires marsh conditions for at least part of the year, while many of the sedges (*Carex*) species grow on damp or marshy ground. Gipsywort (*Lycopus europaeus*) will grow on the banks of rivers and ditches and in marsh environments.

There is little comparative plant macrofossil evidence from other marine crannogs. One potentially useful sample is available from the Old Kilpatrick site, in the Firth of Clyde but it is unclear as to where that sample was taken on-site (Appendix B). Some comparisons between the taxa of the two samples are possible whilst acknowledging the provenance of the Old Kilpatrick sample. Both samples contain evidence of wet, marshy ground and additionally both wetland tree and shrub species are represented, such as alder and willow. Common to both sites is evidence of disturbed ground by the presence of fat hen/goosefoot and chickweed, which may indicate periods of ground preparation during construction periods and agricultural practices, although further evidence of the latter is absent from the plant macrofossil remains found on Redcastle.

8.3. Pollen analysis

Sampling on Redcastle for pollen remains was carried out to produce a pollen diagram that would represent the vegetation of the region in which the site was situated. During the excavation of the wattle pits on the south west side of the site a recognised stratigraphic sequence was established. A section excavated inside one of the pits was chosen for pollen sampling (Plate 8.1.). Two monolith samples were

taken for comparative purposes, inside the same wattle pit (sample numbers RDC95.29 and RDC95.50).

The pollen analysis results from the two monoliths are represented as pollen diagrams (Figure 8.1. and Table 8.3., for sample RDC95.29, and Figure 8.2. and Table 8.4., for sample RDC95.50). The monoliths both display very similar assemblages of pollen taxa so it is useful to discuss them together. Although the counts of pollen decrease below the normal significant number count, around 16cm below the top of the monoliths, they will still be included in the discussion for purposes of demonstrating the presence or absence of the species. The fall in amount of pollen at that point may be indicative of the taphonomic processes on the south west margin of the site. This is supported by the sedimentary evidence indicating a change in conditions around this point, see Chapter 9. Similarly, pollen monolith sample RDC95.50, shows evidence of damage to the pollen grains throughout the section, which indicates that environmental factors have affected some of the grains.

The pollen diagrams can be used to suggest a regional vegetation spectrum with some species that could be indicative of more remote source locations. The presence of a waterside and possibly fluvial influence, which the plant macrofossils highlighted, establishes that the pollen taxa could be comprised of both air and water-borne species from the surrounding landscape. The vegetation indicated by the pollen analysis is dominated by pine (*Pinus* sp.), which may be as a result of its ability to travel greater distances than most taxa in account of its durability (Moore and Webb 1978). The other taxa reflect a background of water-tolerant trees such as alder and with some birch, oak and hazel present. The wet fringe situation is confirmed by the presence of sedges (*Cyperaceae*), ferns (*Filicales*) and moss such as *Spaghnum*.

Monolith RDC95.29 shows a relatively constant count of tree taxa throughout the diagram. Although the gradual increase of pine towards the top of the monolith may be because of preferential movement of some pollen grains through the monolith causing breakage with depth. However, this is not the case with the other species present. The increase of pine taxa towards the top of the monolith probably represents the mobility of this type of pollen and also the dominance of pine woodland in the region today, which may have influenced the very top of the monolith (Moore & Webb 1978, 99).

In monolith RDC95.50, the marked increase of alder and birch pollen is at the same level as the intercalated organic layer identified during the core sampling off-site ($-0.1\text{m} \pm 0.1\text{m}$ OD), between the site and the shoreline. This is also the similar deposit found below the bottom of the wattle pits ($0.13\text{m} \pm 0.1\text{m}$ OD) and sampled for plant macrofossil analysis. The pollen taxa from this monolith also indicates species representing an alder and birch woodland with additional evidence of a more open environment including ferns, *Sphagnum* moss, wild grasses and heathers.

The pollen analysis reflects a wet fringe with stands of water-tolerant trees, part of an alder carr and associated marsh species. The absence of any distinctly marine species may indicate that conditions were different from the present and that the location was influenced by a more fresh or brackish water situation, which supported the species represented. It is interesting to note the absence of willow (*Salix* sp.) from the pollen spectrum despite its use for the wattle rods in two of the pits. This may be as a result of post-depositional processes affecting the presence of those particular pollen grains in the samples.

8.4. Diatoms

Results from the analysis of the samples taken for diatoms shows that this type of palaeoenvironmental indicator was present in the deposits, both on and off-site. The results from the on-site core (sample number RDC94 diatom core 1) contains diatom remains which are representative of varying water salinity levels and may show signs of anthropogenic disturbance. The off-site sample (RDC95.52) contains diatoms that give clear evidence of changing circumstances from marine to brackish water conditions with some evidence of fresh water in the locality.

8.4.1. On-site diatom sample (Table 8.5.)

The diatom taxa from the on-site core were not found in sufficient numbers to produce a diatom percentage diagram and the counts are represented in a table. The taxa analysed in the sample suggest a sequence of marine, fresh and brackish water influences on the site. Overall the amount of taxa was relatively low possibly as a result of anthropogenic disturbance and unlike the off-site sample the species from the core could not be divided into distinct zones. At level $0.71\text{m} \pm 0.1\text{m}$ OD the core is dominated by a *polyhalobous* species *Paralia sulcata*, this species has been identified as a marker representing a sandflat above MHWNT (Dawson *et al* 1998). At $0.83\text{m} \pm 0.1\text{m}$ OD *oligohalobous indifferent* species *Pinnularia viridis* and *Pinnularia alpina* are indicative of fresh water influences above the level of the Highest Astronomical Tide (HAT). The limited number of diatoms in this core, however, make it unsuitable for further interpretation and additional sampling would be necessary on the deposits above the framework phase to establish the exact water salinity levels after that phase.

8.4.2. Off-site diatom sample (Figures 8.3., 8.4. and Table 8.6.)

The following summarises the local diatom zones recognisable in the monolith and the types of environmental conditions indicated by the different species.

RDC95.52 Diatom zone 1: This zone is predominantly characterised by *polyhalobous* species, which indicate marine conditions. The two dominant species are *Pseudopodosira westii*, 40% at -0.24m OD and falling to 20% at -0.23m OD, and *Paralia sulcata*, 45% at -0.23m OD. *Gramatophora oceanica v. oceanica* is present in smaller quantities and rises to 14% at -0.23m OD.

RDC95.52 Diatom zone 2: *Gramatophora oceanica v. oceanica* continues to rise in quantity and peaks at -0.22m OD, 25%. *Paralia sulcata* also rises and peaks in this zone, at 50%, around -0.22m OD. *Delphineis surirella* is emergent and rises towards 12% at the top of this zone, which is similar to *Podosira stelligera*. These species are *polyhalobous* types and indicative of continuing marine conditions.

RDC95.52 Diatom zone 3: This zone, between -0.21m OD and -0.17m OD delineates the initiation of more brackish and freshwater conditions, signified by the increase of *mesohalobous* and *oligohalobous indifferent* species. The marine species therefore proportionately decrease. Specifically *Achnanthes delicatula*, a distinctly brackish water species emerges in this zone, 20% at -0.17m OD. The *oligohalobous indifferent* species *Amphora ovalis v. pediculus* and *Cocconeis disculus* also emerge and rise to counts of 10% at -0.17m OD. Some degree of marine influence is represented by *Paralia sulcata*, which continues to decrease from 42% at -0.21m to 15% at -0.17m OD.

RDC95.52 Diatom zone 4: Mesohalobous species *Achnanthes delicatula* increases to become dominant in this zone, 45% at -0.16m OD and this is contrasted by the relatively rapid decline of *Delphineis surirella* (7% at -0.16m OD) and *Paralia sulcata*, 5% at the same level. The species in this zone indicate the continued brackish water environment and the relatively rapid decline of marine conditions.

RDC95.52 Diatom zone 5: One *oligohalobous indifferent* and one *mesohalobous* species characterise the conditions prevalent in this zone and a number of other features can also be demonstrated. The brackish to freshwater conditions are indicated by the presence of *Cocconeis disculus* and *Achnanthes delicatula*, respectively. However, evidence of marine incursions are indicated by the presence of a peak of *Paralia sulcata*, at -0.10m OD (25%) and the declining, but nevertheless present species *Delphineis surirella* (between 10 and 3%).

RDC95.52 Diatom zone 6: A rise in *Achnanthes delicatula* from 30% at -0.07m OD to 50% at -0.02m OD shows a dominance of the *mesohalobous* species and is indicative of a brackish environment. Additionally, the not insignificant peak of *Fragilaria pinnata* v. *subrotunda* (15% at -0.04m OD), an *oligohalobous indifferent* species, indicates a freshwater influence in the locality. This zone is also noted for the disappearance or significant decline of *polyhalobous* species and this indicates the continued decrease of marine influence on the sample.

To summarise, from -0.18m to -0.24m $\pm$ 0.1m OD, the concentrations of diatoms are low, although fully marine species dominate the remains. The conditions of the marine environment may indeed have damaged and reduced the numbers of diatoms surviving at this level. Above -0.18m $\pm$ 0.1m OD the overall amount of diatoms increases and a distinct change occurs from the underlying *polyhalobous*

species to the presence of *mesohalobous* and *oligohalobous indifferent* forms. This increase and change can be interpreted as representing a local decrease of marine conditions towards a brackish water environment, with some freshwater species indicating a possible influence.

The presence of diatom remains in the samples are a useful palaeoenvironmental indicator of both anthropogenic disturbance on-site and water salinity levels on the edge of the site. The results of the sampling are used in the interpretation of the position and salinity level of the water in conjunction with the structural remains on the south west edge of the site, in Chapter 10.

8.5. Insect remains

A sample taken inside one of the wattle pits on the edge of the site was submitted for insect analysis. The sample was taken as a sediment monolith (RDC95.29) and then sub-sampled (RDC95.29iii and RDC95.29.iv). Analysis of the two sub-samples found a number of extremely well preserved *coleopteral* (beetle) remains.

The coleopteral remains in sample RDC95.29iii, could be identified to family species as *Cryptophagidae* from the well preserved articulated body parts. This family are generally used in insect analysis to be indicative of human presence and are of particular use in identifying human presence on the site if a species rich sample is recovered. The fact that the remains from the sample are still articulated and extremely small and delicate suggests little post-depositional disturbance and an excellent preservational environment occurred. Sample RDC95.29iv, only contained two *coleopteral* skeletal fragments, which could not be identified to species type. Further analysis of a larger sample would be necessary and could provide additional

information on the types of activities that could have taken place on-site and specifically from samples taken from structures such as inside the framework which can be stratigraphically and chronologically controlled.

8.6. Charcoal fragments (Figures 8.5., 8.6. and Table 8.7.)

During the sedimentary analysis of monolith samples RDC95.29, a large quantity of charcoal remains were identified, specifically during preparation for pollen analysis (Haggart A. pers. comm.). The fragments were too small for species identification, although they were counted during the routine scanning procedure used for the above pollen analysis.

The charcoal remains show a concentration of fragments in the upper levels of the monolith with decreasing frequency with depth. From the scanned slides, prepared for pollen analysis the maximum count of charcoal fragments occurred at the top of monolith RDC95.29 ($0.41\text{m} \pm 0.1\text{m OD}$) and was 852, compared with 33 fragments counted on the slide prepared from the bottom of the sample. However, the size of the fragments is inversely proportional to the amount, with some of the largest pieces accumulating towards the bottom of the monolith. This could be the result of preferential movement of heavier pieces and the disturbance of the upper levels causing the fragments to break-up into smaller pieces near the top of the wattle pit. Alternatively the fragment sizes may be the result of the same environmental conditions that damaged the pollen grains in the lower part of the monolith and coincides with the general level at which the change from marine to brackish and freshwater diatom species occurs.

8.7. pH and phosphate test results (Table 8.8.)

Five samples were taken during the excavations and were tested for soil component signatures. The samples were tested to establish whether different areas on-site showed significant variations of pH and phosphate levels possibly suggesting differences in use. A sample was taken as a control from intertidal sediments off-site. The off-site sample was taken at MLWM and the four on-site samples were taken in different locations in Trenches 1, 4 and 5. Samples RDC95.4 and RDC95.32, are both taken from inside one of the wattle pits. Samples RDC95.60 and RDC95.76, were both taken from Trenches 4 and 5, respectively.

The phosphate test results show that the percentage in different parts of the site are all high, whereas the off-site comparison sample had a low count. The variations may be as a result of human and animal activity on-site that has led to higher phosphate levels being detected. The pH test also indicates differences in the soil types across the site as well as in the off-site sample. Samples RDC95.4 and RDC95.32 are representative of acidic soils whereas RDC95.60 and RDC95.76 are neutral. The difference between the on-site results may be owing to the conditions prevalent in those areas. Samples RDC95.4 and RDC95.32 were both taken in Trench 1 from the fine grained, grey sand into which the wattle pits had been dug. Samples RDC95.60 and RDC95.76 were taken from a more silty sand on the eastern margin of the site. The results of the two sets of samples tested for pH may therefore be a result of the type of sediments in those two different parts of the site. However, the two former samples were taken from an area that contained relatively large quantities of animal bones, whereas no animal bones were found in the smaller Trenches 4 and 5.

8.8. Animal bones: identification results (Table 7.3.)

Animal bones found during excavation and while surveying the site total 253 and they are the largest total of single item small finds. 59.27% of the total assemblage were identifiable. There are a number of observations that can be made about the distribution, taphonomy and types of bones preserved, which can contribute to aspects of environmental reconstruction and the palaeoeconomy of Redcastle.

The majority of the bones found during excavation in Trench 1, were found beneath and in contact with the pebble and gravel deposit beneath the surface stones. Adjacent to Trench 1 more bones were found to be protruding through this deposit and during the current research their positions were monitored to help assess the erosion on the site (Appendix D). The scattered nature of the bones ensured that they were found both inside and outside of the wattle-sided pits, on top of and beside the horizontal timbers and inside the square mortise hole of timber RDC94.T.6. Inside the wattle-sided pits, the bones in Trench 1 were only recovered from on top of the internal packing stones. Those outside the wattling were both above and below that level, indicating that the wattling could have been upstanding when the animal bones were deposited and that they could have been forced into their current sub-surface position by the action of building and the builders of the framework.

One bone was found in a different context from the sandy gravel matrix and that was a fish vertebra excavated from 0.3m below the top of sail one in Pit One. It was also the only fish bone found during the excavations. The bone was in the fine grained, grey sand into which the pits were dug and it would seem to have been deposited prior to the building of the pits.

Whether the decreased number of bones from the south west corner of Trench 1 was as a result of erosion, the same forces of which could have caused the damage to the wattling mentioned above, is possible. The rarity of small extremity bones and smaller bones from fish and birds may suggest that taphonomic processes such as tidal erosion could have removed them. The number of bones in Trench 2 totalled two and may highlight the area around Trench 1 as a preferred area for the deposition of animal bones. This predominance in Trench 1 may also be misleading because of the small scale excavations and future investigations will aim to investigate this possible bias in the results.

The identification of the bones revealed a high percentage of cattle (*Bos*) remains. This is not unusual considering the size and weight of such bones which would reduce the possibility of post-depositional removal. Smaller bones, of course, are more likely to be moved by tidal erosion or anthropogenic means. Sixty percent of the total number of bones were identified and 31% of those were cattle remains, 4% were sheep/goat (*Ovicaprid*), 3% red deer (*Cervus elaphus*), 0.4% pig (*Sus*), 3% bird and 0.4% fish. Nine percent of those identified by size alone were large mammals and 6% were medium sized mammals.

From the cattle bones identified; 1.2% were neonatal, 12.6% from juveniles and 27.8% from adults and with the effects of erosion and weathering notwithstanding, it would appear that the animals were kept until adults, possibly for a range of products. Analysis of the sheep/goat assemblage indicates that both juvenile and adults were represented; 5 bones from adults and 2 from juvenile beasts were identified. Assessment of the types of bones represented from each species suggests that the animals could have been brought on to the site as live beasts, given the similar percentages of cranial, axial and long bones; 17.39%, 19.76% and 16.2%

respectively. If a particular body region was predominant then an alternative explanation could be sought, however, all three major body areas are similarly well represented. Post-depositional erosion may have led to the removal of extremity remains, only 6.23% of the total were metatarsals and metacarpals.

The large quantity of fragmentary bones suggests that deliberate on-site or post-depositional breakage has taken place and the 15 examples of cut marks, slicing or splitting lends weight to the above suggestion of the animals being butchered on-site. A specific taphonomic process was indicated on find RDC95.39.v, by the identification of gnaw marks on a metacarpal of an *Ovicaprid* found in Trench 1. The marks could have been caused by a small mammal such as a mouse or vole. Gnaw marks on a bone may show that it was left exposed on the surface of the site and that the animal responsible could have contributed to the removal of the smaller bones.

The faunal remains can be used to interpret aspects of the palaeoeconomy of the site and some of the types of conditions prevalent when the site was occupied. The condition of the bones themselves may also be useful in understanding the taphonomy of parts of the site and these points will be discussed further in Chapter 10.

8.9 Summary

The results from the individual samples analysed for palaeoenvironmental indicators show that they can be used on their own and in conjunction with one another to provide evidence of the conditions on and surrounding the site. Plant macrofossil remains and pollen analysis together can be used to indicate the different types of vegetation and some of the individual species are recognisably derived from

particular ecological niches. The pollen remains not only complement the plant macrofossil evidence, they also show signs of taphonomic processes in the samples, such as translocation and damage to the grains in the lower parts of the monoliths.

Diatoms are very useful for defining the salinity levels of the water surrounding the site and the off-site sample provides a vital sequence. The beetle species, charcoal remains, pH and phosphate analysis were all useful for understanding processes and conditions specific to the sample locations. Further analysis of this type could be useful over the whole of the site, if further excavation were carried out and specific features, structures or activity areas identified. Finally, the animal bones are an important constituent of the small finds from the total remains and can be used to establish aspects of the palaeoeconomy and functions specific to the site.

CHAPTER 9

Redcastle marine crannog excavation, Part 3: sedimentary results

9.1 Introduction

Evidence of certain environmental changes can be found in the sediments on and surrounding marine crannogs. Samples taken on Redcastle and off-site were analysed to understand their grain size attributes and the results used to infer characteristics of the specific samples, which related to the underlying geology and conditions when the wooden structures were built on the south west part of the site. All samples were correlated to one another by lithostratigraphic comparison and were dated relatively to the radiocarbon dates from the timber structural remains.

Three areas were sampled for sedimentary analysis; the area immediately surrounding Redcastle from MHWL towards MLWL, on-site and on two other marine crannogs in the Beaulieu Firth. The samples taken surrounding Redcastle were taken along a core transect, which when analysed provided a linear profile from the current MHWL, across the site and towards MLWL. Additional comparative samples were also taken at MLWL and at MHWL near Redcastle.

Samples taken on Redcastle corresponded with the structural remains found during excavation. They were taken from the basal fine grained, grey sand on the south west edge of the site (see section 7.2.1.), into which the wattle-sided pits had been built and from points associated with the framework. Additional samples were taken from the centre of the site for evidence of sedimentary conditions on top of the timber framework, which could be compared with the diatom core taken from the

same area. Samples taken on Carn Dubh and Phopachy were for comparative purposes.

9.2. Geological profile from the Redcastle core transect (see Figure 4.5.)

The core transect illustrates a stratigraphic profile taken through a geological sequence with three main features and a number of intercalated deposits (Figure 9.1.). The predominant geological features are two palaeo-channels; 80m to the north east of the site and the start of a second 50m to the south west of the site. The third aspect are the sequence of organic and inorganic deposits to the north east and south west of the site.

The palaeo-channel to the north east of the site lies between core numbers 5-11. It covers an area approximately 150m wide and currently this part of the mudflats is drained by a surface runnel - a well developed surface drainage channel found on intertidal mudflats. The sedimentary evidence shows that the channel was approximately 0.4m deep in core 8. Lateral movement of this palaeo-channel is indicated across the cores because the depth of the similar deposits within the cores in this area varies across 100m.

In and between cores 12 and 17, two organic deposits were identified which represent two separate events in the geological record. The upper deposit was found on the north east side of the site, levelled to 0.14m OD and on the south west edge a deposit of similar thickness and characteristics was re-located at the lower tips of the sails of the wattle-sided pits, at $0.13\text{m} \pm 0.1\text{m}$ OD. Sampling and plant macrofossil analysis was carried out on this organic deposit and the results were discussed in Chapter 8. A lower organic deposit present on the north east margin of the site was found in cores 12-14 at -0.05m to $0.05\text{m} \pm 0.1\text{m}$ OD. A similar deposit was found in

core number 17 on the south west edge of the site, between -0.1m and $-0.2\text{m} \pm 0.1\text{m}$ OD.

A deposit of grey sandy silt containing broken shell fragments on the north east of the site was identified in core 16 and was also found in Trench 5 on the margin of the site. This deposit may represent a period of disturbance during which the shells were deposited and its stratigraphic position, between 0.65m and $0.7\text{m} \pm 0.1\text{m}$ OD, suggests that it lies at the same level as the tops of the wattle-sided pits. This deposit could be related to the period during which the secondary framework building took place on the other side of the site. The origins of this deposit are unclear.

The palaeo-channel to the south west of the site was sampled on its north east side and from the contour survey it appeared to continue beyond the core transect and is a much larger feature than the one discussed above. It was first recognised from cores 17 to 22 and there appeared to have been some lateral movement because there are two distinct intercalated deposits in cores 18 and 20. Core number 18 contained two bands of fine sands mixed with organic and shell fragments that suggest they are channel edge or beach-type deposits. Core number 20 contained two bands of organic detritus in fine grained sands, possibly as a result of deposition on a channel edge. Today the area to the west and south west of the site is drained by the surface runnel originating from the current Redcastle Burn, to the west of the linear stone feature, and the sub-surface palaeo-channel identified from the coring appears to be evidence of a remnant drainage system in the same area.

To summarise, the cores taken adjacent to the visible edges of the site on the north east side confirm that south of the large palaeo-channel the geology rises

towards the site and to the south west the geology is relatively lower. The overall profile, beginning at core 1, shows a shallow palaeo-channel, then the geology rises to a sand mound with the site at the highest point. The geology on the south west edge of the site is marked by a distinct break of slope that includes the structural remains situated on the part of the slope between 0.5m and 0.7m $\pm$ 0.1m OD, and additional structural timbers levelled to 1m $\pm$ 0.1m OD in the centre of the site. The site is therefore situated on the south edge of a sand mound that rises above 0.4m $\pm$ 0.1m OD, approximately 250m south west of the current shoreline.

Although the sand mound begins 250m off-shore the structural remains of the site were between 350-375m off-shore. The difference suggests that the mound is rather elongated in a north-south orientation and the contour survey showed that it forms a linear, promontory. Previous research at Tomich, at the head of the Beaully Firth, has identified a sub-surface relict sand spit which may be similar in origin to the one on which Redcastle is built (Firth & Haggart 1990, 130).

9.3. Redcastle on-site samples: results

This section outlines the results of the analysis of samples taken on-site from the trenches on the south west margin, which included two monolith samples taken from the basal deposits, bulk samples at the same level as the top of the wattle pits and the horizontal framework timbers and others from sediments above the framework.

9.3.1. Monolith RDC95.29: results

The top of the first monolith (RDC95.29) was levelled to $0.41\text{m} \pm 0.1\text{m}$ OD. Loss on ignition analysis (Figure 9.2.) shows that the monolith contains very low quantities of organic remains and that the sediment is an inorganic deposit. Particle size analysis at 2cm intervals down the sample has identified sand throughout the monolith, with three discrete variations in grain size. The results are shown in Figure 9.3. and derived from the results in Table 9.1. Appendix F shows the formulae applied for analysis and the grade system used to describe the different sediment particle sizes.

Statistical analysis of the results showed a number of specific characteristics of the sediment sample. These include both descriptive and inferential aspects (Briggs 1977). The distribution curve which shows the size parameters of the analysed sediment is used to describe and infer the methods of transportation and origins of the deposits. The upper 2cm of the monolith consists of Phi mean size fine sand particles whose distribution curve is positively skewed. Skewness is a measurement of the deviation from the mean and median of a sediment coinciding and indicates that the distribution curve is asymmetrical, i.e. a greater percentage of the sediment is made up of finer or coarser particles. In this case the sample is made up of a greater percentage of finer particles, whereas a negative skewness tends towards larger quantities of coarser particles. The analysis also showed that the upper 2cm sample was *platykurtic*. This descriptive term refers to Kurtosis, which is a measure of the peakedness of the distribution curve. It relates to the sorting of a sediment and non-normality of the distribution. For example, a poorly sorted sediment will have a relatively flat particle size distribution curve. Therefore a distribution curve which is flatter than a normal distribution is *platykurtic* and one which is more peaked than normal, is *leptokurtic* and a normal distribution is

mesokurtic. Sorting is the term used to describe the width of the distribution curve. It relates to the ability of the transporting agent to segregate the particles according to size, therefore some environments are very good at sorting, such as active beaches. A high sorting value in analysis terms refers to a low degree of sorted particles in reality.

Between 8-16cm the mean Phi size indicates medium sized sands predominate which are very well sorted and have a very negatively skewed and very *leptokurtic* distribution. The sediments between 16cm and 25cm, at the bottom of the monolith, indicate a third change of transportation and depositional environment; the mean Phi size indicates medium sands that have been very well sorted. The distribution curves are symmetrical and *leptokurtic* at 16-18cm and 20-22cm and *mesokurtic* at 18-20cm and 22-25cm. These alternating banded sediments may represent a depositional cyclical event such as a water level stillstand (16-18cm). This was followed by a reduction of the depositional influence, such as may be the result of a regression of water level (18-20cm) and a further stillstand (20-22cm), and another regression (22-25cm). These events may represent localised changes in the depositional environment, in close proximity to the site, rather than regional events and have therefore resulted in the deposition of sediments only 2-3cm thick.

The overall skewness of the distribution of the sediment from the monolith suggests that the sand was deposited on an environment similar to a beach or channel edge. However, the sands are very well sorted, indicating that the origins of the source sediment could have been different to its final depositional environment. The distribution also suggests that the finer grained sands have been affected by probable winnowing, caused by exposure to wind erosion and resulting in the negatively

skewed results. Depiction of the results in the form of a bivariate scattergram illustrates the variations within the sample (Figure 9.4.).

9.3.2. Monolith RDC95.50: results

The second on-site monolith was taken adjacent to the first and its top was levelled to $0.38\text{m} \pm 0.1\text{m}$ OD. Loss on ignition results from the sample confirmed the very low quantities of organic matter that were found in the above sample.

The analysis of the monolith indicated a pattern similar to the sediments in sample RDC95.29, albeit slightly deeper (Figures 9.5., 9.6. and Table 9.2.). The upper 10cm showed a very slight increase of mean particle size from 0.04mm at 2cm depth to 0.18mm at 10cm. Below 10cm, the mean particle size showed the cyclical pattern of fining and coarsening, with an overall increase in mean particle size towards the bottom of the section, which was discussed above. Similarly to RDC95.29, the overall distribution of the sample demonstrates that the sediment was suggestive of a channel edge or beach environment and the negatively skewed distribution indicates that winnowing, by exposure to wind action could have been a post-depositional factor. The very well sorted characteristics show that the sediment sample was probably deposited on a beach environment, such as a channel edge having undergone fluvial transportation (Figure 9.7.).

From the analysis of both of the monoliths it seems that the sedimentary deposit which overlies the intercalated organic layer identified in the core transect and from the south west edge of the site and sampled for plant macrofossils was formed in a beach environment, albeit either marine or fluvial and the transportation of the material appears to have been fluvial, by the sorting characteristics. However, whether the beach/channel edge was an active feature when building began was not

evident from the sedimentary analysis, although the damage to the wattle pits, slightly above the level of the sample, shows that destructive processes have affected the sediments and that part of the site.

9.3.3. On-site samples: further results

Analysis of the Redcastle monoliths indicated that the distribution curves were both negatively skewed. This has implications for the type of conditions the sediments underwent during transportation and for the final depositional environment. The evidence that some of the samples contained greater quantities of fine particles (between 4 Phi to 11 Phi) than those from the sieving suggested further analysis of the sediments could be useful in their interpretation. Increased quantities of clay particles may indicate that alternative sources of origin material are represented and that aspects of the depositional environment could be interpreted.

During excavation in Trench 2, the contact zone between the sediment into which the wattle-sided pit had been dug and that on to which the overlying timbers had been placed, was analysed. Field observations suggested that a discrete deposit was directly beneath the timbers and this sediment was sampled for further analysis. The deposit was finer grained than the underlying fine sands and had a higher proportion of finer particles. This silty sand was also found beneath the timbers and as an interstitial deposit inside Pit One in Trench 1 and may signify that between the two building phases an event or events had occurred which resulted in its deposition. The exact nature and origins of this deposit are unclear, however, it is possible that it was the result of fluvial conditions that introduced a sediment influx, which could have damaged the wattling of the pits and led to the deposition of a sediment on to which the timbers and packing stones were then placed.

The results of the sieving to 4 Phi (0.063mm) indicated that sample RDC96.6 contained significant quantities of smaller particles, known as fines. Retained after sieving to 4 Phi was 25% of the total sample weight. Whereas after sieving sample RDC96.8, only 3% of the total weight was retained (Table 9.3). The results of the fines X-ray diffraction analysis (see Appendix F) were subjected to statistical interpretation to discover whether further traits of the transport and depositional environments for the sediment could be recognised (Figure 9.8.). The results from RDC96.6 confirm the above suggestion that the deposit directly beneath the horizontal timbers contained a greater finer grained percentage than those at the bottom of the pit. These results indicate an overall fining upwards trend of the sediment size and lend weight to the suggestion that the silty sand, into which the horizontal timbers and packing stones inside the wattle pits were placed, was deposited under different conditions to those which led to the deposition of the basal sands into which the pit sails were driven.

9.3.4. Phase Three sediments: results

A sample was taken from sediments found above the level of the timber framework, near the centre of the site and adjacent to where the diatom core (RDC94. diatom core 1) was taken. They were analysed to provide sedimentary evidence to complement the on-site diatom core and to establish sedimentary conditions on top of the timber framework. However, the results of the analysis may be more relevant to anthropogenic activity than to natural events that affected that part of the site, given their location on-site above the known structures.

In the centre of the site, between the two stone mounds, samples were taken at the surface and at every 0.1m to a depth of 0.4m. The results from sieving are shown in Tables 9.5. - 9.8. They were statistically analysed (see Table 9.16.) by

plotting as cumulative frequency curves (Figure 9.9.), and plotted as bivariate scattergrams with the results from the other marine crannogs sampled (Figures 9.10. and 9.11.). The results indicate that all the samples were relatively poorly sorted sediments. Sample RDC94.1 (1m $\pm$ 0.1m OD) was a medium grain sized-sand and had a normal distribution curve. The Phi mean of the next sample RDC94.2 (0.9m $\pm$ 0.1m OD) indicated that the sample was also a medium sand although, it was weighted towards the fines and this was attested in the positive skewness of the distribution. RDC94.3 and RDC94.4 (0.7m $\pm$ 0.1m OD) were similar in characteristics to RDC94.1 and RDC94.2 respectively, although they have *platykurtic* distributions.

The similarities between RDC94.1 and RDC94.3, and between RDC94.2 and RDC94.4 is suggestive of a cyclical nature of the fluvial conditions during which the sediments were deposited. The poor sorting of all of the samples suggests sudden, relatively short-lived, moderately high energy events. Such deposits may be affected by anthropogenic disturbances, during re-occupation of the site or owing to brief incursions, such as inundations of the site by localised water level change.

The analysis of these samples shows that the deposits in that part of the site may be disturbed and the presence of dated timbers above the level of the framework confirms this (see Chapter 2 and 10). The disturbed diatom sample (see section 8.4.1.) from the same area also confirms the suggestion that anthropogenic activity has affected the sediments and palaeoenvironmental indicators in the centre of the site.

9.3.5. Off-site sample: results

An off-site sample was taken 15m beyond the slope on the south west edge of the site (for location see Figure 4.5.). The sample (RDC95.52) was taken as a

Kubiena monolith levelled to $0\text{m} \pm 0.1\text{m}$ OD and the top of the monolith tin was 0.05m below the surface estuarine muds. Analysis of the results show that the mean Phi size throughout the monolith was higher than those monoliths sampled on-site (Table 9.9.) and that the sediments were deposited under different conditions (Figure 9.12.). Analysis showed that it had a very positively skewed distribution, indicating that the sample was dominated by the finer grades, which probably originated from river sands discharged from the River Beaulieu.

The analysis illustrates that the two monoliths taken on-site were from sediments deposited in conditions different to the off-site sample. The on-site samples represent a sequence of deposits that are evidence of a channel edge, whereas the off-site sample showed a signature of more mobile sediments, such as river sands. This would confirm the implication from the core profile that a palaeo-channel was situated below the south west margin of the site, and that the structures in that area had been built into the edge of the sand mound, probably formed as part of a channel edge, confirmed by the change of deposits found 15m off-site in sample RDC95.50.

9.3.6. MLWM and MHWL sediments: results (Table 9.3., Table 9.4. and Appendix F))

Samples taken from the current MLWM and MHWL near Redcastle were taken to provide modern comparisons with the samples on-site. Two areas were sampled; RDC96. 14 was taken 0.05m beneath surface beach gravels at the current MHWL and at the current MLWM, sample RFT95.6 was taken on the surface of an intertidal sandbank.

Results from analysis of sample RFT95.62 and the results of on-site sample RDC96.6, resembled one another. However, the sedimentary characteristics and fines proportions of RDC96.14 when compared with on-site sample RDC96.8 also appear similar. These results suggest that the samples taken from beneath the framework timbers (RDC96.8 and RDC96.6) and the current MHWL could have been deposited in similar environments. The sample taken from the contemporary MLWL is altogether different from the on-site samples and the one from MHWL. Analysis of the sample also shows that the sediments sampled on Redcastle, around the south west of the site were not deposited in a situation towards the LWL of a tidal environment.

9.4. Sediment analysis results from Carn Dubh and Phopachy

Samples were taken from the surface and sub-surface sediments of Carn Dubh and Phopachy, to act as comparisons to results from the samples taken on Redcastle. In particular, the sediments sampled from the upper part of Redcastle, which when analysed showed signs of anthropogenic disturbance, compared with the sediments of the sand mound beneath the wattle pits.

9.4.1. Carn Dubh (Table 9.10. - 9.13.)

The cumulative frequency curves indicate that the samples alter with depth and statistical analysis has been used to interpret the specific characteristics of the sediments (Figure 9.13., based on Table 9.14.). Bivariate scattergrams of the Phi mean plotted against sorting, and skewness against kurtosis, indicated the homogeneity of the upper sediments on Carn Dubh (Figure 9.10. and 9.11.). They also showed the difference between the upper sediments and those in the lower section of the sample site. Samples CD94.1 and CD94.2 represent a sediment that is comprised predominantly of medium grain sized-sand, that is moderately well sorted

and that towards its base becomes slightly negatively skewed towards the coarser sized particles. This slight increase in coarseness is evident in CD94.3, mean Phi size 1.97. CD94.4, at $-1.3\text{m} \pm 0.1\text{m}$ OD, displays the highest Phi mean, indicating a larger proportion of medium sized sand particles of a very well sorted sediment.

The statistical analysis of the Carn Dubh samples indicates that the surface remains are typical of an intertidal estuarine deposit of medium grained sands. The slight coarsening at 0.3m and the fining at 0.4m below the surface suggests a change of sediment owing to different transportation and depositional environments. This change may indicate a more turbulent interval of deposition after a lower energy environment, possibly indicative of a lower or more distant water source (CD94.3) followed by an increased marine or fluvial influence (CD94.4).

The results from the samples taken on Carn Dubh indicate the differences between a marine crannog in the centre of the Beaully Firth and Redcastle which is located in a sheltered tidal bay. Overall, the grain sizes on Carn Dubh are coarser than on Redcastle, although throughout the depth of the sample the sediment showed cyclical characteristics similar to those recognised in the samples taken on Redcastle.

9.4.2. Phopachy (Tables 9.17. - 9.21. and Figure 9.14.)

The sediments were analysed for mean Phi size, skewness of the distribution, sorting of the sediment and the kurtosis of the distribution curve. Plotted as bivariate scattergrams similarly to the samples from Carn Dubh and Redcastle, certain characteristics of the sediments can be identified (Figures 9.10. and 9.11.).

The Phi mean plotted against sorting of sample P94.1 shows that this sediment is a very well sorted, predominantly medium to fine sand. Its distribution is

negatively skewed towards coarser particles. P94.2, 3 and 5 are very similar sediments; medium sands, negatively skewed distributions and moderately well sorted. P94.4, however, has a higher percentage of coarse sand particles and is very positively skewed. This change of sediment with depth, at around 0.3-0.4m is at a similar level to that identified from the Carn Dubh samples.

The analysis of the Phopachy samples suggests that P94.1 was a fine grained estuarine, surface sediment (Buller & McManus 1979). However, beneath the surface deposits the sediments coarsen and are therefore indicative of a change in environment. This may have been because of an alteration of the sediment source, from a nearby channel to one of greater influence and faster current. The coarsest sample, P94.4, may indicate a brief period during which the site was influenced by an event such as a flood. This brief episode may have occurred in the Beaully basin and is reflected in a discrete deposit on both Phopachy and Carn Dubh, at $-1.8\text{m} \pm 0.1\text{m OD}$ and $-1.3\text{m} \pm 0.1\text{m OD}$, respectively.

The results of particle size analysis show that those sediments analysed from Redcastle were quite different to those on Carn Dubh and Phopachy. The sediments on the two sites in the main body of the Firth; Carn Dubh and Phopachy showed similarities and evidence of natural cyclical deposition, caused by varying inputs of different types of sediment. Furthermore, the analysis of the Redcastle sediments show that the site could have remained in an environment that has been further away from fast flowing water. This has resulted in less well-sorted sands, unlike those on Carn Dubh and Phopachy which are situated in the middle of the Firth and appear to have been in locations with different depositional environments.

9.5. Summary

Sedimentary analysis of the remains on and around Redcastle and from the two other marine crannogs sampled show that environmental conditions have changed and that some of those changes can be inferred using particle size analysis techniques and statistical interpretation of the resultant data.

The geological core transect shows distinct sub-surface features and confirms the contour survey that the site is built on the end of a sand promontory, which extends from a possible palaeo-shoreline. The presence of two palaeo-channels either side of the site emphasise the linear nature of the promontory. Within the geological sequence, either side of the site, organic remains were found and the analysis of subsequent samples (section 8.2.) showed that particular environmental conditions were prevalent.

On Redcastle below the surface deposits the results of the sampling indicated a general fining-upwards trend from the basal sands to the silty sand, which surrounds parts of the framework. This type of fining upwards sequence is typical of a decrease of energy, possibly as a result of a reduction in fluvio-marine influence. A lessening of these conditions in the area surrounding the site may have occurred prior to the occupation and construction phase on the site. In the case of Redcastle, this period is the time when the sand promontory could have become exposed as an extant dry point. Construction on the sand mound could therefore have begun during a period of reduced fluvio-marine influence in the immediate vicinity, although not necessarily a period of lower groundwater level.

The surface layer of pebbles and gravel on Redcastle, beneath the large surface stones and above the framework, are similar to those present on the adjacent

shoreline. Their presence on-site may be of anthropogenic origin, natural or a combination of the two. This layer may have been part of a construction phase possibly to form a firm flooring or work surface. The possibility that it is a natural deposit is supported by observations on the current shoreline, where gravels overlie sands and silts at the MHW. This may suggest that the site is situated on or near a former shoreline, which has since transgressed to the current position. Subsequent post-depositional processes have therefore left the surface stones and underlying pebbles and gravel in a situation resembling a well-sorted natural sequence. Evidence from research on the Swiss lake dwellings has illustrated that preferential erosion to organic deposits can result in a well-sorted stratigraphic profile, with a surface capping of stones, overlying organic structural remains (Speck 1981). Clearly further analysis of the surface sediments on marine crannogs would be necessary to test this, but the tidal fluctuation could provide the required mechanical action to erode and alter the different types of deposits.

Sedimentary analysis of random samples shows evidence of natural deposition events on Carn Dubh and Phopachy. Their position in the centre of the Beaulieu Firth appears to have affected the sediments on these sites differently to those on Redcastle and this may be owing to increased exposure to tidal fluctuations and previous changes in the estuarine system around those sites. The different positions of all the marine crannogs in the Beaulieu Firth will be discussed in more detail in the following chapters.

CHAPTER 10

Redcastle marine crannog: interpretation

10.1 Introduction

This chapter interprets the Redcastle structural remains and the development of the site using the evidence excavated and the radiocarbon dates from the different phases. It also takes account of the results of the palaeoenvironmental sampling in context of the local area, to outline the conditions that led to the sand mound becoming used for the location of the marine crannog. The topography, water levels and types of vegetation represented by the results of the palaeoenvironmental and sedimentary analysis are also discussed.

10.2. Structural remains

The results of the excavations on Redcastle indicated that two major structural phases were built. This section discusses the development of those phases and the possible functions for which the structures could have been built.

10.2.1. Wattle pits

Three wattle-sided pits were built into the top of the short slope on the south west edge of the site, approximately $0.7\text{m} \pm 0.1\text{m OD}$ and $0.2\text{m} \pm 0.1\text{m OD}$. They were constructed by driving sails into the underlying sediment and wattling the upstanding posts. The pattern of wattling used two rods wound together at the same time and this is a recognisable method that is still practised called 'pairing' (Davidson A. pers. comm.). Evidence of how the ends of the wattle rods may have been fixed in position was recovered near sail 10, in Pit Two, where the end of a rod had been

twisted around on itself forming a withy tie (Plate 10.1.). This method of 'finishing off' wattling is known in hurdle making and has been identified from wattle structures in other archaeological contexts, such as from near Structure 6 of the Iron Age intertidal site at Goldcliff, in the River Severn estuary (Bell 1992, 20).

The excavation of sail 5 from Pit One revealed it to have a lower end sharpened to a point, which would have facilitated easy penetration into the ground surface. The tool used to fashion this sail was probably a bronze or iron axe blade, approximately 5cm wide (Sands R. pers. comm.). As mentioned previously when excavated the sail displayed a 'chisel-ended' profile, this term was developed during research on the wooden trackways in the Somerset Levels for smaller wooden structural members and has subsequently been used to describe piles and other structural timbers excavated on crannogs (Coles & Orme 1985, 26). This term indicates that the roundwood chosen for the sail was cut to form an eccentric profile, leaving the sapwood down one side to the point. This form of point is a rapid method of cutting a sail in order that it could be driven into the ground.

The tops of the sails of all three pits showed signs of erosion and some had pronounced hard cones of heartwood, indicating that they had been exposed above the protective ground surface and that the outer bark and soft sapwood had been eroded away. The splitting and damage to the tops of the sails in Pit Three may have been caused during the construction of the pit when the sails were driven into the ground surface. Whether the sails were any longer than when excavated is difficult to tell, considering they have been eroded. However, the limited depth of wattling suggests that if they formed upstanding edges, the pits would only have been shallow features, no deeper than 0.3m.

Parts of the wattle edges of the pits had been very well preserved whereas others were damaged and absent. The overall state of the pits may indicate some of the environmental conditions prevalent and what factors have led to the damage. Both the sails and the wattle rods showed no signs of natural deformation such as splitting along the grain, which suggests that they were buried and protected in a sediment that provided enough moisture to prevent drying. An environment with little or no light and reduced oxygen levels was probably prevalent. Biological degradation were therefore at a minimum. The sediments surrounding the wooden remains would have contributed to the preservation of the structures if the ground water levels were relatively high. During excavation the groundwater level, at low tide was less than 0.5m below the tops of the sails, at $-0.1\text{m} \pm 0.1\text{m OD}$ and this rose in relation to the tide level.

It became clear that prior to excavation some damage to the wattle rods continued on those areas exposed above the level of the surface sediments. The damage could have been caused by erosion possibly as a result of sediment loss and subsequent tidal scouring, especially of the very south west side of the pits. This has resulted in some of the wattle rods becoming dislodged from their positions wound around the sails, to lying splayed outwards and other pieces were missing altogether, for example between sails 3 and 7 of Pit One. Whether this erosion was immediately after the use of the site or occurred later is unclear and dependent on water levels, however, reconstruction of wattle pits at the current MHWL aimed to investigate the erosion potential to such structures.

10.2.1.1. Reconstruction wattle pits

A reconstruction of a wattle-sided pit on the shoreline opposite Redcastle showed that wattling could become dislodged within 2-3 months if it was exposed

above the surrounding sediments (Plate 10.2.). However, the prevalence of the damage to the wattling on the south west side of the original pits suggests that it was only that side that was vulnerable to the erosion and this is the side of the site that is open to the rising tide. This concurs with the suggestion that a change of conditions led to the wattle becoming dislodged (see Chapter 9), perhaps owing to the influence of moving water which became increasingly active on that side of the site. Whether the damage to the wattling took place during the use of the pits or later and was a contributing factor to their demise is unclear. The positioning of the timber framework over two of the pits indicates that they were no longer necessarily in use when this construction phase was implemented.

10.2.2. Functions of the pits

This section discusses the possible uses of the wattle-sided pits and compares them with similar features from other sites. The explanation of the function of pits from archaeological contexts has varied widely from the storage of commodities and specific industrial practices to other uses that remain unclear (Ross 1968, Reynolds 1974). The construction of a pit with wattle sides suggests that the deposit surrounding it is unable to support vertical sides to any height and may be prone to collapse. This is possibly as a result of the pit being cut into soft sands that may be occasionally inundated with water. In order that the pits on Redcastle could perform their specific function (s) the sides needed reinforcing and the wattling around the pits would have maintained vertical sides in the sand.

Wattle-sided pits have been recorded on other freshwater and marine crannogs and it is useful to consider their suggested uses, as well as others from different archaeological contexts. One such freshwater site was the Ballinderry 2 crannóg in Co. Offaly, Ireland, which was excavated by Hugh O'Neill Hencken in

1933 (Hencken 1942). His comprehensive excavation report contained both plans and photographs of ten wattle-sided pits scattered around the south and east margins of the primary structural remains. Although Hencken interpreted the pits as huts, it seems likely that they were part of a pre-crannóg construction phase, dating to the Early Historic horizon (Newman, C. pers. comm.). Their size and position in the primary phase of the occupation of the site, however, suggest that they were used for a specific purpose, perhaps as small hearths, rather than huts prior to the construction of the overlying platform and superstructure.

The appearance and construction techniques shown in Hencken's photographs, of the Ballinderry features reflect a striking similarity to those excavated on Redcastle and also those found on another Irish freshwater crannog, Crannóg 61, in Lough Gara, Rathtinaun, County Sligo, excavated by Joseph Raftery between 1952-1955. Interpretations of the Lough Gara features associated them with the large quantities of metal-working remains found on the site and indicate that the pits were used as fire baskets (Raftery 1994, 33). One of the pits on the Lough Gara crannóg had wattling that formed a 0.5m high surround and was covered with clay (Plate 10.3.). It could have been used as an enclosed hearth, the wattle being protected by the clay lining. This form of enclosed and therefore oxygen reducing feature could be used to provide the high temperatures required for metalworking that could not necessarily be achieved in an open hearth.

Evidence of burning from the Redcastle pits came from some blackening of the bark on the rods in Pit One, additionally the presence of the charcoal fragments in the sediments beneath Pit One lends weight to support the suggestion that at some point the structure could have been used as a fire pit. The absence of fired clay from the Redcastle pits may, however, suggest that they were used for an alternative

purpose and that the charcoal was a deposit as a result of other actions, such as air-borne fragments.

The function of Pit One may also be linked to the leather fragments found inside it. If the pit was completely lined with clay, its function could be the collection of water, either salt or fresh. The salt water could have been brought from the firth and the fresh water could have been taken from the adjacent streams and drainage channels. In association with filling the pits with water, the leather fragments may be evidence for the preparation of animal skins. This could have involved the soaking of skins to make them supple prior to their being left to steep in solutions of bark and other organic remains for tanning in pits (Reed 1972). The analysis of the leather fragments confirmed that they were fragments probably of calf skin that had been de-haired and had been treated to produce a leather-like consistency (Thames, C. pers. comm.).

Excavations in York on 12-13th century AD structures have identified industrial areas inside a stone building in which a series of pits, some timber and others wattle-lined contained leather fragments. The pits were interpreted as possibly being used for preparing animal skins for the tanning process (Addyman 1976). The pits from one particular area were associated with large quantities of animal bones, especially those representative of cranial and limb extremities, which suggested that either the carcasses or live animals were brought to the site with those features intact (O'Connor 1984). This interpretation of a faunal assemblage for a specific function may indeed be pertinent to the structures on Redcastle in association with the animal bones, see below.

Evidence of prehistoric tanning processes is rare in Britain. Information from Egyptian, Roman and other Near Eastern sources suggests that both traditional tanning methods using vegetable tannins and chemical tanning, using animal fats, took place in lined pits during prehistory (Lucas 1948, 46-48; Neuburger 1930, 77-81; White 1984, 236-237). Leather objects are present in the Scottish archaeological record from later prehistory and it is therefore likely that tanning took place in Scotland. However, the methods for making objects such as the Pytodykes leather sheath remain obscure (Coles, Coutts & Ryder 1964). The presence of the pits together with leather fragments on the Redcastle site is early evidence that could be interpreted as for the soaking of skins and one aspect of the tanning process in Scotland.

The leather fragments together with the assemblage of animal bones and the possible footprints shows that animals were present on Redcastle, both alive and as butchered remains, during the use of the primary and secondary building phases. The wide range of ages represented from neonatal to adult, and specifically of the cattle bones allows for a number of suggestions to be made as to the use and palaeoeconomy of the site. The juveniles represent the optimal age of slaughter for their meat, which for cattle is approximately 2 years old and the bones of animals younger and older than these may represent different practices (Uepermann 1973, 312). The high percentage of bones of adult cattle suggests that they may have been used for practices such as dairying, although this would need to be qualified by testing for the sexes of the remains. Unfortunately, no sexually diagnostic bones were identified from the assemblage. Alternative uses of adult cattle could have been for their hides and other by-products such as bone marrow, and the splitting and slicing of some long bones may suggest the latter.

The sheep/goat bones show that they could have been kept for their meat and also their fleeces/hides are at an optimum between 2 and 6 years old (Rackham 1994, 49). It is probable that the 4% of sheep/goat bones actually represent the presence of sheep, as goats are not so well adapted to wet conditions. The relatively low percentage of sheep/goat remains may also be a reflection of the adverse affects of liver fluke on either of these species when kept in wetland environments (van Wijngaarden-Bakker 1998, 176). Perhaps these animals were kept elsewhere, away from the coastal edge, and brought to the site either as live animals or carcasses when necessary.

The presence of cranial and extremity bones of both cattle and sheep/goats lends weight to the argument that animals were alive on-site, rather than their being slaughtered elsewhere and taken on-site as butchered joints. Carcasses often have their cranial and extremity bones removed when being divided into joints and the presence of such bones on-site shows that the animals could have been brought onto the site alive. The marks found in the sands in the south west quadrant of Trench 2 are similar to those found at the Goldcliff site in the River Severn which were identified as animal hoof prints (Bell 1995, 121). The photographs of the Redcastle marks indicate similarities with those found at Goldcliff (Plate 7.10.) and may also confirm the presence of live animals on-site.

The paucity of small finds and debris associated with the Redcastle pits must at present leave their function open to further discussion. If, for example, the pits were used in metalworking or salt production, two other possible functions of pits of this kind, then perhaps artefacts of those two distinct activities would have been found such as slag and briquetage, respectively. However, no such evidence was recovered and the function of the pits as such remains inconclusive.

Perhaps the wattle-sided pits were later used to perform a structural function and were used as a foundation to the framework, after they had served their original purpose? Evidence of similar structures of this nature designed to strengthen surfaces that were otherwise unstable, are not known from archaeological contexts. However, modern engineering techniques use gabion or caisson structures, for example on shorelines and river banks, to maintain slopes and embankments. Modern materials used include wire baskets filled with stones. If the Redcastle pits were incorporated in part of a slope consolidation process, which involved their in-filling with stones and the building of the framework they would represent a unique sequence. In conclusion, it would seem that the pits could have been used to perform a variety of functions originally and two of them were subsequently re-used to hold packing stones placed around the overlying framework timbers.

10.2.3. The framework

The second construction phase; the framework, demonstrates a more extensive and complex level of workmanship. New or more ambitious building techniques and the greater extent of the structure suggests a change in the use of the site from when the underlying pits were built. A horizontal framework provides a firm foundation structure if it was to support a building. Research on certain Swiss lake dwellings has demonstrated that foundation frameworks consisting of sill beams were used to maintain the integrity of foundations of buildings on ground that was unstable owing to sporadic waterlogging (Ruoff 1987, 66). The framework on Redcastle differs in form from the Swiss examples, but its use as a sill beam structure on a surface affected by moisture and possibly prone to sporadic waterlogging, is one possible explanation.

Given the erosion to the wattle pits, possibly caused by an increased water influence, the builders of the framework may have recognised the need for a stabilising foundation onto which vertical components could have been placed or fixed. For example, at the Late Neolithic settlement at Fiavé in Italy, mortised beams were held in place with piles which extended above the beam to create a grid system for settlement foundations in a shore-side environment (Perini 1987, 77). The oak piles through the mortise holes on Redcastle may thus have been part of the structure on top of the framework which has been eroded leaving their erosion cones protruding above the horizontal timbers.

Sill beams can also be used to prevent the rising of moisture through superimposed timbers, by providing a base onto which vertical members could be positioned without the latter being imbedded directly into a moisture-prone surface (Zwerger 1997). The point at which the vertical member intersects with the ground surface may be prone to rot and erosion, but above the sill beam the rest of the structure is not affected to the same degree and hence the use of beams in some examples of prehistoric wetland architecture (Perini 1987).

The Redcastle framework has three particular aspects of construction method. First, the timbers were converted using the tangentially faced method, a conversion method which produces the greatest number of planks from a tree by splitting or cutting it into planks with their bark still intact (Allen 1994, 4). Prior to their positioning, some of them had mortise holes cut near their ends, in order that they could be laid partially overlapping one another and they were then kept in place by posts driven through the holes. Cut-mark evidence inside the mortise holes indicates that they were cut prior to them being laid in position (Sands R. pers. comm.). Secondly, once these timbers were positioned the large stones were placed

inside the wattle pits, which at that time were partially open and were thus infilled by the stones. The stones respected the wattling of the pits and are positioned either side of the horizontal timbers, occasionally jammed against the framework (Plate 7.9.). However, they are only found inside the pits, confirming that the pits were partially open when the framework was built and were only infilled as the framework was laid out. The stones inside the pits also had a further supportive role to play in the construction of the framework. By placing the timbers over the pits and then placing the large stones either side of the horizontal members the framework would have been reinforced in position. This concurs with suggestions by previous freshwater crannog excavators that some stones were integral to the timber structures (Ritchie, J. 1941-1942, 38).

The third aspect to the building of the framework was the positioning of external retaining piles on either side of the horizontal beams. These appear to give additional support to the horizontals. The combination of posts driven through the mortised horizontals, large stones used to wedge the horizontal beams in place and the external retaining piles represents a large amount of structural reinforcing. However, the separate features clearly reflect the need to retain the horizontals in fixed positions on a sloping surface, perhaps one that was also prone to rising groundwater or surface inundations, which had to be mitigated against with alternative and additional strengthening features.

The excellently preserved condition of the framework timbers suggests that they were originally placed on a surface that provided enough moisture to prevent the majority of them from deforming and that after the site was used they remained in an environment that maintained a high moisture content. Three timbers did show signs of upper surface deformation and this was a result of being exposed above the

level of the consolidated sands and gravels. Continued protection and re-burial of the timbers is necessary to maintain their current good condition. This was undertaken after the final excavation season. However, given the results of the erosion survey, the south west area of the site is prone to sediment removal and the timbers may become re-exposed in the future.

Foundation structures consisting of horizontal frameworks have been found on a wide range of different sites from Scottish crannogs, including the site excavated by James Ritchie in Loch Treig (Ritchie 1942), to the large Iron Age structures excavated on the Isle of Man (Bersu 1977). Two large timber structures on the site investigated by Gerhard Bersu on the Isle of Man act as a useful comparison to the Redcastle framework. At the Ballacagen Lough site B, Bersu excavated two wooden foundation structures that closely resemble the dimensions and woodworking techniques used on the Redcastle framework. He interpreted the Ballacagen features as integral elements of the large structures inside which they were built. His suggestion that they may have served as 'strongrooms' for grain storage appears at odds with subsequent investigations into grain storage on other Iron Age sites, although they could have been used more as granary-type structures for large quantities of produce (Reynolds 1974). Given the position of the Ballacagen sites in a marshy wetland edge the framework timbers may in fact be the foundations which formed a horizontal framework for the large superstructure and were necessary on a wet or moisture prone surface, like those at Redcastle.

The framework on Redcastle unlike those discussed above, is a curvilinear structure. This follows the plan of the edge of the sand promontory on which the site was constructed and emphasises the break of slope. Speculation as to the form of the building on top of the framework can at present be only very limited, although the

plan of the framework suggests that it may have been an unusual concave-shaped structure. Further excavation of the deposits in the centre of the site would be necessary to establish whether a superstructure existed and what form it took.

10.2.4. Other structural remains

Evidence of the building or structures on top of the horizontal framework were not found during the excavations and this may again be a result of preferential erosion on the south west side of the site. The likelihood that a phase of building on top of the framework occurred is high, given the additional height of deposits towards the centre of the site and further excavations in other parts of the site would be necessary to locate them. As previously noted in section 2.3.2. in Chapter 2, preliminary trial trenches in 1991 located sub-surface timbers on the highest deposits of the site and they were dated to a period after the framework dates: 2150 ± 60 BP (Beta-48763) and 1750 ± 90 BP (Beta-48764) (see Appendix E for calibration and section 10.3). These timbers indicate that not only may there have been a structure on top of the framework but their separation indicates that evidence of later occupation phases may be present near the centre of the site.

In Trench 3, the stone walling overlying the circular piled structure shows that an alternative method of construction was used in that area. This also indicates a change of materials and may be because of the aspect or use of that part of the site. Further investigation of that area would be necessary to establish the complete structural sequence and extent.

The stone mounds on the surface of the site are from a later period of use, which may have disturbed some of the upper deposits on top of the framework. The small finds found beneath the mounds suggest that the site was used recently for

wildfowling. Further research would be necessary to establish the construction sequence above the foundation pits and framework and below the superficial stone mounds.

The phasing of the structural remains began with the construction of the wattle-sided pits (Phase One), which in the cases of Trenches 1 and 2 were replaced by the overlying horizontal timber framework (Phase Two). In Trench 3, the framework was absent but a three course stone wall had been built over the Phase One feature. A third phase may be represented from the timber found during the 1991 trial trenches near the centre of the site and finally, a fourth phase of construction occurred when the stone mounds were built to form protection for modern day wild fowlers.

10.2.5. Timber species

The wood species used for the sails in Pits One and Two were alder and oak, respectively and in Pit Three both species were used. The mixture of different species may represent different periods of construction, repairs or additional re-use. Future analysis of the cut-marks on the tips of the sails of the different pits may enable the differentiation of individual tools, which relate to separate periods of construction to be identified (Sands 1997). Preliminary counts of the tree rings from the oak timbers sampled did not provide enough rings (see Table 7.1.), which could be used to produce data valid for comparison with a master chronology and therefore dendrochronology was not possible on those timbers.

A number of preliminary observations concerning woodland exploitation in the Redcastle area can be made from the results of the species identifications. A scatter plot diagram combining the age in years and diameter in centimetres of the

rods and sails from the pits indicates that there is a predominance of sails between 6 and 9 years old, although the full range of ages is between 4 and 13 years (Figures 10.1. - 10.4.). The sails range between 0.03m and 0.09m in diameter with a cluster between 0.04m and 0.08m. The rods range between 4 and 10 years old and are predominantly clustered between 5 and 6 years and range from 0.02m to 0.028m in diameter. Individual scatter plot diagrams indicate that a similar choice of the age and diameter of the sails and rods was used in all three pits. The individual species used in the pits indicates that the builders preferred particular sizes of branches for the sails and others for the wattling.

The following discusses the particular properties of the individual timber species represented in the primary phase pits and secondary framework on Redcastle. Black or grey alder is a well-known wetland species. It is a light-demanding pioneer that also coppices well (Coles *et al* 1978). It is durable when submerged and maintains its structural integrity. Its semi-diffuse porous structure allows it to be worked easily and this is illustrated by the size of the framework timbers at Redcastle (Schweingruber 1990). The different types of oak cannot be differentiated from their anatomical characteristics alone. The species is tolerant of poor soil conditions, such as waterlogging and can be coppiced. It is well known for its mechanical strength and has been found as structural components as both split and roundwood posts in wetland contexts (Orme & Coles 1985). White, Osier, goat and creeping willows cannot be differentiated on their anatomical characteristics (Schweingruber 1990, 154) but the species is well known for growing along watercourses and in coastal fen and marshland environments. They are tolerant of poor soils and the common Osier is grown for its twigs and withies for hurdling (Press 1991, 33) and has been previously recorded from wattle structures in archaeological contexts (Morgan 1988, 87). Hazel responds well to coppicing and is

used because the rods are both flexible and durable in wet conditions. It can tolerate a wide variety of soil types and is a very widespread shrub. If felled from the base of the trunk it grows multiple new shoots forming straight rods, suitable for wattling. It is a traditionally coppiced species and is often used for hurdle making (Rackham 1980).

The species identification and the scatter diagrams indicate that the timbers used were chosen specifically for their ability to be used as wattling, verticals and framework members. The species of the sails could have been chosen to maintain their mechanical strength during wet conditions. Some species used for coppicing have been recorded to put on additional rings at the end of the rod where it joins the main trunk (Morgan 1988, 81) and the random sampling of the Redcastle rods may not be a true reflection of all of the age ranges. The choice of naturally coppiced rods, or those that have been cut from stands of trees that were regularly used, is difficult to demonstrate and the limited size of the Redcastle sample currently precludes any further interpretation (Crone 1987).

It is probable that the two species of the sails were selected specifically for use in an environment that was influenced by high moisture content caused by high groundwater levels. Excavation from the Oakbank freshwater crannog highlighted a preference for alder and oak in piling and evidence from other wetland sites supports this evidence (Sands 1997). Dixon suggests that alder and oak were selected on Oakbank for their resistance to deformation and their maintenance of structural strength even when completely submerged (Dixon 1984). This may also have been a factor in the choice of species for the pit sails and framework timbers on Redcastle.

The species used for wattling were also chosen to suit the needs of the structure; to maintain a solid vertical edge on a sand slope which if waterlogged, would not be able to support a section to a particular height. Willow and hazel are known for their flexibility and durability; these are clearly essential qualities for the construction of wattle structures.

Wood sampling and species identification of the horizontal timbers on Redcastle allows aspects of environmental reconstruction to be attempted. Analysis of the small finds associated with the second construction phase can also contribute to the environmental discussion. All the horizontal framework timbers were identified as alder and the vertical piles through and retaining posts associated with the horizontals were oak. The alder seeds found in the on-site plant macrofossil samples, which were associated with the construction phase show that the alder trees could have been brought on to the site whole. Their conversion could therefore have taken place on-site and this is supported by the presence of the alder wood-chips.

The species represented from the structural remains enable aspects of environmental conditions to be reconstructed. For example, the species are all tree or large shrub types and these typically grow adjacent to water courses and in wetlands. This suggests that the environment from which the materials were taken from to build the Redcastle structures was certainly a wetland-type. This type of environment was also represented in the pollen spectrum and from the various different species recovered during the plant macrofossil sampling and analysis.

10.3. Dates from the structural sequence

Results from radiocarbon assay of various samples from the structural remains on Redcastle enable a chronology for the site to be established. The dates

may also be compared with the other marine crannogs, see Chapter 11. Some of the Redcastle dates fall within the period between 800 and 400BC, when calibrated, as a result of the variations between calendar date and radiocarbon dates and reflected in the calibration curve (Stuiver & Pearson 1986). Therefore the dates can only be used to identify general chronological events of the construction phases.

Radiocarbon dating of specific parts of the Redcastle structures produced six dates and a seventh was obtained from the leather fragment found inside Pit One, and is included in the dating sequence. The dates were calibrated using Methods A and B (Stuiver *et al* 1998), and the discussion below uses the Method B results which applies the two sigma calibration, 95.4% probability distribution and the highest relative area under the probability distribution curve (see Appendix E). The following points outline the main phases of construction and their corresponding date ranges;

- Primary wattle pit building phase: 531 - 343 BC, with leather fragment dated to between 399 - 106 BC.
- Overlying timber framework phase: 827 - 481 BC, with retaining pile date between 796 - 485 BC.
- Later phase, from sample taken in 1992, near the centre of site: 367 - 46 BC.
- Final radiocarbon dated phase, from 1992 sample date: AD75 - 466.

From the above range of dates an overlapping period between 531 - 481 BC exists from the earliest date from the pits and the final date of the framework. If it is assumed that the sails used for the pits were felled and used without seasoning then 531 BC would be the *terminus post quem* for the building of the first structures on Redcastle. However, in reality the sails may have been felled and prepared or used for other purposes prior to being incorporated on the site and this is additionally true

for the framework timbers, hence their earlier date. As regards the date range of the framework retaining pile, it cannot be used to distinguish a later or contemporary event with the construction of the framework itself. However, the result from the leather fragment is interesting because it represents a later period, which may indicate a time when Pit One remained open after the construction of the framework or it was re-opened.

The radiocarbon dates attained prior to this research, during trial trenching in 1991 (Hale 1992), extend the chronology of the site towards the present. Sampled from a trench in the centre of the site, amongst the highest level of consolidated deposits, the earlier date (367 - 46 BC) indicates a period after the range of dates of the framework. Finally, the most recent date indicates that activity on-site occurred between AD 75 - 466. This final date concludes a chronology of the site of almost 1,000 years, however, it is not assumed that it was occupied continuously.

10.4. Water level change around Redcastle

Results from the multi-spectrum analysis of samples from Redcastle and the surrounding deposits gives an opportunity for refinement of aspects of the palaeoenvironment. The following is a summary of how the results from the palaeoenvironmental investigation on Redcastle contributes to the understanding of the late Holocene water levels around Redcastle and the environmental development of the site.

Prior to any occupation of the Redcastle site birch and alder leaf litter was deposited, possibly marginal to a water course, which was identified from the pre-construction plant macrofossil evidence. This deposit suggests that the contemporary land surface was acidic and well-drained. The initial phase of building indicated by

the wattle-sided pits shows that the sand mound (see Chapter 9, section 9.2) was exposed; diatom evidence from Chapter 8 demonstrated that the site was then near MHWST and at the time experienced a period of lower water-level than previously. This has implications for the lower sea level shorelines at the head of the Beaulieu Firth outlined by Firth and Haggart (1989) and discussed in section 5.2, Chapter 5. The pits were then influenced by brackish and freshwater sources, suggesting estuarine conditions were present and also a freshwater source, possibly a stream adjacent to the site, which was at or above the level of the HAT. Subsequent to this was the period during which the deposition of the silty sand horizon found under the framework timbers occurred. This was probably a brief event according to the available radiocarbon dates (between 531 and 481 cal BC) because the overlying framework, apart from implying a change of use for the site, also indicates that exposure of the site allowed time for the framework to be built. Finally, deposits above the framework were influenced by both brackish and marine water conditions, around the level of the HAT, although this appears to have been interspersed with periods when the site was exposed, given the later two radiocarbon dates.

Above the framework the diatom species show that conditions changed from an environment of reduced marine influence to one which involved a minor transgressive event bringing intertidal brackish conditions to influence the site, confirmed by the pollen and plant macrofossil analysis. The security of this interpretation is however challengeable: the variety and low number of diatoms found in the core taken from the sediments on top of the framework show that on-site disturbance may have affected the deposits. Further sampling would be necessary for quantifiably more robust data, to establish previous water levels and thereby enabling aspects of the development of the site above the level of the framework, to be reconstructed.

The assemblage from the off-site diatom sample can also be used to indicate sea level in relation to the adjacent marine crannog. The significant markers are those that indicate the change from *polyhalobous* to *mesohalobous* species (see section 8.4.2, in Chapter 8). This boundary has been demonstrated from other sites around Scotland to indicate the change from intertidal mudflats to developing salt marsh (Dawson *et al* 1998, Shennan *et al* 1995). Evidence based on modern diatom assemblages suggests that this boundary is indicative of a position occurring at c. 0.15m above the predicted level of MHWST. The results from the Redcastle off-site monolith therefore show that MHWST $\pm$ 0.15m, can be ascribed to between -0.18m and -0.16m $\pm$ 0.1m OD, based on the diatom species identified in the off-site sample (Table 10.1. to 10.3.).

The change of conditions indicated from the diatom monolith shows that there was a period when the end of the sand promontory was exposed as a result of a relative decrease in marine influence, before the primary pits were built. This occurred after 531 cal BC and marks the beginning of the occupation of the site. Whilst the area may still have been affected by brackish conditions it was situated above MHWST when the pits were first built.

The species present in the plant macrofossil and pollen analyses on and around Redcastle suggest that the site occupied a wetland environment that was colonised by marsh species. Additional to the marshy plants were alder trees, a species that thrives in wetland environments. Sedges, rushes and crowfoot are indicative species of a sedge fen, complement the alder carr species and indicate that the site could have been close to or influenced by water courses. The exact position of those features were not clear from the plant macrofossil evidence, although in

combination with the sedimentary coring two possible locations have been identified; to the north east and to the south west of the site. Evidence of an alder carr surrounding the site and adjacent to the two open watercourses, therefore comes from combining the sedimentary evidence with the plant macrofossil and pollen remains, whereas on-site the plant remains show that the site had been disturbed, possibly as the ground was prepared for the building of the timber structures.

The timing of the final abandonment phase of the site is unclear and will remain so until the deposits near its centre are investigated. If Christian Maclagan's description of the sites in the Beaulieu Firth is to be believed, then inundation of Redcastle or a more recent period of lower sea level has also occurred:

As late as 1745 the place (Redcastle) was an island refuge to which some of Prince Charles Edward's defeated adherents fled after the Battle of Culloden. (Maclagan 1875, 89)

10.5. Conclusion

Excavation and sampling on Redcastle marine crannog have established construction phases and possible uses, water level variations, environmental conditions, including vegetation types and aspects of the topography that led to the sand mound being used to build the structures. The results also show that excavation on a marine crannog during low water periods is possible and that small scale trenches suited the types of well preserved organic remains encountered.

CHAPTER 11

Marine crannogs: interpretation.

11.1. Introduction

This chapter widens the focus from a specific interpretation of the Redcastle site to a more general interpretation of marine crannogs. It discusses all the sites located, surveyed and investigated in the course of this thesis together with data and interpretations put forward in the previous work discussed in Chapter 2. Three hypotheses are proposed to account for the location, functional possibilities and structural forms of marine crannogs. The general and specific characteristics of the sites are discussed in the context of the chronological framework provided by the radiocarbon dates and the diagnostic artefacts. Certain aspects of each hypothesis are inevitably inter-related and present strong evidence for considering establishing marine crannogs as a distinct sub-group.

The three hypotheses are:

- Marine crannogs were built in selected estuaries as access points from firth to land and vice versa. Within this hypothesis the use of log boats associated with marine crannogs and the water levels when the sites were built, are discussed.
- Marine crannogs were built as places where specific processing activities could take place.
- Marine crannogs share structural characteristics with contemporary architecture on land and they can be compared with other contemporary structures in the archaeological record.

11.2. The access point hypothesis

Previous investigations on marine crannogs have proposed a variety of explanations about their origins, function and form, ranging from beacon stances (RCAHMS 1979a, 30) to piles of stones dumped by quarry barges which had run aground on shallow sandbanks (Blundell 1909-1910, 17). However, what these interpretations have in common is that they equate marine crannogs strongly to their position as points in firths that are related to shipping transport, whereas earlier interpretations suggested that they were cairns and burial sites (Lowther 1699). It is their location within the firths and the fact that two groups of sites are found in estuarine environments that this first hypothesis is directly concerned.

In general terms, firths are good access points for transport by water both inland and as starting points for coastal and marine routes. Estuaries are significant locations between open sea and inland riverine routes because they are places where boats used for riverine transport can be changed for others more suitable to coastal and marine conditions (Westerdahl 1994, 268). The upper parts of firths are also usually the lowest points where rivers can be crossed or forded, prior to the body of water becoming affected by fully marine conditions. For example, it has been reported that before the dredging and canalisation of the Firth of Clyde the river could be forded as far down as Dumbarton Rock (Riddell 1979).

For boats, firths are parts of linear routeways between inland rivers and coastal and marine environments. These routes may require changes of boat type to cope with different conditions but the water provides the route (McGrail 1987). However, for terrestrial routes firths represent obstacles, such as for cattle drovers (Baldwin 1986). If this was the case during the later part of the first millennium BC, marine crannogs may indicate positions where access to the waterways was possible

and from where boats could be taken to cross the firth, and where inland and coastal journeys began and ended.

Sean McGrail states that a number of criteria are pertinent to the location of landing places (McGrail 1987, 269). According to McGrail's observations firths could present favourable situations for landing places. Within the firths themselves different parts of the shorelines may be better locations for access. For boats, certain points can be chosen for launch points and others may deter landfall (McGrail 1985). Rocky shores suggest the latter whereas shallow gradient, muddy or sandy shorelines make good launching sites. Prevailing winds and weather conditions may encourage certain parts of a firth's shoreline to be used as an access point, where sheltered or exposed conditions may be required. Tidal currents, the angle of shoreline slope and the distance from the navigable channel are all aspects of access points that have been considered in the assessment of the location of marine crannogs. Results from the survey around the marine crannogs on both the east and west coasts show that they are situated in locations which possess a variety of favourable conditions, which could have been chosen for both landing and launching boats. Marine crannogs and specifically boat access and their association will be discussed further below.

Survey reflects the advantageous position of marine crannogs as access points. Contour surveys show that Redcastle was built on the end of a promontory, which projected from a palaeo-shoreline. The analysis of the sediments surrounding and beneath the site showed that it was built directly onto a former land surface, between two palaeo-channels. Redcastle was therefore built above and adjacent to water courses that could be used as an access route to the site or into the rest of the firth. Similarly, Carn Dubh is built on the end of a sandbank in the middle of the Beaully Firth indicating a location which could have been used to access the deep

water channel adjacent to the site. Coulmore is situated on the north edge of the same sandbank and is located close to the main low water channel. Phopachy is built on a raised sandbank close to the south shore and it forms a raised point to the west of a low water channel. All these sites are therefore built on raised features adjacent to deeper water channels, which in the past could have been used as access routes to and from the sites. These locations would be suitable for access by shallow draft boats, such as log boats, which is discussed in detail below.

The sites in the Firth of Clyde are all located upstream from the confluence between the Firth of Clyde and the River Leven. This confluence where Alt Clut (Dumbarton Rock) is situated has been an important location at least since the early historic period (Alcock & Alcock 1990). Alt Clut clearly could control access to the inner Firth of Clyde and the River Leven and the concentration of marine crannogs just to the west of this point indicates that they too could have been built to control or allow access, especially to the upper reaches of the Firth of Clyde. Perhaps the presence of marine crannogs in the Firth of Clyde indicates that this area was an important access route in later prehistory as well as in early historic times.

Survey showed that the Dumbuck site was built on a raised spit of land that ran perpendicular to the current shoreline and that the site itself formed a short promontory close to the edge of the low water channel. This location suggests that the site was built in such a way as to be close to a former channel edge, but that it could have remained raised above a previous, lower water level. Erskine is situated on the edge of a sandbank and is again adjacent to the low water channel. Landward of the site the sandbank rises towards MHWL suggesting that the crannog could have been built on the edge of a former shoreline. Further work would be necessary to understand the geology between the site and the current shoreline because

comparisons between Hanson and Macdonald's 1985 plan of Erskine (Figure 2.9.) and the current survey (Figure 4.9.) indicated that sediments have built up and buried features in this area over the intervening period.

The location of Old Kilpatrick indicated by the previous plans suggests that it was built directly at the water's edge. The contour survey of the area also suggests that it was built on a raised promontory of land, which projected towards the edge of the river. The location of the Old Kilpatrick site was perhaps carefully chosen as a point of access to the River Clyde. Fragments of a curvilinear structure (Figure 2.8.) allow for comparisons between it and the framework on Redcastle, which was built to follow the form of a geological feature, along the edge of a palaeo-channel (Figure 9.1.), to be made.

The survey of Langbank East showed it to be situated on the lower margin of a relatively flat part of the intertidal zone next to a break of slope towards MLWM. This position indicates that the site was possibly built on a former shoreline, rather than taking advantage of a geomorphological feature, such as a sand spit, and that it formed a raised feature on or near a channel edge. In the case of Langbank West, the survey results highlighted a short promontory between the site and the current shoreline. However, it should be noted that modern road building has altered the shoreline adjacent to the site. A short distance below the site, towards MLWM, a break of slope was identified which may be the remains of a former shoreline close to which the site was built. The contour survey of An Dòirlinn showed that it is located near the end of a promontory which extends from MHW and the site itself forms a distinct upstanding feature on the promontory.

All of the locations of marine crannogs suggest that access to their respective firths was necessary and their setting was enhanced by locating them on promontories of land, edges of palaeo-channels or former shorelines. In the case of Redcastle, it was a former palaeo-channel whereas Langbank West appears to be built on the edge of a feature that lies parallel with the current MHWL and may be a former shoreline. Whether all the marine crannogs were built directly at MHWL or a little distance above it, perhaps at the level of the highest astronomical tide, remains to be seen with further analysis of the individual sites.

The effect of building on, or enhancing, a natural raised feature in the intertidal zone is therefore a common factor in the development of many of the marine crannogs. This raised feature may be a promontory or part of a former shoreline but would ultimately have been used to allow access to the site from the land. Marine crannogs would also have formed prominent shoreside sites built to stand at and above the water level as the site surveys and investigations on Redcastle have shown. Despite their limited elevation which is measured in tens of centimetres rather than metres, these sites would have stood proud above the surrounding land surface and water level.

There are other sites in the archaeological record of north west Europe which make use of raised ground in this way. The rectangular timber structures excavated at Goldcliff on the intertidal shores of the River Severn in south west Britain are an example (Bell 1992). The Goldcliff structures were located on top of a peat shelf, on slight rises in the peat. In context of the research done on the marine crannogs, it is possible that the location of the sites at Goldcliff on raised points may have been deliberate siting in order that they remained above a former water level. Bell suggests that the seven Goldcliff structures were used seasonally during the later part

of the first millennium BC, because the area was liable to occasional flooding (Bell 1992, 25). The actual purpose of erecting structures on such a site is currently unclear, although Bell suggests that they could have been used for holding cattle, given the good quality grazing land of the coastal marshes and the large quantity of cattle hoof prints surrounding structure 8.

Prehistoric sites built on raised areas adjacent to waterways have also been extensively researched in the Netherlands, especially during the Assendelver Polders project (Brandt *et al* 1987). The Assendelver Polders site F is particularly interesting as it was built adjacent to a tidal creek system, which could have allowed access to the site in addition to the terrestrial routes. The excavation results from the Assendelver Polders shows that these sites were built as domestic units which included areas where animals could be stalled in the same building. Clearly the builders of these sites recognised the value of raised points in wetland environments and also the resources available for their livestock.

Farther east along the southern north Sea coastline, especially around the tidal estuaries of the Ems, Weser and Elbe rivers, rectangular, late prehistoric aisled structures have been excavated in coastal wetlands (Schmid 1978). Similarly, to the Dutch terps and in some respects to marine crannogs, especially Redcastle, these 'flachsiedlung' sites were built directly on sandy banks of tidal inlets. An example of these was at Feddersen Wierde, on the east shore of the Weser river. Its primary construction phase consisted of three aisled houses built on a naturally raised sand island and surrounded by active tidal channels (Schmid 1978, 132). However, unlike the marine crannogs, these sites continued to be occupied into the second century AD and as water levels fluctuated the island was artificially raised, forming a terp and the site continued to be occupied until the fifth century AD.

11.2.1. Marine crannogs and boat transport

The theory that marine crannogs were used as access points is strengthened by the existence of a transport system to support them; log boats. A large number of log boats have been found in, for example, the Firth of Clyde (Gregory 1998) which lend weight to the idea of the river as a major transportation route, aided by the existence of landing and access points in the form of marine crannogs. The distribution of log boat finds from the Firth of Clyde is concentrated between Glasgow and Dumbuck and since 1800, 34 boats have been recovered from the river or from former river channels (Mowat 1996). The number of finds from this part of the Firth is probably the result of recent development in that area, which has led to excavations of former river channels and terraces during construction projects. However, it is also surely a strong indication that this part of the Firth was used by log boats probably during the same period as the marine crannogs.

Two of the Firth of Clyde log boats are of particular interest and can be used as direct evidence that boats were used in conjunction with, and at the same time as, some of the marine crannogs. The first was found during the original excavation inside the dock structure at the Dumbuck site, reinforcing the idea that the site could have been accessed using a log boat and that the location of the site was a point of access from the firth to the shoreline and from the shoreline to the firth. Whether the dock in which the boat was found opened directly onto the river channel is unclear from the previous reports and the current survey has relocated the probable location of this structure and its open side was directed towards the main channel (Figure 4.7.).

Analysis of the Dumbuck log boat design shows that it could carry large quantities of cargo weighing over 3000 kilos (Gregory N. pers. comm.). Its shape and form indicate that it was built to be either punted in very shallow waters or paddled in deeper-water conditions and that it could be used in estuarine or more open marine conditions. The very form of the log boat therefore ties it in with a transportation function; one which would take it into the shallow waters by the site and then into the deeper waters of the Firth.

The second log boat of interest was found near Erskine harbour, opposite Old Kilpatrick, in 1977. The boat was found exposed in the intertidal muds in a location where two other boats had been found in the later part of the nineteenth century (Mowat 1996). A sample of the boat was submitted for radiocarbon dating and the resultant date was: 1955 ± 45 BP (GU-1016) (Hanson W. pers. comm.). This date corresponds with the radiocarbon dates from both the Erskine and the Dumbuck marine crannogs, reflecting a clear correlation between these sites and this mode of transport. It therefore seems likely that the marine crannogs particularly in the Firth of Clyde provided points of access to the river channels and that the log boats were used in the firth system as a means of transport between the sites and shorelines.

By contrast, only one log boat has been discovered in the area of the firths of the north east of Scotland, in a former channel at the confluence of the River Conon and the Cromarty Firth (Bruce, W. 1881-1882, 11, Mowat 1996). The paucity of log boats in this area is not necessarily indicative of a different function for the Beaully Firth marine crannogs but probably related more closely to the circumstances of discovery of the log boats in the Clyde. It is well known that the enormous amount of public works in the Firth of Clyde has substantially changed the character of the river but it has also resulted in the opportunity for discovering shoreside or river-

related finds like log boats. This kind of activity, by contrast, in the Beauly Firth has been minimal especially at the River Beauly end of the Firth. The opportunity for the discovery of log boat type finds is therefore significantly smaller. One type of boat found in the north east of Scotland is the skin boat which also lessens the chances of discovery (Fenton 1972). Skin boats are less likely to survive unless the optimum conditions exist and although a wet, anaerobic environment such as in the intertidal sediments of the Beauly Firth is ideal, the inherent fragility of the boats must compromise their survival. The idea of the Beauly Firth marine crannogs as access points is not therefore undermined by the slightness of the evidence of a relationship between the sites and log boats. It merely begs questions about the context of the discovery of log boats in the region.

Evidence from the archaeological record from both regions where marine crannogs have been found shows that contemporary shoreline and hinterland sites were occupied during the same period (RCAHMS 1975, 1978a, 1978b, 1979a, 1979b, 1979c). In the Beauly Firth region, sites such as Craig Phadrig, excavated by Alan Small (Small & Cottam 1972) and Ord Hill hillforts occupy imposing positions above the firth. Other sites surrounding the Firth, which may be contemporary in age with the marine crannogs are included on Figure 11.1. Similarly, in the Firth of Clyde sites such as Sheep Hill hillfort and Dunbuie dun, above the northern shoreline overlook the marine crannogs and may have been occupied at the same time and formed part of the cultural and economic landscape (see Figure 11.2.). These occupation sites suggest the existence of a significantly sized population who may have required access to the firths, using the marine crannogs as points of entry. This point is supported by radiocarbon dates and artefactual evidence which highlights the contemporaneity of some of these sites and the marine crannogs (Small & Cottam 1972, MacKie 1976).

11.2.2. Marine crannogs and water levels

Sea level research in Scotland has identified specific positions until c. 3,000 BP, after which it has been proposed that a series of relatively small ($\pm 1\text{m}$) and localised fluctuations occurred (Shennan 1987). Marine crannogs therefore represent an opportunity to identify localised positions of water level, that may not necessarily be caused by widespread sea level change and which can be levelled to OD and dated from particular structural remains on the individual sites.

It should be assumed that the known structures on marine crannogs, i. e. the wattle-sided pits and secondary framework on Redcastle, and the platform structures on Dumbuck, Erskine and Langbank East were all built at or above the contemporary water level. Based on this and assuming that none or negligible compaction of the underlying sediments has occurred, given the lack of visible compactive damage to the excavated structures, the marine crannogs remain in the same vertical position as when they were first built. If we accept the above then marine crannogs can be used to define previous water levels. Therefore in the Beaully Firth the water level would have been 80cm lower than the current MHW to continually expose the structures on Redcastle. However, it would have to be nearer 2m lower to expose Coulmore and 1.5m for Carn Dubh and Phopachy. In the Firth of Clyde the water level would have been around 1m lower to expose Dumbuck and Erskine and about 60cm lower around Langbank East. These variations may be as a result of a slightly lower sea level, or alternatively may also be owing to localised water levels fluctuations caused by different drainage systems and tidal regimes in the respective firths. Because the variations are in the magnitude of centimetres and not metres, apart from those in the centre of the Beaully Firth, it may be difficult to identify specific positions of sea level for those periods when the sites were built, but

rather they may signify periods of altered water level which have been caused by changes only within the individual firths.

When the calibrated radiocarbon dates are considered from the individual sites a particular period and altered water level can be identified for the two firths. Therefore it can be proposed, in the Beauly Firth that between 531 and 481 cal BC in the vicinity of the Redcastle site the water level was c. 0.8m lower than the present level. On Phopachy if the radiocarbon dated timbers were structural remains it can be inferred that the water level was c. 1.5m lower than the current position between 199 BC and AD 299, although not necessarily for the whole period. On Carn Dubh if the timber found by Blundell, re-located and sampled for dating during the current research was part of a structure, the same general lower position of water level could be deduced for the period 803 BC - 481 BC. The other date from Carn Dubh implies that the site was used some time in the more recent past. On Dumbuck and Erskine the radiocarbon dates imply that the water levels would have been c. 1m lower than that today, between 198 BC and AD 232, in order that the horizontal timber platforms would have been above water.

Changes of water level can have widespread effects especially on the areas of low-lying coastal wetlands which surround firths. For example, at the head of the Beauly Firth and the Firth of Clyde the shallow gradient shorelines are susceptible to small changes of water level and changes in the tidal regime. Prior to the canalisation of the Firth of Clyde the flood plain, in which the marine crannogs are situated, would have been wider and prone to variations of water level, which are now controlled by the main channel dyke system and the shoreline training walls (Riddell 1979). Therefore the current water level has been altered since the position when the sites were built and occupied anthropogenically and further water level and

geomorphological research would be necessary to identify the previous positions around the other marine crannogs .

To conclude, the access point hypothesis has been developed using the results of the contour surveys of all the sites which identified slight variations in the topography of the intertidal zone. These changes were highlighted by the site surveys and the sampling and excavation on Redcastle, which showed that this particular site was built on a shoreline promontory, on the edge of a palaeo-channel and that water levels have risen since the site was used. The other sites in the Beaulieu Firth are also located on raised features adjacent to tidal channels. Further support for the hypothesis is provided by the log boats found in the Firth of Clyde, some of which were contemporary with these structures, which seem to have been built in locations that could have been chosen specifically to access channels in the firths. Obvious though it may seem then, these sites could merely have been built as a means to an end; the use of the natural waterway as a transportation route for goods or people and the sites provided the means from which access could be gained to and from the firth. However, the small finds and structural remains should also be considered in conjunction with the location of marine crannogs.

11.3. The processing hypothesis

The processing hypothesis brings aspects of the access point hypothesis together with a more radical interpretation of the finds on marine crannogs. The location of these sites on the edges of previous watercourses, the paucity of domestic artefacts, the predominance of animal bone small finds and the wattle structures, found particularly on Redcastle, indicate that processing activities may have taken place on marine crannogs. It is therefore possible that these sites have been located and built specifically for processing purposes.

As previously outlined, the position of marine crannogs on shorelines and close to previous water courses, such as the palaeo-channels near Redcastle, indicate that their locations were chosen carefully. As discussed above the sites may have been in use to access the firth for transport purposes but they may also have been used to access the brackish water resources in the estuaries. Diatom analysis from the sediments directly adjacent to Redcastle showed that the site experienced brackish water conditions during a period of exposure. Some of the sites such as Redcastle and Dumbuck are close to modern day freshwater streams and in the past, these streams may have been in similar positions. Freshwater is of course an everyday necessity for animals and humans but can also be used for washing and cleaning purposes. The salt water of the Firths offers the potential extraction of valuable salt for preservation and a means for washing and cleaning animal skins and hides. Therefore water, either salt or fresh, would have been an important resource available on these sites by virtue of their location. The evidence from the surveys shows that at least four of the sites are situated close to (within 100m) of a freshwater source.

The paucity of domestic finds on marine crannogs, illustrated by the absence of pottery finds, although possibly a result of the lack of comprehensive and modern excavation, suggests that they were not occupied in the everyday sense of a freshwater crannog and were probably built away from domestic sites for specific reasons. For example, the activities that took place on the sites may have required resources other than a supply of fresh or salt water which only the firth edges could supply. Other resources may have included strong winds, often experienced on exposed promontories in firths with extensive fetches, which could have been utilised for drying foods and animal skins. The position of marine crannogs on firth

edges could allow the transportation of materials and finished products to and from the sites using them as access points as well as processing sites. The areas surrounding both the Beaully Firth and the Firth of Clyde would have offered a variety of supplies of building material to construct the necessary structures for processing such as the pits on Redcastle; a fact supported by the species used in the buildings on that site.

The location of marine crannogs and the types of small finds associated with them indicate that perhaps they were part of larger trading networks within their regions. This is underlined again by the presence of rotary querns found on Dumbuck and Erskine, which may represent artefacts of domestic activities. Perhaps the markets for such processed goods were to be found in the occupation sites which overlooked the firths like Craig Phadrig, above the Beaully Firth, which offer contemporaneous dates to some of the marine crannogs ?

The most common debris on all the marine crannogs investigated are animal bones and within the faunal assemblages, cattle remains were the dominant species. Given the pollen and plant macrofossil evidence from Redcastle, which suggested that the site was located in a wetland landscape, the area surrounding these sites probably provided good grazing land for cattle and other species. The Redcastle assemblage shows examples of broken, cut and split bones, all of which point to the butchering of the animals on-site. This was also confirmed from the identification of roughly equal amounts of the major body parts were represented in the assemblage, indicating that the animals were alive on-site. The animal footprints on Redcastle also testify to the presence of live animals on-site.

Certain features of the structural remains of marine crannogs lend weight to the hypothesis that at least some of these sites were built as processing sites. The Dumbuck, Langbank West and Erskine sites in the Firth of Clyde are all circular or semi-circular platform structures near the edges of water courses. The positioning of a large platform, near water, on a raised area of ground may suggest the need for a large flat site on which activities such as animal butchery could take place. If this was the case the adjacent water could have been used to clean the products of the animal processing, the salt from the water being necessary for curing meat, such as salt beef and the log boats to transport them to other parts of the firth.

Some of the structures found on marine crannogs give a clearer impression of the kinds of processing which may have taken place on these sites. For example, the wattle pits on the Redcastle and Dumbuck sites suggests a number of processing activities linked with water. It is possible that if these pits were made watertight by clay linings, they could have been used for soaking skins (a by-product of the animal processing) prior to tanning. Another possible interpretation is that the pits formed hearths used for metal-working. The association between the pits on the Redcastle site and the charcoal and leather small finds suggests a combination of processes may have been in use.

The bone comb from Langbank West offers a more sophisticated kind of processing and craftsmanship as it is an example of a fine late Iron Age object. The inscribed markings on the comb have clear associations with La Tène art work from both Ireland and mainland Europe and a similar object has been found near Seacliff in East Lothian, Scotland (Foster 1990). Alternatively, if the object was produced on-site it would be evidence of the location of manufacture and be another type of processing activity using animal by-products that occurred on a marine crannog.

The location of the sites adjacent to firths, which are well known to be fish breeding grounds, would suggest that the sites could have been used for fishing purposes. However, the paucity of fish bones in the faunal assemblages may be used to interpret these sites as locations not necessarily related to fishing activities, as a result of preferential erosion of fish bones. Similarly the paucity of bones from wild-fowl, such as ducks and geese also implies that these activities were not necessarily the reasons why the sites were built on the shores of firths.

11.4. The roundhouse hypothesis

The processing theory ties in closely with the access point hypothesis by looking at the firth as a resource and as a location factor. The final hypothesis about marine crannogs discusses the structures and analyses the architectural constructions used. The third hypothesis is based more specifically on the structural remains of three of the marine crannogs in the Firth of Clyde group. It suggests that the Dumbuck, Erskine and Langbank East plans represent the remains of circular timber foundations on which roundhouse superstructures could have been constructed. The structural attributes of double ring roundhouses germane to this discussion are an outer ring of timber piles, representing the outer wall line and an inner ring of piles, which would have supported the roof ring-beam. The structural remains and dimensions of the three sites and the reasons why the other marine crannogs are not included in this hypothesis are outlined below.

The survey of Dumbuck during the current research confirmed some of the preliminary observations by Munro and others (Bruce 1899-1900, Donnelly 1898), such as the ring of piles and internal horizontal timbers and enabled the dimensions of the circular timber structure to be recorded. The dimensions suggested that it

could be compared with the dimensions and structures attributed to timber roundhouses. The central pit, which corresponds to the position of hearths often found in roundhouses, could affirm this if we assume that the feature was a hearth. The external piling around the edges of the horizontal timbers could represent the remains of the main wall supports and the internal piles, of which only two were found, could be part of the inner pile ring. The external stone 'breakwater', could be the outer support for the roof timbers, if the structure was built on a double-ring type roundhouse plan (Guilbert 1981).

Measurements from the plan of Dumbuck were used to provide data which was tested against Peter Hill's formula for Iron Age roundhouses (Hill 1984). Hill's formula is: $\pi y^2 = 2\pi x^2$, where πy^2 is twice the size of the inner ring (πx^2). The optimum ratio of outer ring to inner ring is 1:0.707. When the dimensions of the Dumbuck structure, using the outer piles as the outer ring (15m diameter) and the two inner piles as the inner circle (7.5m diameter) are used, the results fit well within Hill's formula and result in a ratio of 1:0.5. There is therefore a strong case for interpreting the structural remains of Dumbuck as the foundation of a roundhouse. Other aspects of the site can be used to strengthen this hypothesis. Features such as the western stone causeway and the stone and timber causeway from the site to the dock indicate where entrance ways into the structure were located and the mortised timber could be the remains of a structural timber, possibly similar to those found on Milton Loch freshwater crannog (Piggott 1952-1953, 137) and the one recently excavated from Oakbank crannog in Loch Tay (Sands 1997, 47).

If Dumbuck was a roundhouse, then the reported three levels of timber flooring may indicate that re-building phases took place (Bruce 1899-1900, 437). It is possible that the site became inundated and that these events necessitated the

additional floor levels. Evidence of sea level change in the Firth of Clyde is unclear after c.5000 BP (Jardine 1980), however, evidence from the marine crannogs may indicate localised changes within that part of the Firth. Alternatively, given the assumed weight of a thatch roof the timber piles may not have been able to support the structure because they were driven into soft estuarine sands (Munro 1905,134). The absence of pile stabilisation devices on the site, such as the 'foot-plates' found at some of the Swiss lake-dwellings (Ruoff 1987) may indicate that the weight of the building did not lead to the piles sinking into the sub-surface geology and therefore the piles were able to support a building with a roof. If this was the case, the original excavators therefore only found the horizontal foundation remains with no evidence of the superstructure lying on top of it, such as thatch material. Inundation and water level fluctuations may of course have eroded the superstructure and removed this material. The remains of the structure, below the current ground surface therefore provide limited potential for evidence of the superstructure but could produce evidence of palaeoenvironmental conditions and the nature of the foundation structure. Further investigation of the timber remains and their capacity for load-bearing would be necessary to confirm whether a superstructure could have been supported by the piles and the geology into which they were driven or whether sleeper beams were more suitable to support uprights.

Part of the plan of Erskine forms a roughly circular shape, possibly with a smaller, semi-circular feature to the west of the main platform. The diameter of the main structure made up of the horizontal roundwood members is approximately 15m if the piles on the eastern margin are assumed to be the external piling. Unfortunately, no piles were found in the interior of the site and Hill's formula cannot thus be applied to this site at present. The circularity of the site, however, must make this interpretation a possibility if further piles are found. The remains of

Langbank East consisted of a ring of piles, approximately 15m in diameter. No inner ring of piles was reported in the excavation report, which indicates a different design of foundation and possibly superstructure.

The species of timber used for the verticals and horizontals on the three sites in the Firth of Clyde that have been investigated were the same: oak for the vertical piles and alder for the horizontals, although this may be coincidence, it suggests a pattern of species use by the builders of all three sites. It is also known that both oak and alder are often used to construct sites in wetland conditions owing to their structural properties which maintain strength and form when waterlogged. Perhaps the builders of the three sites recognised the properties of those timber species and utilised them in the structures, knowing that they could be inundated by changes of water level.

It is as yet unclear whether the remaining uninvestigated marine crannogs in the Beaully Firth and the Firth of Clyde were built to this roundhouse pattern. Certainly the results from the Redcastle excavations show that the individual phases on that site are not comparable with the Dumbuck platform. In the case of the sites like Langbank West, it is as yet unclear what kind of structures lie beneath the surface stones. The oval plan suggested by the stones may not, for example, be borne out by the structures beneath it. On the basis of the previous investigations of Old Kilpatrick, it does not seem that the site was circular although there are some large framework timbers noted from the archive material (Figure 2.8.) which could have acted as a strong foundation for a building such as a roundhouse.

From the Beaully Firth group, the plan of Carn Dubh although oval, is probably too large according to Hill's definition to represent a roundhouse and

further intrusive research would be required to investigate this suggestion. However, large structures outwith Hill's dimensions have been described as roundhouses, such as the sites on the Isle of Man (Bersu 1977). On the basis of the surface remains, the plans of Coulmore and Phopachy are closer in diameter to the size of roundhouses but again closer investigation of subsurface features would be needed to confirm this. An Dòirlinn is comparable in surface diameter to a roundhouse and aspects of Munro's description of the sub-surface remains indicated that a section of horizontal timber, which may represent a foundation platform structure was present at the time of his investigation. However, further analysis of the site would be necessary to develop and test the roundhouse hypothesis on that site.

The existence of large diameter roundhouses in the Firth of Clyde region in the later part of the first millennium BC and the beginning of the first millennium AD would be unusual in the archaeological record for that region and period. However, it is an acknowledged fact that regional variation in size and distribution is common in relation to British roundhouses (e.g. Harding 1982). The Firth of Clyde marine crannogs are not outwith the maximum size of a Scottish double ring roundhouse for the Iron Age. For example, the roundhouse site excavated by Trevor Watkins at Newmill, Perthshire was over 19m in diameter (Watkins 1980). Even at this preliminary stage it is clear that these sites are large foundation structures which are, in some cases, similar to roundhouse remains. It is thus possible that roundhouse building technologies were applied in a different environment which required variations on this well-established theme.

11.5. Conclusion

The three hypotheses outlined with regard to marine crannogs draw together all the research undertaken on these sites for this thesis. The hypotheses cannot, of

course, be regarded as conclusive bearing in mind that none of the sites discussed has been fully excavated using modern techniques. However, what can be gleaned from the multi-spectrum analysis and intensive survey methods used is that the location of these sites is inextricably tied to their structure and function. More work is necessary to develop these hypotheses further and an enlarged dataset would be advantageous in drawing conclusions about the sites as a whole. The next chapter therefore presents a model for the enlargement of that dataset by suggesting the kinds of conditions and locations in which these kinds of sites may be found.

The survey and investigations of the two groups of marine crannogs enables certain variations between them and freshwater crannogs to be identified. The sub-group of marine crannogs appear to have been built on former shorelines, promontories or on channel edges and the primary phase pits on Redcastle showed that it was constructed directly onto a land surface. The apparent absence of any causeway structures from the sites, towards the contemporary shorelines, is a distinct feature that remains absent from the archaeological record. Additionally, the location of marine crannogs in estuarine conditions enables them to be considered as a sub-group of the overall group of sites that fall under the generic term crannog, and within that sub-group there are distinct variations.

CHAPTER 12

Summary: a predictive model and some future recommendations.

12.1. Introduction

This chapter outlines a predictive model to identify locations around Scotland where further marine crannogs may be found, in order that the current dataset may be increased. The model has identified a number of criteria from the current research common to the marine crannogs that can be identified in other parts of the Scottish coastline and used to identify potential locations where further sites may be located. The chapter also outlines some future recommendations for marine crannog research in addition to the extension of the present dataset.

12.2. A predictive model

The predictive model aims to identify locations around the coastline of Scotland where further marine crannogs may be found. Specific attributes common to the two known groups in the Beaully Firth and the Firth of Clyde have been combined with geomorphological factors such as glacio-isostatic recovery rates to identify criteria that should be present where further marine crannogs could be located. The following list describes the individual criteria:

- a shallow gradient shoreline.
- sandy sedimentary regime.
- shallow water shorelines, adjacent to deeper water, below LWM channels.
- extensive intertidal zones.

- protected/sheltered zone at the head of well developed firths, close to confluence between river and estuarine conditions.
- good shoreline grazing land or marshland for possible grazing, such as coastal wetlands, commonly known as 'merse'.
- palaeo-shorelines or promontories recognisable in the intertidal zone.
- evidence of cultural activity on shoreline and surrounding area that could be contemporary with potential marine crannogs.

Using the above criteria, the Scottish coastline has been assessed for potential sites and three categories of area have been chosen. The first category is areas where marine crannogs are known to exist. The second category identifies locations which fulfil most of the above criteria and are therefore where marine crannogs could probably be found. The third category is areas which meet some of the criteria which are thus areas where marine crannogs could possibly be found. The areas falling within the above three categories have been included on a map of Scotland, see Figure 12.1.

The resultant map highlights areas in each of the categories but it should be regarded only as a preliminary guide to identify some locations where further marine crannogs could be found. The model should then be tested at a local level by aerial photographic survey and fieldwalking in order to verify any possible sites. So, for example, an area where marine crannogs could probably be found is the upper reaches of the Firth of Tay. This area fulfils most of the outlined criteria. Aerial photographic archive research, followed by fieldwalking of the shorelines of the upper parts of the Firth of Tay would be necessary to confirm the existence of sites and to ground-truth the predictive model.

Historic Scotland has recently instigated a series of coastal assessment surveys, which could also be used to examine the predictive model (Ashmore 1994). Results from the 10 surveys, indicate that no further marine crannogs have been located, other than those identified in the Beaully Firth (Cressey & Hale 1998), in the Firth of Clyde and at Eriska. However, it should be noted that the surveys were not designed to locate specific types of sites, rather to assess known and unknown archaeology and to record erosion features. Further testing would therefore be required by applying shoreline fieldwalking, during low water periods and specific aerial photographic coverage of the areas targeted. The model proposed has identified a number of possible locations which fulfil the criteria to possess further intertidal sites. The testing of the model is the first step in the location of more marine crannog sites and the consequent increase of the dataset.

12.3. Future recommendations

The future recommendations for research on the known marine crannogs can be divided into non-invasive survey and sampling assessment projects, and further in-depth research, which applies invasive techniques and would require support from sizeable project funding to adequately excavate, conserve, analyse and display the site.

Non-invasive research could begin by fieldwalking the areas identified from the above model to enlarge the dataset of marine crannogs. Potential areas which may contain sites could be intensively surveyed to identify local topographical details. It should be noted, however, that certain non-invasive survey techniques such as ground penetrating radar have had limited success rates in estuarine sediments. Other methods for sub-surface survey have been more successful in waterlogged sediments have included seismic-reflection techniques and these could

be tested on estuarine sediments to locate buried sites (McClennen, Ammerman & Schock 1997).

Palaeoenvironmental sampling, using multi-spectrum analysis techniques could be applied to the other marine crannogs and combined with the survey work, could be designed to quantify the extent and variety of archaeological deposits on them. Specific sampling, such as for dendrochronology samples, could also be applied to suitable timbers and help to develop the Scottish record for the 1st millennium BC and the beginning of the 1st millennium AD.

It would, of course, be beneficial if one of the known or an undiscovered marine crannog is ultimately fully excavated. This would be a complex project which would require substantial funding to, for example, build a coffer dam structure around the site to allow for permanent exposure of the remains. The coffer dam would need to be supported with a water pumping system to keep areas partially waterlogged, if necessary and to expose areas which may be below the level of the water-table. However, given the erosive nature of tidal fluctuation and wave action, the limited marine crannog resource is under threat.

APPENDIX A

**Report by a member of the Inverness Scientific Society and Field Club,
reproduced with kind permission of the Trustees of the Inverness Museum and
Art Gallery.**

On 4th July, 1936, thanks to the kind help of Dr R. MacKay, Beaulieu, who offered the use of his 14 foot sailing boat, and his services as pilot and excavator, further investigations were begun upon it (Carn Dubh).

The expedition consisted of Dr MacKay and Mr Fraser of Reelig, and left Beaulieu on an ebb tide about 3.30 p.m. By good luck the boat was beached upon the E. of the cairn itself about 4.45: thus avoiding the trouble involved in having to leave her on the surrounding sand bank, and at some distance from the water. By far the greater portion of the island was uncovered by the ebb in the course of the afternoon, though a part of the W. of it remained submerged. The expedition left the island at about 7.15 p.m.

Their first task on arriving was to check the measurements taken twenty five years before: no compass was used to give direction, and to this, and to the washing of the tide, which completely covers the island at every flow, must be ascribed the discrepancies between the figures obtained on the two separate occasions. The earlier measurements are given in brackets for purposes of comparison.

From N. to S. 138 feet. (135 feet.)

From E. to W. 190 feet. (170 feet.)

Estimated height. 3 1/2 feet. (3 feet.)

Father Blundell gives the weight of the individual stones upon the surface of the Cairn as about one cwt.: though there are many large ones, the average weight hardly seemed so great. The whole surface of the cairn is covered with sea weed, which conceals an immense quantity of mussels.

Since the chief object of the expedition was to confirm Father Blundell's theory that the island was of artificial origin, and probably constructed upon wooden logs or piles, a crowbar was used to raise the stones at a spot on the S. E. corner, two or three yards from the apparent edge of the cairn. A hole was then dug about four feet in diameter; a number of other stones was met with, and a quantity of dark mica-flecked ooze so common in the Beaulieu Firth. About two feet down some shells were seen; among them some Oyster shells; and also a few small pieces of wood, dark in colour. The spade then turned up a stone about 4 inches long, which had the appearance of having been roughly shaped - possibly as a Whetstone? Between 2 1/2 and 3 feet down the spade revealed a wooden post or peg fixed in the usual vertical position; it was obviously shaped by some implement, and the grain of the wood was quite plain. Unfortunately, it broke in the handling; but must have measured about 12 to 14 inches when in position. The diameter at the top was about 3 inches, and it was roughly tapered.

Some other small pieces of wood were found, dark in colour, and possibly sapwood: the post just mentioned was light in hue, and may consist wholly of the heartwood of a larger post.

One of the small bits of dark wood, some 6 inches long, is curiously curved, as if for a particular purpose. Towards 7 o'clock the tide began to flow, and excavations could no longer be proceeded with; the hole was filled in once more, and the boat launched. The post, the shaped stone and the Oyster shells, together with some smaller bits of wood and a sample of silt from the hole, were taken away in the boat.

There would appear to be little doubt of the island's artificial origin; and in view of the number of objects found in one small hole dug at random at the edge of it, a more thorough excavation would certainly seem well worth while.

At high tide the island is covered by at least 8 feet of salt water, which would greatly impede the progress of any systematic digging; it is probable, too, that access to it might be extremely difficult at certain tides, on account of sandbanks. The expedition was most fortunate to be able to bring a boat so near.

Captain R. S. Fraser MacKenzie, of Bunchrew House, Bunchrew, who has known the Firth all his life, declares that tradition has it that the island is a burial ground.

This may be the case, but it also has every appearance of a lake dwelling.

5th July, 1936.

C. I. Fraser, M. A., F. S. A. Scot.
Reelig House,
Kirkhill,
Inverness-shire.

APPENDIX A



Plate A.1. Carn Dubh photographed from South East.



Plate A.2. Trench showing vertical wooden pile *in situ*.

APPENDIX B

Camilla Dickson's unpublished report on the plant remains from Old Kilpatrick. Reproduced with kind permission from James Dickson. As this is a direct copy of Dickson's report, her style has been retained throughout.

PLANT REMAINS

Camilla Dickson

Department of Botany, University of Glasgow

INTRODUCTION

The bag of plant material, of c. 1.5kg contained labels bearing two numbers, one certainly 869/1052. It was found in a box together with Old Kilpatrick material. As demonstrated below there is little doubt that the plant material is also from the Old Kilpatrick crannog.

The material examined for plant remains consists mainly of charcoal with stems, some burnt, broken ears and loose cereal grain, in all some forty three plant taxa, mainly of uncarbonized fruits and seeds, are represented. Occasional animal remains, including rare bone fragments, pebbles and small pieces of coal and minerals were also noted. A pollen sample was prepared but the pollen, much of which was corroded, proved too sparse to count.

Part of the material was sorted, dry and unsieved, using a stereo-microscope at X4 magnification and 520 carbonized cereal grains with other remains removed for identification. The remainder was examined for larger fruits and seeds (mainly over 1.5 mm), although all taxa not previously found were kept for subsequent identification. Those seeds not recovered with the 520 cereal grains are marked with an X.

C = carbonized: U = uncarbonized: Rare = 1-3:

Occasional = 4-7: Frequent = 8-20: Abundant = over 20 fragments.

The nomenclature is according to Clapham et al (1981) for the wild plants and Renfrew (1973) for the cereals. The plants have been listed in ecological groups but are not necessarily exclusive to them.

Plant remains from crannogs have only rarely been recovered, e.g. Piggott, 1952-3, and the list from Old Kilpatrick is by far the most comprehensive. The state of preservation of these plant remains is unusual in that cereals and wood are mainly carbonized but only a few of the other seeds. Uncarbonized seeds are usually only well-preserved in waterlogged deposits; these have preserved dry. Not surprisingly all fleshy and thin parts have decayed away and those preserved have resistant often woody outer layers; it is probable that seeds with delicate testas have decayed away. However, frond fragments of Pteridium (bracken) have been preserved; the durability of dead bracken from one season to the next in all weathers is well-known.

PLANT MACROFOSSILS

IMPORTED

- u Eicus carica (fig), 2 seeds

WOODLAND AND SCRUB

- c Alnus (alder), abundant charcoal
- +u Carex cf. pallescent (pale sedge), 1 nutlet
- c, u Corylus (hazel), rare charcoal, occasional nut fragments
- c Fraxinus (ash), rare charcoal
- +u Mercurialis perennis (dog's mercury), 1 seed fragment
- c Prunus avium or padus (gean or bird-cherry), rare charcoal
- +u P.padus (bird-cherry), 6 fruit stones
- +u P.spinosa (blackthorn, sloe), 2 fruit stones
- u Quercus (oak), rare wood
- +u Rosa canina gp. (dog rose), 2 achenes
- u Rubus fruticosus s. l. (blackberry), 28 fruit stones
- u R.idaeus (raspberry), 8 fruit stones
- u R.fruticosus s. l. or idaeus, 5 fruit stones
- u Salix sp. (willow), 1 bud-scale

CEREALS

- c Hordeum vulgare (hulled six-row barley) 227 grains, rare ear fragments, abundant awns, occasional rachis fragments and cf. straw
- c Triticum aestivum s. l. (bread or club wheat), 1 grain
- c T.dicoccum (emmer wheat) 224 grains, 68 spikelets, rare ear fragments, abundant awns, occasional rachis fragments and cf. straw.

ARABLE AND WASTE GROUND

- c Avena fatua (wild oats), 14 grains with floret bases
- c Avena sp. (wild or cultivated oats), 11 grains
- u Avena sp. (wild or cultivated oats) 1 floret
- u Chenopodium album (fat hen), 24 seeds
- +c, u Fallopia convolvulus (black bindweed), 2 nutlets
- u Galeopsis speciosa or tetrahit (hemp-nettle), 3 nutlets
- c, u Polygonum lapathifolium (pale persicaria), 3 nutlets

- u Spergula arvensis (spurrey), 1 seed
- u Stachys cf. arvensis (field woundwort), 2 nutlets
- u Urtica dioica (stinging nettle), 3 nutlets

GRASSLAND AND HEATH

- u Carex flacca (carnation-grass), 1 nutlet
- u C. ovalis (oval sedge), 1 nutlet
- u C. pilulifera (pill-headed sedge), 1 nutlet
- c Danthonia decumbens (heath grass), 1 grain
- u Potentilla erecta (common tormentil), 3 achenes
- u Prunella vulgaris (self-heal), 2 nutlets
- c, u Pteridium aquilinum (bracken) , frequent frond fragments, abundant
rachis, stalk and rhizome fragments
- u Ranunculus acris (meadow buttercup), 4 achenes
- u R. repens (creeping buttercup), 1 achene
- +u Rumex acetosella (sheep's sorrel), 2 nutlets
- +u Stellaria graminea (lesser stitchwort), 1 seed

AQUATIC AND MARSH

- u Eleocharis palustris s. s. (spike-rush), 1 nutlet
- +u Montia fontana (blinks), 1 seed
- u Potamogeton perfoliatus (pond-weed), 1 fruit stone
- u Ranunculus flammula (lesser spearwort), 1 achene

MISCELLANEOUS

- +c Bromus sp. (brome or lop-grass), 1 grain
- +u Carex spp. (sedges), 3 nutlets
- +u Musci (moss), 1 leafy shoot
- +u Rumex spp. (docks), 2 nutlets

The habitats represented by the plant remains

Ficus carica, the edible fig, a plant which cannot produce ripe fruit without winter protection in Scotland at the present time, is represented by two seeds (pl. lg.). There is no evidence to suggest that the climate was very different in the Iron Age. It seems highly probable that dried figs were imported; the nearest native source is the Mediterranean region. At the present time there is no evidence to

suggest that food was imported by the native population in Scotland, but fig seeds have been found at Bearsden Roman fort some 10 km. to the east, together with other imported seeds, by the present author (Knights et al, 1983). This Antonine wall fort has been dated to between 142 and 158 AD. It seems probable that fig seeds were traded to the local inhabitants during the Roman occupation. Such luxury foods do not reappear in the fossil record until the Medieval period in Scotland.

Woodland and Scrub

Alnus (alder) is by far the commonest wood represented; since all of it is of charcoal it seems probable that this represents use for fuel, Alnus grows in waterlogged sites. Fraxinus (ash) and Corylus (hazel), rare charcoal finds, denote drier woodland, usually on the better soils. A small fragment of Quercus (oak) wood and Prunus avium or padus (gean or bird-cherry) charcoal were found. Salix (willow) is represented by a single bud-scale.

A single seed fragment of Mercurialis perennis (dog's mercury) and nutlet of Carex cf. pallescent (cf. pale sedge) may have been gathered with Pteridium (bracken) which can grow in clearings in woods.

The other plants of woodland and scrub are Prunus padus (bird-cherry), P. spinosa (blackthorn, sloe), Rosa canina gp. (dog rose), Rubus idaeus (raspberry) and R. fruticosus s. l. (blackberry) (all pl. I). All these are remains of fruit and, together with hazel nut fragments, were presumably gathered for food. It is of interest that three of the fruit-stones of the two Prunus spp. have been gnawed (pl. I e, f). The gnawed edges lack tooth marks and were probably made by Clethrionomys glareolus (bank vole) which eats the kernels inside the stones (Bang and Dahlstrom, 1972, fig. on p. 127).

Cereals

Hordeum vulgare (six-rowed hulled barley) is represented by rare ear fragments, abundant grain, occasional rachis and cf. straw fragments (Pl I b, d); there are also abundant awn fragments, these are not usually preserved. Similar fragments of Triticum dicoccum (emmer wheat) were recovered (Pl. I a, c). One grain of T. aestivum s. l. (bread or club wheat) was also found. Hordeum vulgare is the cereal most commonly found in prehistoric sites in Scotland; it is now only grown occasionally as a crop in Orkney. Triticum dicoccum is rarely grown, even on a world scale; its scattered areas include Ethiopia and the Anatolian region of Turkey. There is some evidence that it grew in Scotland in the Bronze Age, but from Iron

Age and Early Christian sites it has only been recorded as rare grains in with barley; emmer seems to have died out before the Medieval period in Britain.

Unfortunately there is no record of artefacts associated with cereal processing at the crannog. Hulled six-row barley was ground into meal using a rotary quern until comparatively recently. It was also prepared as pot barley using a knocking stone and mallet as described by Fenton (1978, p. 396). Traditionally emmer was made into groats for gruel or porridge using a pestle and mortar (Hillman, 1984).

Arable and Waste Ground

It seems probable that all the oats is of Avena fatua (wild oats), still a common cornfield weed. Most if not all of the other plants listed could have grown with the corn and have been gathered with the straw. It is not possible, on this material, to determine whether the straw was gathered separately, after cutting off the ears, as was the custom when long lengths were needed for thatch.

Grassland or Heath

Both carbonized and uncarbonized fragments of all parts of Pteridium aquilinum (bracken) are present. Bracken has long been used for thatch as well as animal and human bedding and it could have been used for any of these purposes at Old Kilpatrick. Other plants of heathy places were found and although some of these could have been inadvertently, collected with the bracken it can cast such a dense shade that few plants may grow underneath it.

Another possible origin for the sedges and other plants, many of which are low growing, is as plants included in grassy turf traditionally used for walling and roofing. The absence of grass remains is not surprising; grass seeds and their vegetative parts are not usually durable unless carbonized or permanently waterlogged.

Aquatic and Marsh

Only one plant represented here, Potamogeton perfoliatus (pond weed), is a true aquatic and grows in lakes, ponds and streams, especially on moderately organic substrata (Clapham et al 1981). The other three species listed can grow in marshy ground, such as damp hollows in cornfields, and may have been brought in with the crops.

Previous identifications from Old Kilpatrick

Among items exhibited in the Palace of History and listed in the catalogue as "Relics got in the foundation of a wooden structure at Old Kilpatrick" (1911, vol. 2, p. 864) were a number of plant remains, all from the floor layer, identified and mounted by Clement Reid F.R.S. They are listed on the next page, those on the right hand side were identified by the present author.

Grains, stalks and heads of barley	Hordeum vulgare, ear fragments, grain chaff
Fruit stones	Prunus spinosa, Rosa canina gp, Rubus spp.
Charcoal	Charcoal of Alnus, Corylus, Fraxinus, Prunus
92 cherry stones	
Polygonum Convolvulus L.	Fallopia (Polygonum) convolvulus
Arenaria Trinervia L	
Polygonum	Polygonum lapathifolium
Urtica Dioica	Urtica dioica
Rumex	Rumex acetosella, Rumex spp.
Prunella Vulgaris L.	Prunella vulgaris
Galeopsis Tetrahit L.	Galeopsis speciosa or tetrahit
Carex	Carex flacca, C. ovalis, C.cf. pallescens, C. pilulifera
Polygonum Aviculare L.	
Spore (Carboniferous)	Coal

Stellaria Media

Stellaria Graminea L.

Stellaria graminea

Polygonum Persicaria

Alchemilla Arvensis L.

Ranunculus Flammula L.

Ranunculus flammula

Ranunculus Repens L.

Ranunculus repens

5 seeds of Prunus Padus

Prunus padus

Unfortunately it has not proved possible to locate the original identified grain and seeds in Kelvingrove Museum but the strong similarity between the two lists must mean that both samples originated from the same source and that both are from the Old Kilpatrick crannog.

Comparison with other sites

The only other native site in the Clyde area which may be of comparable age, and from which an extensive list of pollen and macrofossils is available, is at Shiels, 0.5 km south of the River Clyde 10 km south west of the crannog. It consists of an Iron Age ditched enclosure; the plant remains from the ditch have been identified by Robinson (1983). The only crop evidence is from one carbonized grain and a few chaff fragments of barley. The other fruits and seeds consist of plants of arable land and waste places, heathland, and wet habitats (Ibid., fig. 6.5). Similar species are present to those at Old Kilpatrick but no edible fruits are represented other than a single hazel nut fragment. Leafy shoots of Calluna (heath) were found but no Pteridium (bracken). Robinson concludes that "the pollen and plant macrofossil data show that the enclosure was built and occupied in an open landscape with well established pastoral and arable agriculture".

CONCLUSIONS

It has been shown that the plant material here discussed is in all probability from the Old Kilpatrick crannog. The presence of fig seeds shows that imported fruit was

eaten; if the crannog is of Iron Age date the most likely origin for the figs would be in trade with the Roman army. Ear fragments of emmer wheat show conclusively that emmer was grown locally as was hulled six-row barley. Five types of fruit together with hazel nuts were gathered. Seeds of low growing grass or heathland plants suggest that grassy turf was brought to the crannog, perhaps for building use.

ACKNOWLEDGEMENT

Mr T Norman Tait of the Department of Botany, University of Glasgow kindly took the photographs for Plate 1.

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APPENDIX C

Risk assessment for groups and individuals carrying out fieldwork research on marine crannogs.

HAZARD	GENERAL RISK	DETAILED RISK	MITIGATION
<i>Environment</i>			
Adverse weather	Extreme heat, extreme cold, fog, thunder storms.	Exposed situations, confined spaces, snow conditions, lightning strike.	Protective clothing and footwear, consult weather forecast, water provided, spare clothing.
Unpredictable weather	Rapid changes.	Cloud base lowering, disorientation, strong winds.	Correct clothing, map. compass, adequate weather forecast.
Fallen trees	Obstructing paths and access.	Sudden falling causing injury.	Plan alternative routes, carry communication telephone or radio and first aid equipment.
Fallen rocks	Obstructing access.	Causing injury to fieldworkers.	Plan alternative routes, carry telephone, radio and first aid equipment.
Ice or mud	Hazardous access.	Causing injury, preventing access.	Plan alternative routes, carry safety equipment.
Holes, trenches, cliff fissures on path or route	Difficult access.	Injury to fieldworkers, changes of access route to a more hazardous approach.	Correct footwear, plan alternative route, carry safety equipment.
Slippery paths due to sea spray	Access problems.	Sudden waves causing injury, more hazardous routes taken.	Correct footwear, safety rope.
Cliffs	Access obstructions.	Fall causing minor to fatal injuries.	Inform Coastguard of location, safety rope required.
Overhanging rocks	Rock fall	Danger to workers underneath.	Safety helmets required.
Unstable rocks	Unsafe paths	Falls causing minor to fatal injuries, preventing access to site.	Safety rope, correct footwear, alternative access.
Unstable rock faces	Hazardous access.	Falls causing minor to fatal injuries.	Safety helmets, safety rope, correct footwear.
Caves	Lack of light, heat.	Sudden flooding, hypothermia, disorientation, falls causing injury.	Torches, safety helmets, safety rope and correct clothing and footwear.
Tidal peninsulas	Access problems.	Cut off by tide and sudden immersion.	Consult tide tables, inform Coastguard of location.

Intertidal areas	Access restrictions.	Sudden immersion and unstable surfaces leading to submergence.	Inform Coastguard of location, consult tide tables.
Disused installations; piers, slipways	Slippery, unstable surfaces.	Falls causing injury, hazardous materials causing injury.	Safety helmets, adequate footwear, safety rope may be required.
River/ estuarine/ coastal traffic	Boats.	Wash from motor boats causing submergence, collision causing injury.	Consult Port authorities and Coastguard.
Saltmarsh	Unstable surfaces.	Falling into rills or unseen creeks, submergence as tide rises.	Map access routes, adequate footwear and clothing, inform Coastguard of location.
Tidal lagoons	Access restrictions.	Sudden submergence, unstable surfaces, deep sediments.	Map access routes, adequate footwear and clothing, inform Coastguard of location.
Rock pools	Access problems.	Falls due to slippery surfaces causing injury.	Adequate footwear.
Quick sand	Access restricted.	Falls causing injury or fatality.	Carry safety rope, VHF radio and mobile telephone.
Unstable sands/ muds	Access restrictions.	Unable to reach site(s).	Safety rope, adequate footwear.
Streams, conduit, sewage outfall pipes	Access restrictions.	Toxic outflow causing injury.	Adequate footwear, protective clothing.
Fast rising tide	Access restrictions.	Drowning, submergence.	Consult tide tables, inform Coastguard of location.
Strong currents/ tidal streams	Access restrictions.	Unstable intertidal surfaces, submergence, drowning.	Consult tide tables and Admiralty Charts, inform Coastguard of location, carry safety rope and life-jacket.
Vegetation e.g. brambles, nettles	Access restrictions.	Injury from vegetation, allergic reactions	Protective clothing and footwear.
Pollution (visible)	Litter, needles, oil drums, glass, batteries, toiletries.	Injury, toxic reactions	Protective footwear and clothing.
Pollution (invisible)	Chemicals in waters, disease.	Severe health problems, injury.	Protective footwear and clothing.
Hazardous animals	Access restricted.	Injury from being charged by animals	Contact livestock owners, alternative access routes.

Shore use by others	Shooting parties, beach buggies.	Shooting injuries, collision with other users.	Contact landowners alternative access routes
Machinery; discarded, out of use, dumped	Access restrictions.	Collapse of installations, corroded equipment.	Adequate footwear, clothing.
Electrical cables and appliances	Electric shock.	Water and electric charges causing injury.	Alternative access routes, adequate footwear and clothing.
Low frequency, high magnitude events	Storm surges, tsunami.	Submergence, drowning.	Consult Coastguard, weather forecast.
Fire	Rapid spread of hazard.	Access restricted, injury caused by burns and smoke inhalation.	Consult safety authorities, carry telephone or VHF radio.
People			
Illness	Restriction activity.	Split up group to allow injured person to gain medical help and cause group to lose leader or co-ordinator.	Consult with individuals before departure, first aid kit.
Toilet requirements	Curtail activity.		Arrange for requirements to be catered to prior to visit or ensure that facilities are in close proximity.
Food	Inadequate preparation.	Low blood sugar, fainting, dizzy spells.	Carry supplies.
Tools and Equipment			
Tools used for survey, sampling and excavation	Equipment causing injury.	Wooden poles, spades, coring devices or hammers.	Supervision of activity.
Miscellaneous			
Landowners	Access problems.		Contact landowners and inform them of the activities and location.
Safety equipment			Ensure those using the equipment are familiar with the equipment.

APPENDIX D

The following document is a report which was produced for Historic Scotland in 1997 to present the results of an erosion survey of the Redcastle marine crannog. The report includes two illustrations which show the positions of the monitoring posts on the Redcastle site and the results of the 10 individual monitoring posts, recorded from April 1996 to April 1997.

The objectives of the project are to identify the possible threats affecting, if at all, the archaeology of the Redcastle marine crannog and to monitor the threats on the site. The specific aims were as follows;

- To identify the individual threats to the sample site and to assess the possibility of monitoring those threats.
- To monitor a specific threat over a given time period
- To interpret the monitoring programme, to identify the wider implications for other marine crannogs and to suggest any future improvements.
- To suggest measures to maintain the present state of the site and to mitigate against possible threats

Results

Redcastle was chosen due to the previous research carried out on the site had identified an area of possible erosion which had resulted in the exposure of different types of archaeological deposits, from the inorganic sediments to the delicate animal bones and timbers.

Threats identified

Marine crannogs are situated in highly dynamic environments. The action of tidal currents, constantly flowing water, surface waves and the transport of substantial sedimentary loads are all possible threats to the delicate archaeological remains. The Redcastle site is situated in a relatively sheltered part of the Beaully Firth. The mudflats surrounding the site attest to the low energy environment and lack of major currents. The site is over 700 m from the main channel and is therefore relatively unaffected by the primary sediment transport route. However, the site does become completely submerged at high tide, for approximately 4 hours. During this time it may experience current and wave action, affecting the surface sediments and any exposed archaeological remains. Conversely as the water falls the tidal streams may remove loose surface sediment. When the site becomes exposed drying of the previously waterlogged sediments may cause mud cracking and hardening of the upper sediments. Any exposed organic remains will lose moisture during low tide with the threat of becoming dried and possibly desiccated.

A further threat to the organic archaeological remains on Redcastle is the attack by marine animals. The most common threat to waterlogged wood is the

attack by a boring mollusc, such as the *Teredinidae* family, the 'shipworm'. The shipworm bores tunnels into waterlogged timbers and leaves the tunnels lined with calcium, as it digests the wood. A quite different mollusc, the bivalve *Mya arenaria* was also found during excavation. It burrows into the soft intertidal sediments and was concentrated amongst the wattling of the three wattle-lined structures, in trenches 1 and 2. This type of burrowing can dislodge archaeological remains, expose delicate organics and re-deposit sediments.

Exposed timbers are also prone to marine plant colonisation and can be damaged by the plants attachment mechanisms. During the fieldwork seasons various types of seaweed were found growing on the exposed timbers; *Fucus vesiculosus* (bladder wrack), *Fucus serratus* (toothed wrack) and *Alaria esculenta* (dabberlocks). The first two species attach themselves to stones or, in the case of Redcastle, timbers with small stalks. The dabberlock attaches itself to the surface with a branching holdfast. These plants have the potential to damage waterlogged timbers and other archaeological remains onto which they can attach themselves.

The exposure of a number of surface timbers on the south-west part of the site indicated an erosion zone, possibly due to the removal of surface sediment with the resultant re-deposition elsewhere.

Erosion survey methodology

The Redcastle erosion survey was initiated in April 1996 and was carried out over a period of 12 months. Ten monitoring points were set up on-site using solid dowel rods, 20 mm diameter. They were driven into the sub-soil and the protruding 300-400 mm were marked at 100 mm intervals. Each post was measured and recorded at the end of every month. The measurements were taken from the mark on the post nearest to the surrounding ground surface. The measurements were tabulated and depicted as graphs covering the survey period from April 1996 to April 1997.

Monitoring results

Figure 1 shows the positions of the monitoring posts on the Redcastle site and Figure 2 the results of the 10 individual monitoring posts, recorded from April 1996 to April 1997.

Discussion

The ten erosion posts around the Redcastle site indicate some movement of sediment, as would be expected of highly mobile fine grained silts and sands. However, studies have shown that despite their mobility, the sediments are rarely transported any great distance (McCave in Dyer 1979). The possibility therefore exists that the sediments eroded from one area of Redcastle, were re-deposited elsewhere on-site.

The possibility that there are specific areas on site that experience greater than normal changes of sediment level are suggested from monitoring points Off-Site 2 (OFS2) and Off-Site 4 (OFS4) and that the deposition of the sediment occurred around monitoring point Margin 2 (M2). These three points are the only significant variations noticed over the 12 month monitoring period. The 7 other points indicate negligible variations.

Between the recording stages November 1996 and December 1996 On-Site Timber 1 (ONST1) monitoring post became damaged. It was found to lean severely in S. E. direction. Damage to the pole suggested a stone or heavy object had caused the damage and no further measurements were taken from the point. The possibility that a large stone had caused the damage appears somewhat at odds with the results from the other monitoring points. However, the possibility that the large surface stones on the site can be moved, should be considered.

Some of the monitoring poles had shallow pools around their bases at various times during the monitoring period. These were measured because similarly protruding timber piles or stones on-site could create hydrological obstructions. Measurement when the pools were present were taken into the bottom of the pool.

During the survey a number of vulnerable areas were identified and observed. One such area was adjacent to trench 1. This area, disturbed by excavations became consistently more exposed and some bones on the surface became exposed, loosened and occasionally removed. The timbers exposed during excavation, were also subject to localised erosion and in the case of horizontal timber RDC'94 T. 5, the western end became totally exposed. Reinstating measures in this vulnerable area included the positioning of sandbags and the introduction of

off-site sediment, covered with stones. Despite these measures the area became the focus for continued erosion.

The erosion survey period was a short-term monitoring programme and a more extensive period would be required to observe if any trends and seasonal variations exist. The results indicate various changes on and off-site which could be identified as diurnal, seasonal or annual events through further monitoring. It was evident that the surface stone cover and interstitial sediments act as protection of the underlying deposits. However, once the exposure of the archaeological remains had occurred they became threatened by a number of damaging processes ranging from plant colonisation to sediment erosion and accretion and stone movement.

Site maintenance and protection

The maintenance of the current state of the Redcastle site must involve the prevention of further exposure of the delicate surface and sub-surface archaeological deposits, especially on the south-west area. A series of sandbags should be placed over and around the exposed features to afford initial protection of the timber framework and the other organic and inorganic deposits. Subsequent monitoring of the sandbag protection would be necessary to evaluate its effectiveness and future protection may require more substantial and permanent structures.

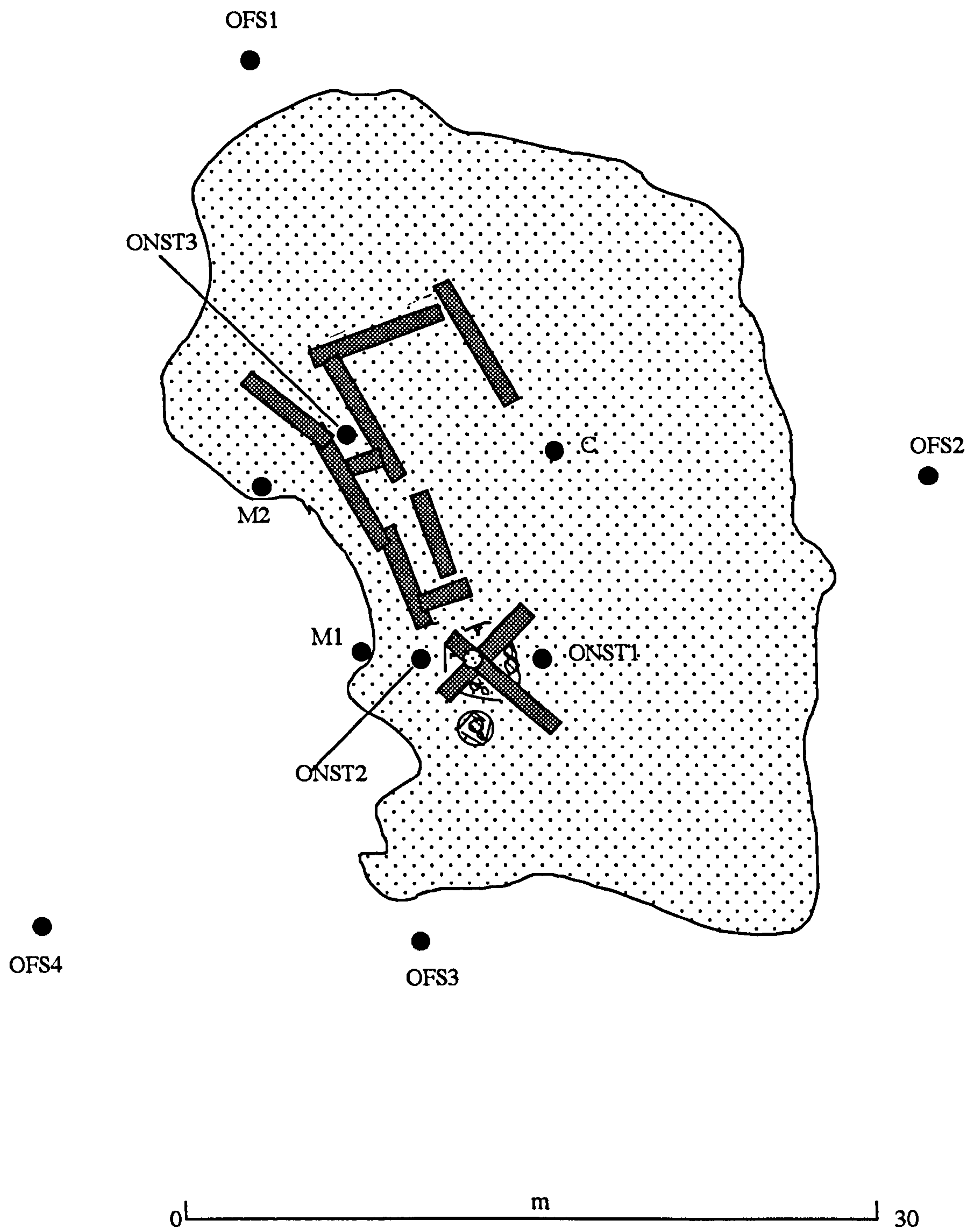


Figure A.1. Location map of the erosion monitoring posts on and around Redcastle marine crannog.

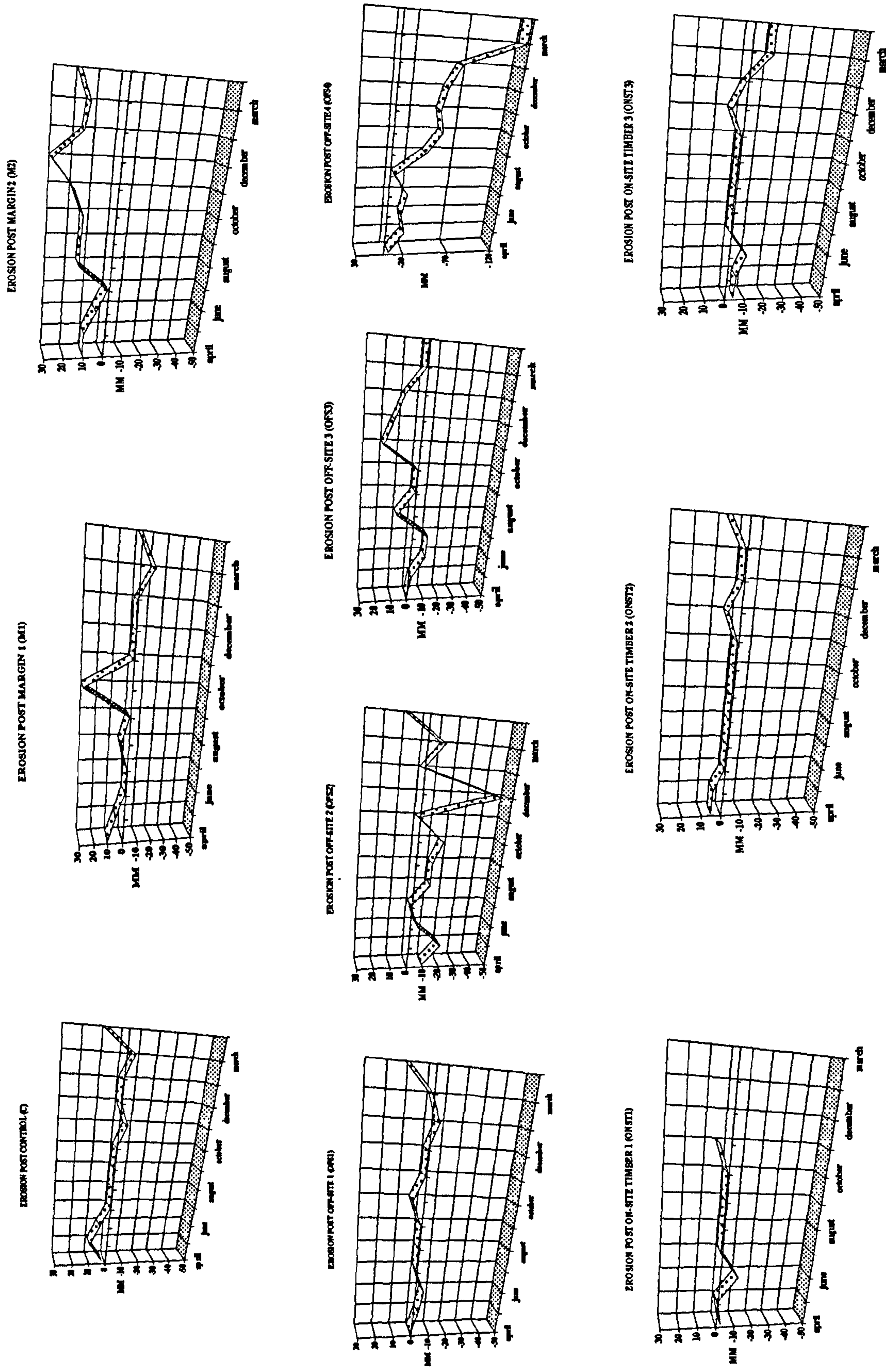


Figure A.2. Graphs of the results of the erosion monitoring survey, showing sediment change at the individual points on Redcastle marine crannog.

APPENDIX E

Calibration results of radiocarbon dates from marine crannogs.

Calibration file(s): intcal98.14c
Listing file: marine crannogs

Beta 48763

Redcastle RDC92.1
alder timber
Radiocarbon Age BP 2150 +/- 60

Calibrated age(s)

cal BC 197, 190, 176

cal BP 2146, 2139, 2125

cal AD/BC (cal BP) age ranges obtained from intercepts (Method A):

one Sigma**	cal BC 352 - 295 (2301 - 2244)
	230 - 219 (2179 - 2168)
	210 - 94 (2159 - 2043)
two Sigma**	cal BC 382 - 40 (2331 - 1989)
	27 - 24 (1976 - 1973)
	9 - 2 (1958 - 1951)

Summary of above:

maximum of cal age ranges (cal ages)	minimum of cal age ranges:
1 sigma	cal BC 352 (197, 190, 176) 9
	cal BP 2302 (2146, 2139, 2125) 2044
2 sigma	cal BC 382 (197, 190, 176) 2
	cal BP 2332 (2146, 2139, 2125) 1952

cal AD/BC & cal BP age ranges (cal ages as above) from probability distribution (Method B):

% area enclosed	cal BC (cal BP) age ranges	relative area under probability distribution
68.3 (1 sigma)	cal BC 351 - 300 (2300 - 2249)	.274
	230 - 213 (2179 - 2162)	.091
	209 - 99 (2158 - 2048)	.635
95.4 (2 sigma)	cal BC 367 - 46 (2316 - 1995)	1.000

Beta 48764

Redcastle RDC92.2
alder timber
Radiocarbon Age BP 1750 +/- 90

Calibrated age(s)
cal AD 258, 283, 287, 300, 320
cal BP 1692, 1667, 1663, 1650, 1630

cal AD/BC (cal BP) age ranges obtained from intercepts (Method A):
one Sigma** cal AD 134 - 162 (1816 - 1788)
168 - 199 (1782 - 1751)
208 - 408 (1742 - 1542)
two Sigma** cal AD 74 - 444 (1876 - 1506)
446 - 471 (1504 - 1479)
479 - 531 (1471 - 1419)

Summary of above:

maximum of cal age ranges (cal ages) minimum of cal age ranges:
1 sigma cal AD 134 (258, 283, 287, 300, 320) 408
cal BP 1816 (1692, 1667, 1663, 1650, 1630) 1542
2 sigma cal AD 74 (258, 283, 287, 300, 320) 531
cal BP 1876 (1692, 1667, 1663, 1650, 1630) 1419

cal AD/BC & cal BP age ranges (cal ages as above) from probability distribution (Method B):

% area enclosed	cal AD (cal BP) age ranges	relative area under probability distribution
68.3 (1 sigma)	cal AD 177 - 191 (1773 - 1759)	.073
	213 - 402 (1737 - 1548)	.927
95.4 (2 sigma)	cal AD 75 - 466 (1875 - 1484)	.982
	493 - 526 (1457 - 1424)	.018

GU-4541

Redcastle RDC94.retaining pile 2
oak pile adjacent to framework
Radiocarbon Age BP 2510 +/- 50

Calibrated age(s)
cal BC 762, 678, 671, 607, 602
cal BP 2711, 2627, 2620, 2556, 2551

cal AD/BC (cal BP) age ranges obtained from intercepts (Method A):
 one Sigma** cal BC 789 - 755 (2738 - 2704)
 721 - 538 (2670 - 2487)
 528 - 523 (2477 - 2472)
 two Sigma** cal BC 800 - 409 (2749 - 2358)

Summary of above:

maximum of cal age ranges (cal ages) minimum of cal age ranges:
 1 sigma cal BC 789 (762, 678, 671, 607, 602) 523
 cal BP 2738 (2711, 2627, 2620, 2556, 2551) 2472
 2 sigma cal BC 800 (762, 678, 671, 607, 602) 409
 cal BP 2749 (2711, 2627, 2620, 2556, 2551) 2358

cal AD/BC & cal BP age ranges (cal ages as above) from probability distribution (Method B):

% area enclosed	cal BC (cal BP) age ranges	relative area under probability distribution
68.3 (1 sigma)	cal BC 786 - 755 (2735 - 2704)	.145
	697 - 541 (2646 - 2490)	.855
95.4 (2 sigma)	cal BC 796 - 485 (2745 - 2434)	.940
	465 - 449 (2414 - 2398)	.017
	444 - 415 (2393 - 2364)	.044

GU-4542

Redcastle RDC94.pile
oak pile through framework mortise hole
Radiocarbon Age BP 2570 +/- 50

Calibrated age(s)

cal BC 791

cal BP 2740

cal AD/BC (cal BP) age ranges obtained from intercepts (Method A):

one Sigma** cal BC 801 - 763 (2750 - 2712)
677 - 673 (2626 - 2622)
two Sigma** cal BC 825 - 756 (2774 - 2705)
702 - 540 (2651 - 2489)

Summary of above:

maximum of cal age ranges (cal ages) minimum of cal age ranges:

1 sigma cal BC 801 (791) 673
cal BP 2750 (2740) 2622
2 sigma cal BC 825 (791) 540
cal BP 2774 (2740) 2489

cal AD/BC & cal BP age ranges (cal ages as above) from probability distribution (Method B):

% area enclosed	cal BC (cal BP) age ranges	relative area under probability distribution
68.3 (1 sigma)	cal BC 807 - 760 (2756 - 2709)	.522
	682 - 665 (2631 - 2614)	.129
	632 - 591 (2581 - 2540)	.241
	579 - 557 (2528 - 2506)	.107
	534 - 525 (2483 - 2474)	.010
95.4 (2 sigma)	cal BC 827 - 537 (2776 - 2486)	.990

GU-4543

Redcastle RDC94.T5
alder framework timber
Radiocarbon Age BP 2550 +/- 50

Calibrated age(s)

cal BC 786

cal BP 2735

cal AD/BC (cal BP) age ranges obtained from intercepts (Method A):

one Sigma**	cal BC 798 - 760 (2747 - 2709)
	681 - 667 (2630 - 2616)
	627 - 622 (2576 - 2571)
	613 - 593 (2562 - 2542)
	576 - 563 (2525 - 2512)
two Sigma**	cal BC 809 - 536 (2758 - 2485)
	533 - 519 (2482 - 2468)

Summary of above:

maximum of cal age ranges (cal ages) minimum of cal age ranges:

1 sigma	cal BC 798 (786) 563
	cal BP 2747 (2735) 2512
2 sigma	cal BC 809 (786) 519
	cal BP 2758 (2735) 2468

cal AD/BC & cal BP age ranges (cal ages as above) from probability distribution (Method B):

% area enclosed	cal BC (cal BP) age ranges	elative area under probability distribution
68.3 (1 sigma)	cal BC 799 - 759 (2748 - 2708)	.345
	684 - 662 (2633 - 2611)	.130
	640 - 587 (2589 - 2536)	.308
	586 - 546 (2535 - 2495)	.216
	cal BC 815 - 514 (2764 - 2463)	.985
95.4 (2 sigma)	459 - 454 (2408 - 2403)	.008
	437 - 435 (2386 - 2384)	.007

AA-21248 (GU-4635)

Redcastle RDC94.leather fragment inside Pit 1

Radiocarbon Age BP 2220 +/- 70

Calibrated age(s)

cal BC 354, 291, 256, 251, 232, 217, 213

cal BP 2303, 2240, 2205, 2200, 2181, 2166, 2162

cal AD/BC (cal BP) age ranges obtained from intercepts (Method A):

one Sigma** cal BC 387 - 197 (2336 - 2146)
191 - 175 (2140 - 2124)

two Sigma** cal BC 402 - 90 (2351 - 2039)
76 - 60 (2025 - 2009)

Summary of above:

maximum of cal age ranges (cal ages) minimum of cal age ranges:

1 sigma cal BC 387 (354, 291, 256, 251, 232, 217, 213) 175
cal BP 2337 (2303, 2240, 2205, 2200, 2181, 2166,
2162) 2125

2 sigma cal BC 402 (354, 291, 256, 251, 232, 217, 213) 60
cal BP 2352 (2303, 2240, 2205, 2200, 2181, 2166,
2162) 2010

cal AD/BC & cal BP age ranges (cal ages as above) from probability distribution (Method B):

% area enclosed	cal BC (cal BP) age ranges	relative area under probability distribution
68.3 (1 sigma)	cal BC 376 - 333 (2325 - 2282) 327 - 204 (2276 - 2153)	.238 .762
95.4 (2 sigma)	cal BC 399 - 106 (2348 - 2055)	1.000

GU-4094

Redcastle RDC94.sail 1, Pit 1
alder sail
Radiocarbon Age BP 2310 +/- 50

Calibrated age(s)

cal BC 393

cal BP 2342

cal AD/BC (cal BP) age ranges obtained from intercepts (Method A):

- one Sigma** cal BC 401 - 376 (2350 - 2325)
267 - 264 (2216 - 2213)
- two Sigma** cal BC 475 - 474 (2424 - 2423)
410 - 351 (2359 - 2300)
316 - 230 (2265 - 2179)
219 - 208 (2168 - 2157)

Summary of above:

maximum of cal age ranges (cal ages) minimum of cal age ranges:

- 1 sigma cal BC 401 (393) 264
cal BP 2350 (2342) 2213
- 2 sigma cal BC 475 (393) 208
cal BP 2424 (2342) 2157

cal AD/BC & cal BP age ranges (cal ages as above) from probability distribution (Method B):

% area enclosed	cal BC (cal BP) age ranges	relative area under probability distribution
68.3 (1 sigma)	cal BC 407 - 356 (2356 - 2305)	.685
	289 - 251 (2238 - 2200)	.250
	249 - 236 (2198 - 2185)	.065
95.4 (2 sigma)	cal BC 511 - 461 (2460 - 2410)	.055
	460 - 432 (2409 - 2381)	.020
	426 - 343 (2375 - 2292)	.522
	326 - 203 (2275 - 2152)	.403

GU-4095

Redcastle RDC94.sail 5, Pit 2
oak sail
Radiocarbon Age BP 2330 +/- 50

Calibrated age(s)

cal BC 397

cal BP 2346

cal AD/BC (cal BP) age ranges obtained from intercepts (Method A):

one Sigma**	cal BC 404 - 383 (2353 - 2332)
two Sigma**	cal BC 512 - 462 (2461 - 2411)
	451 - 439 (2400 - 2388)
	429 - 420 (2378 - 2369)
	414 - 356 (2363 - 2305)
	288 - 257 (2237 - 2206)
	246 - 233 (2195 - 2182)

Summary of above:

maximum of cal age ranges (cal ages) minimum of cal age ranges:

1 sigma	cal BC 404 (397) 383
	cal BP 2353 (2346) 2332
2 sigma	cal BC 512 (397) 233
	cal BP 2461 (2346) 2182

cal AD/BC & cal BP age ranges (cal ages as above) from probability distribution (Method B):

% area enclosed	cal BC (cal BP) age ranges	relative area under probability distribution
68.3 (1 sigma)	cal BC 487 - 465 (2436 - 2414)	.095
	418 - 358 (2367 - 2307)	.705
	282 - 255 (2231 - 2204)	.162
	241 - 240 (2190 - 2189)	.038
	cal BC 710 - 710 (2659 - 2659)	.000
95.4 (2 sigma)	531 - 350 (2480 - 2299)	.775
	313 - 221 (2262 - 2170)	.212
	220 - 208 (2169 - 2157)	.013

GU-4097

Redcastle RDC94.T6
alder framework timber
Radiocarbon Age BP 2480 +/- 50

Calibrated age(s)
cal BC 758, 684, 660, 645, 586, 584, 543
cal BP 2707, 2633, 2609, 2594, 2535, 2533, 2492

cal AD/BC (cal BP) age ranges obtained from intercepts (Method A):
 one Sigma** cal BC 765 - 482 (2714 - 2431)
 466 - 448 (2415 - 2397)
 442 - 413 (2391 - 2362)
 two Sigma** cal BC 795 - 404 (2744 - 2353)

Summary of above:

maximum of cal age ranges (cal ages) minimum of cal age ranges:
 1 sigma cal BC 765 (758, 684, 660, 645, 586, 584, 543) 413
 cal BP 2714 (2707, 2633, 2609, 2594, 2535, 2533, 2492) 2362
 2 sigma cal BC 795 (758, 684, 660, 645, 586, 584, 543) 404
 cal BP 2744 (2707, 2633, 2609, 2594, 2535, 2533, 2492) 2353

cal AD/BC & cal BP age ranges (cal ages as above) from probability distribution (Method B):

% area enclosed	cal BC (cal BP) age ranges	relative area under probability distribution
68.3 (1 sigma)	cal BC 757 - 680 (2706 - 2629)	.350
	671 - 606 (2620 - 2555)	.283
	605 - 522 (2554 - 2471)	.367
95.4 (2 sigma)	cal BC 774 - 481 (2723 - 2430)	.865
	469 - 414 (2418 - 2363)	.135

Beta 48765

Phopachy P92.1
alder timber
Radiocarbon Age BP 1940 +/- 60

Calibrated age(s)

cal AD 69

cal BP 1881

cal AD/BC (cal BP) age ranges obtained from intercepts (Method A):
one Sigma** cal AD 2 - 128 (1948 - 1822)
two Sigma** cal BC 51 - cal AD 228 (2000 - 1722)

Summary of above:

maximum of cal age ranges (cal ages) minimum of cal age ranges:
1 sigma cal AD 2 (69) 128
cal BP 1948 (1881) 1822
2 sigma cal BC 51 (cal AD 69) cal AD 228
cal BP 2001 (1881) 1722

cal AD/BC & cal BP age ranges (cal ages as above) from probability distribution (Method B):

% area enclosed	cal BC (cal BP) age ranges	relative area under probability distribution
68.3 (1 sigma)	cal AD 3 - 129 (1947 - 1821)	1.000
95.4 (2 sigma)	cal BC 51 - cal AD 229 (2000 - 1721)	1.000

Beta 48766

Phopachy P92.2
alder timber
Radiocarbon Age BP 2030 +/- 60
Calibrated age(s)
cal BC 41, 25, 25, 8, 3
cal BP 1990, 1974, 1974, 1957, 1952

cal AD/BC (cal BP) age ranges obtained from intercepts (Method A):
one Sigma** cal BC 95 - cal AD 29 (2044 - 1921)
cal AD 40 - 50 (1910 - 1900)
two Sigma** cal BC 197 - 189 (2146 - 2138)
179 - cal AD 84 (2128 - 1866)
cal AD 104 - 118 (1846 - 1832)

Summary of above:

maximum of cal age ranges (cal ages) minimum of cal age ranges:
1 sigma cal BC 95 (41, 25, 25, 8, 3) cal AD 50
cal BP 2045 (1990, 1974, 1974, 1957, 1952) 1900
2 sigma cal BC 197 (41, 25, 25, 8, 3) cal AD 118
cal BP 2147 (1990, 1974, 1974, 1957, 1952) 1832

cal AD/BC & cal BP age ranges (cal ages as above) from probability distribution (Method B):

% area enclosed	cal BC (cal BP) age ranges	relative area under probability distribution
68.3 (1 sigma)	cal BC 106 - cal AD 30 (2055 - 1920) cal AD 40 - 50 (1910 - 1900)	.944 .056
95.4 (2 sigma)	cal BC 196 - 190 (2145 - 2139) 182 - cal AD 84 (2131 - 1866) cal AD 108 - 116 (1842 - 1834)	.009 .983 .008

GU-4098

Phopachy P94.1
alder timber
Radiocarbon Age BP 2060 +/- 50

Calibrated age(s)

cal BC 50

cal BP 1999

cal AD/BC (cal BP) age ranges obtained from intercepts (Method A):

one Sigma**	cal BC 163 - 129 (2112 - 2078)
	120 - 35 (2069 - 1984)
	34 - 18 (1983 - 1967)
	13 - cal AD 1 (1962 - 1949)
two Sigma**	cal BC 199 - cal AD 32 (2148 - 1918)
	cal AD 37 - 54 (1913 - 1896)

Summary of above:

maximum of cal age ranges (cal ages) minimum of cal age ranges:

1 sigma	cal BC 163 (50)	cal AD 1
	cal BP 2112 (1999)	1949
2 sigma	cal BC 199 (50)	cal AD 54
	cal BP 2148 (1999)	1896

cal AD/BC & cal BP age ranges (cal ages as above) from probability distribution (Method B):

% area enclosed	cal BC (cal BP) age ranges	relative area under probability distribution
68.3 (1 sigma)	cal BC 153 - 134 (2102 - 2083)	.132
	117 - 19 (2066 - 1968)	.790
	12 - 2 (1961 - 1951)	.078
95.4 (2 sigma)	cal BC 198 - cal AD 33 (2147 - 1917)	.982
	cal AD 36 - 53 (1914 - 1897)	.018

GU-4099

Phopachy P94.2
alder timber
Radiocarbon Age BP 1990 +/- 50

Calibrated age(s)

cal AD 4, 8, 21

cal BP 1946, 1942, 1929

cal AD/BC (cal BP) age ranges obtained from intercepts (Method A):
one Sigma** cal BC 43 - cal AD 70 (1992 - 1880)
two Sigma** cal BC 106 - cal AD 93 (2055 - 1857)
cal AD 97 - 126 (1853 - 1824)

Summary of above:

maximum of cal age ranges (cal ages)	minimum of cal age ranges:
1 sigma	cal BC 43 (cal AD 4, 8, 21) cal AD 70
	cal BP 1992 (1946, 1942, 1929) 1880
2 sigma	cal BC 106 (cal AD 4, 8, 21) cal AD 126
	cal BP 2055 (1946, 1942, 1929) 1824

cal AD/BC & cal BP age ranges (cal ages as above) from probability distribution (Method B):

% area enclosed	cal BC (cal BP) age ranges	relative area under probability distribution
68.3 (1 sigma)	cal BC 40 - cal AD 61 (1989 - 1889)	1.000
95.4 (2 sigma)	cal BC 109 - cal AD 125 (2058 - 1825)	1.000

GU-4539

Carn Dubh CD95.1
pine pile
Radiocarbon Age BP 280 +/- 50

Calibrated age(s)

cal AD 1642

cal BP 308

cal AD/BC (cal BP) age ranges obtained from intercepts (Method A):

one Sigma** cal AD 1522 - 1574 (428 - 376)
1627 - 1659 (323 - 291)
two Sigma** cal AD 1479 - 1673 (471 - 277)
1777 - 1800 (173 - 150)
1942 - 1946 (8 - 4)

Summary of above:

maximum of cal age ranges (cal ages) minimum of cal age ranges:
1 sigma cal AD 1522 (1642) 1659
cal BP 428 (308) 291
2 sigma cal AD 1479 (1642) 1946
cal BP 471 (308) 4

cal AD/BC & cal BP age ranges (cal ages as above) from probability distribution (Method B):

% area enclosed	cal AD (cal BP) age ranges	relative area under probability distribution
68.3 (1 sigma)	cal AD 1519 - 1591 (431 - 359)	.637
	1623 - 1661 (327 - 289)	.363
95.4 (2 sigma)	cal AD 1475 - 1676 (475 - 274)	.927
	1772 - 1802 (178 - 148)	.063
	1939 - 1941 (11 - 9)	.010

GU-4540

Carn Dubh CD95.2
oak timber
Radiocarbon Age BP 2530 +/- 50

Calibrated age(s)

cal BC 764

cal BP 2713

cal AD/BC (cal BP) age ranges obtained from intercepts (Method A):

one Sigma**	cal BC 794 - 758 (2743 - 2707)
	686 - 659 (2635 - 2608)
	647 - 543 (2596 - 2492)
two Sigma**	cal BC 803 - 481 (2752 - 2430)
	468 - 447 (2417 - 2396)
	443 - 412 (2392 - 2361)

Summary of above:

maximum of cal age ranges (cal ages) minimum of cal age ranges:

1 sigma	cal BC 794 (764) 543
	cal BP 2743 (2713) 2492
2 sigma	cal BC 803 (764) 412
	cal BP 2752 (2713) 2361

cal AD/BC & cal BP age ranges (cal ages as above) from probability distribution (Method B):

% area enclosed	cal BC (cal BP) age ranges	relative area under probability distribution
68.3 (1 sigma)	cal BC 793 - 757 (2742 - 2706)	.252
	688 - 656 (2637 - 2605)	.167
	647 - 546 (2596 - 2495)	.581
95.4 (2 sigma)	cal BC 803 - 511 (2752 - 2460)	.959
	463 - 443 (2412 - 2392)	.020
	439 - 419 (2388 - 2368)	.020

GU-7470

Dumbuck D97.1
oak pile surrounding central platform

Radiocarbon Age BP 2090 +/- 50

Calibrated age(s)
cal BC 94
cal BP 2043

cal AD/BC (cal BP) age ranges obtained from intercepts (Method A):

- one Sigma** cal BC 195 - 194 (2144 - 2143)
173 - 43 (2122 - 1992)
6 - 4 (1955 - 1953)
- two Sigma** cal BC 348 - 320 (2297 - 2269)
227 - 222 (2176 - 2171)
205 - cal AD 5 (2154 - 1945)
cal AD 7 - 22 (1943 - 1928)

Summary of above:

maximum of cal age ranges (cal ages) minimum of cal age ranges:
1 sigma cal BC 195 (94) 4
cal BP 2144 (2043) 1953
2 sigma cal BC 348 (94) cal AD 22
cal BP 2297 (2043) 1928

cal AD/BC & cal BP age ranges (cal ages as above) from probability distribution (Method B):

% area enclosed	cal BC (cal BP) age ranges	relative area under probability distribution
68.3 (1 sigma)	cal BC 168 - 48 (2117 - 1997)	1.000
95.4 (2 sigma)	cal BC 347 - 320 (2296 - 2269)	.039
	206 - cal AD 20 (2155 - 1930)	.961

GU-7471

Dumbuck D97.2
alder horizontal in central platform

Radiocarbon Age BP 1910 +/- 50
Calibrated age(s)
cal AD 82
cal BP 1868

cal AD/BC (cal BP) age ranges obtained from intercepts (Method A):
one Sigma** cal AD 31 - 39 (1919 - 1911)
53 - 131 (1897 - 1819)
two Sigma** cal BC 36 - 33 (1985 - 1982)
19 - 12 (1968 - 1961)
cal AD 0 - 236 (1950 - 1714)

Summary of above:

maximum of cal age ranges (cal ages) minimum of cal age ranges:
1 sigma cal AD 31 (82) 131
cal BP 1919 (1868) 1819
2 sigma cal BC 36 (cal AD 82) cal AD 236
cal BP 1985 (1868) 1714

cal AD/BC & cal BP age ranges (cal ages as above) from probability distribution (Method B):

% area enclosed	cal BC (cal BP) age ranges	relative area under probability distribution
68.3 (1 sigma)	cal AD 26 - 137 (1924 - 1813) 200 - 201 (1750 - 1749)	.953 .047
95.4 (2 sigma)	cal AD 1 - 232 (1949 - 1718)	1.000

GU-7472

Dumbuck D97.3
oak pile surrounding central platform

Radiocarbon Age BP 2040 +/- 50
Calibrated age(s)
cal BC 43, 6, 4
cal BP 1992, 1955, 1953

cal AD/BC (cal BP) age ranges obtained from intercepts (Method A):
one Sigma** cal BC 95 - cal AD 4 (2044 - 1946)
cal AD 7 - 21 (1943 - 1929)
two Sigma** cal BC 196 - 193 (2145 - 2142)
174 - cal AD 71 (2123 - 1879)

Summary of above:

maximum of cal age ranges (cal ages) minimum of cal age ranges:
1 sigma cal BC 95 (43, 6, 4) cal AD 21
cal BP 2044 (1992, 1955, 1953) 1929
2 sigma cal BC 196 (43, 6, 4) cal AD 71
cal BP 2145 (1992, 1955, 1953) 1879

cal AD/BC & cal BP age ranges (cal ages as above) from probability distribution (Method B):

% area enclosed	cal BC (cal BP) age ranges	relative area under probability distribution
68.3 (1 sigma)	cal BC 103 - cal AD 21 (2052 - 1929)	1.000
95.4 (2 sigma)	cal BC 172 - cal AD 64 (2121 - 1886)	1.000

Dumbuck D97.4
alder horizontal in central platform

Radiocarbon Age BP 2060 +/- 50
Calibrated age(s)
cal BC 50
cal BP 1999

cal AD/BC (cal BP) age ranges obtained from intercepts (Method A):
one Sigma** cal BC 163 - 129 (2112 - 2078)
120 - 35 (2069 - 1984)
34 - 18 (1983 - 1967)
13 - cal AD 1 (1962 - 1949)
two Sigma** cal BC 199 - cal AD 32 (2148 - 1918)
cal AD 37 - 54 (1913 - 1896)

Summary of above:

maximum of cal age ranges (cal ages) minimum of cal age ranges:
1 sigma cal BC 163 (50) cal AD 1
cal BP 2112 (1999) 1949
2 sigma cal BC 199 (50) cal AD 54
cal BP 2148 (1999) 1896

cal AD/BC & cal BP age ranges (cal ages as above) from probability distribution (Method B):

% area enclosed	cal BC (cal BP) age ranges	relative area under probability distribution
68.3 (1 sigma)	cal BC 153 - 134 (2102 - 2083)	.132
	117 - 19 (2066 - 1968)	.790
	12 - 2 (1961 - 1951)	.078
95.4 (2 sigma)	cal BC 198 - cal AD 33 (2147 - 1917)	.982
	cal AD 36 - 53 (1914 - 1897)	.018

APPENDIX F

Size table for identifying sediment particle grades and the formulae used for statistical analysis of the sedimentary samples taken on and around the marine crannogs in the Beaully Firth. Also included are the results sheets from the x-ray defraction particle size analysis of sediment samples from Redcastle marine crannog.

Phi size (Ø)	Millimeters (mm)	Micrometers (μm)	Wentworth grade
-6.0	64	64000	Cobbles 60.0mm
-5.5	44.8	44800	Coarse gravel
-5.0	32	32000	20.0mm
-4.5	22.4	22400	
-4.0	16	16000	
-3.5	11.2	11200	Medium gravel
-3.0	8	8000	6.0mm
-2.5	5.6	5600	
-2.0	4	4000	Fine gravel
-1.5	2.8	2800	
-1.0	2	2000	2.0mm
-0.5	1.4	1400	
0.0	1	1000	Coarse sand
0.5	0.71	710	0.6mm
1.0	0.5	500	
1.5	0.355	355	Medium sand
2.0	0.25	250	0.2mm
2.5	0.18	180	
3.0	0.125	125	Fine sand
3.5	0.090	90	
4.0	0.063	63	0.06mm
4.5	0.045	45	
5.0	0.032	32	Coarse silt
5.5	0.023	23	0.02mm
6.0	0.016	16	
6.5	0.011	11	Medium silt
7.0	0.008	8	0.006mm
7.5	0.0055	5.5	
8.0	0.004	4	Fine silt
8.5	0.00275	2.75	0.002mm
9.0	0.002	2	Clay
9.5	0.00138	1.38	
10.0	0.001	1	

(after Briggs 1977)

Graphical measures for median, mean, skewness, sorting and kurtosis (taken from particle size distribution curve).

Median $\varnothing 50$

Mean $\frac{\varnothing 75 + \varnothing 50 + \varnothing 25}{3}$

or $\frac{\varnothing 90 + \varnothing 80 + \varnothing 70 + \varnothing 60 + \varnothing 50 + \varnothing 40 + \varnothing 30 + \varnothing 20 + \varnothing 10}{9}$

Skewness $\frac{\varnothing 84 - \varnothing 50}{\varnothing 84 - \varnothing 16} - \frac{\varnothing 50 - \varnothing 10}{\varnothing 90 - \varnothing 10}$

or $\frac{\varnothing 84 - \varnothing 50}{\varnothing 84 - \varnothing 16} - \frac{\varnothing 50 - \varnothing 5}{\varnothing 95 - \varnothing 5}$

Sorting $\frac{\varnothing 84 - \varnothing 16}{2}$

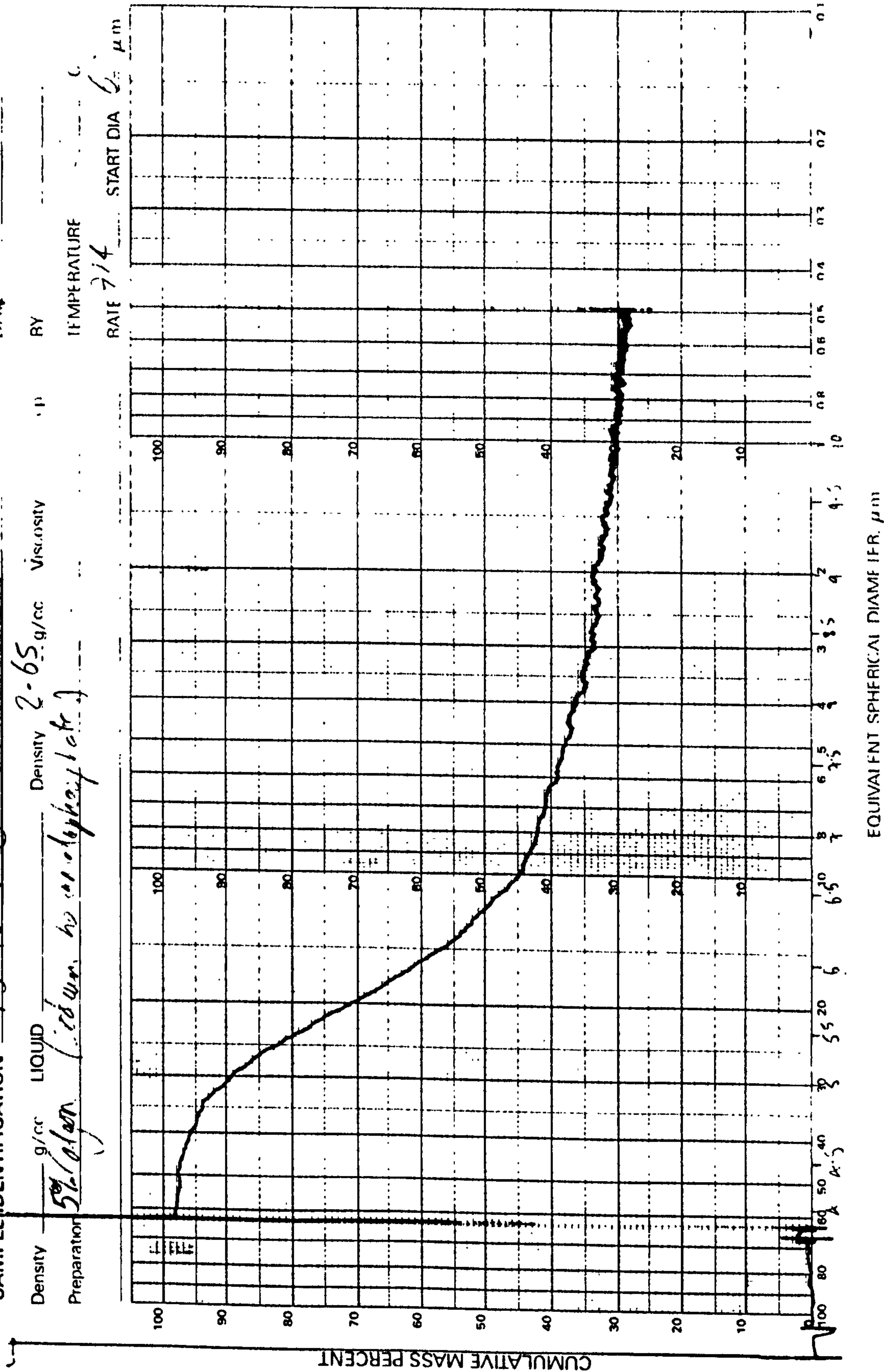
or $\frac{\varnothing 90 + \varnothing 80 + \varnothing 70 - \varnothing 30 - \varnothing 20 - \varnothing 10}{5.3}$

Kurtosis $\frac{\varnothing 90 - \varnothing 10}{1.9 (\varnothing 75 - \varnothing 25)}$

or $\frac{\varnothing 95 - \varnothing 5}{2.44(\varnothing 75 - \varnothing 25)}$

PARTICLE SIZE DISTRIBUTION

SAMPLE IDENTIFICATION RDC'96-6.0 DATE 24.10.96
 Density 5.0 g/cc LIQUID LIQUID Density 2.65 g/cc Viscosity 1.0 BY RY
 Preparation 5% / 1000 (1000 to 1000000) TEMPERATURE 214 START DIA 6 μm



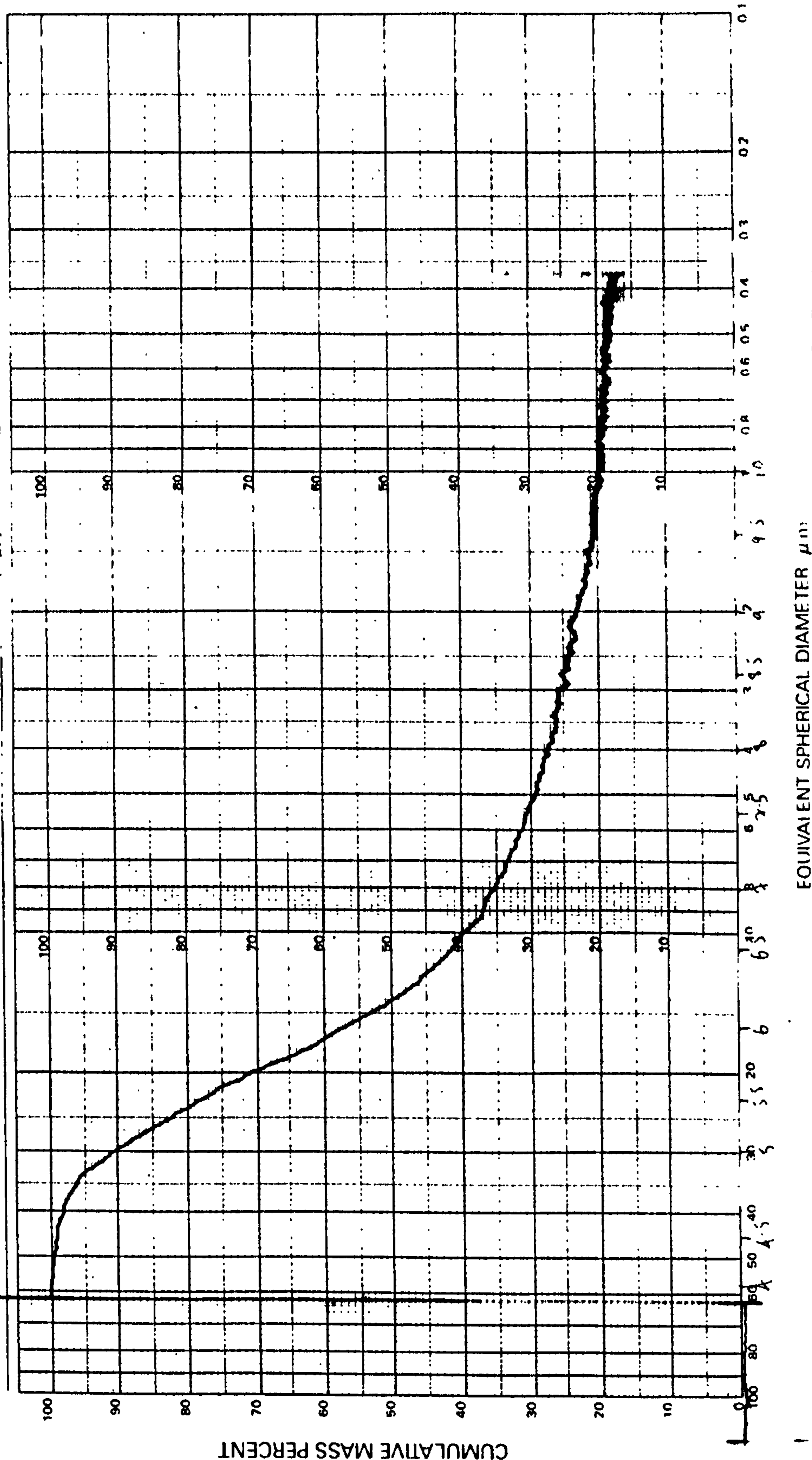
m **micromeritics**
 instrument corporation

COULTER ELECTRONICS
 LIMITED
 PART No 8936012

Figure A.3. X-ray diffraction analysis of sample RDC96.6.i.

PARTICLE SIZE DISTRIBUTION

SAMPLE IDENTIFICATION RDC 96-6.6(ii) DATE 12.19.88
 Density g/cc LIQUID 2.65 g/cc Viscosity cp RY 1
 Preparation 100 g/cc TEMPERATURE 22 C
 RATE 3.4 START DIA 2.2 μ m



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 LIMITED
 Model No 9930u12

Figure A.4. X-ray defraction analysis of sample RDC96.6.ii.

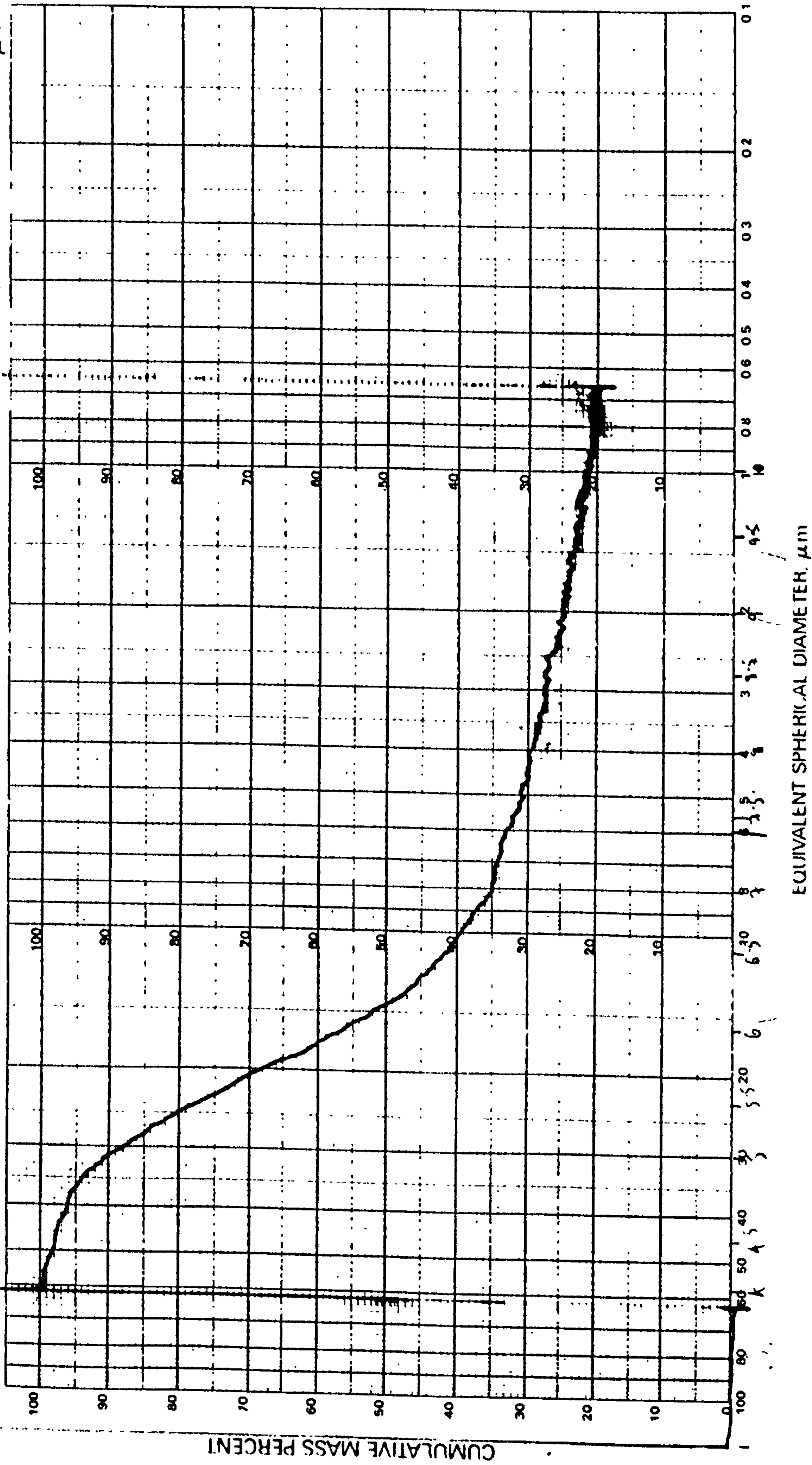
PARTICLE SIZE DISTRIBUTION

SAMPLE IDENTIFICATION RNC 96.6. (1.1) DATE 24.10.96

Density g/cc LIQUID 2.65 g/cc Viscosity cp BY 22 C

Preparation 1.0 (alga) TEMPERATURE 22 C

RATE 114 START DIA 63 μm



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instrument corporation



Figure A.5. X-ray diffraction analysis of sample RDC96.6.iii.

PARTICLE SIZE DISTRIBUTION

RDC 96.8 ①

22-10-91

DATE

SAMPLE IDENTIFICATION

Density g/cc LIQUID

Density 2.65 g/cc

Viscosity cp

RY

Preparation

5% Calson Cellulose phosphate

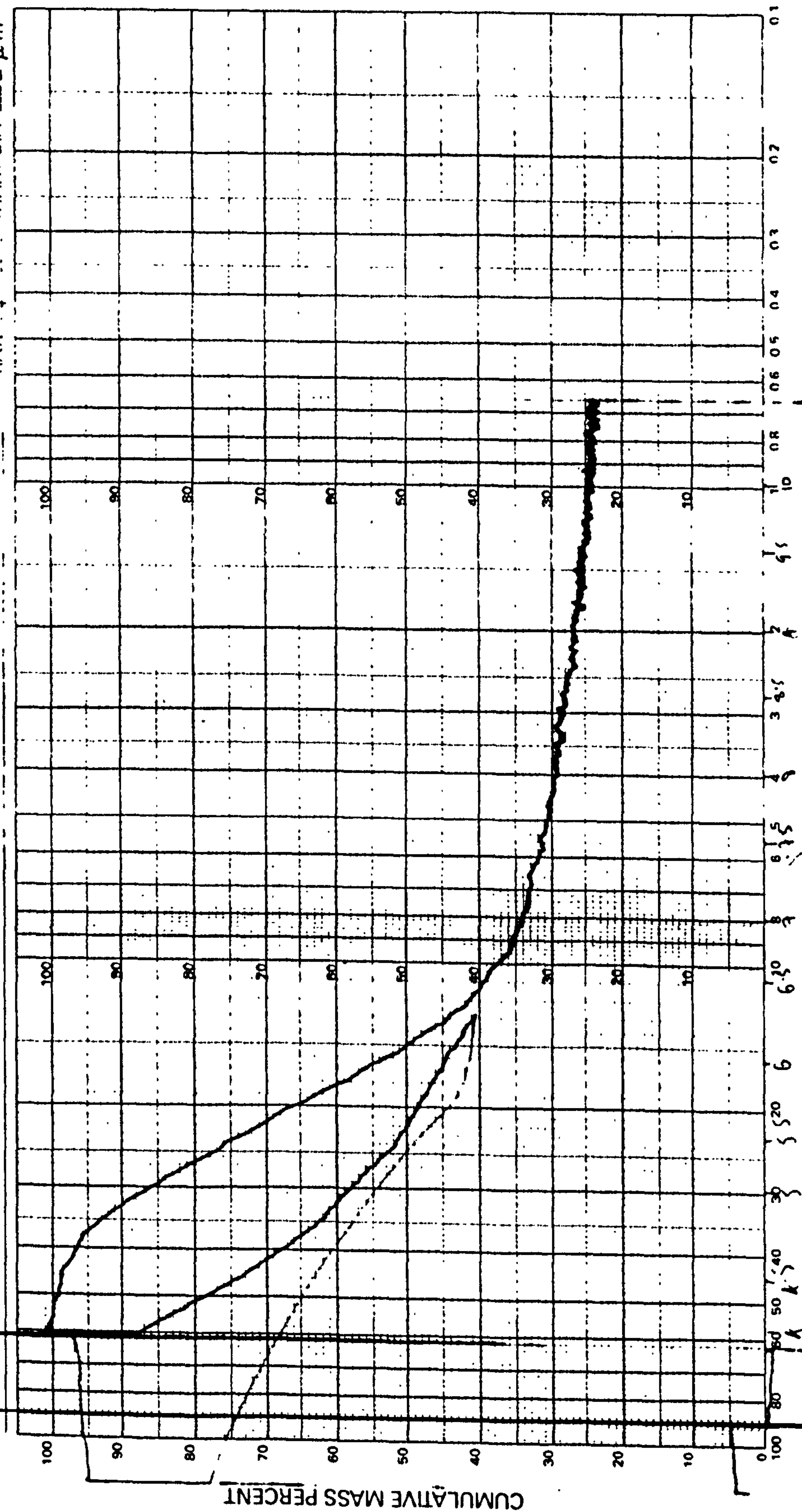
TEMPERATURE

32 °C

RATE

714

START DIA 3 μm



EQUIVALENT SPHERICAL DIAMETER, μm

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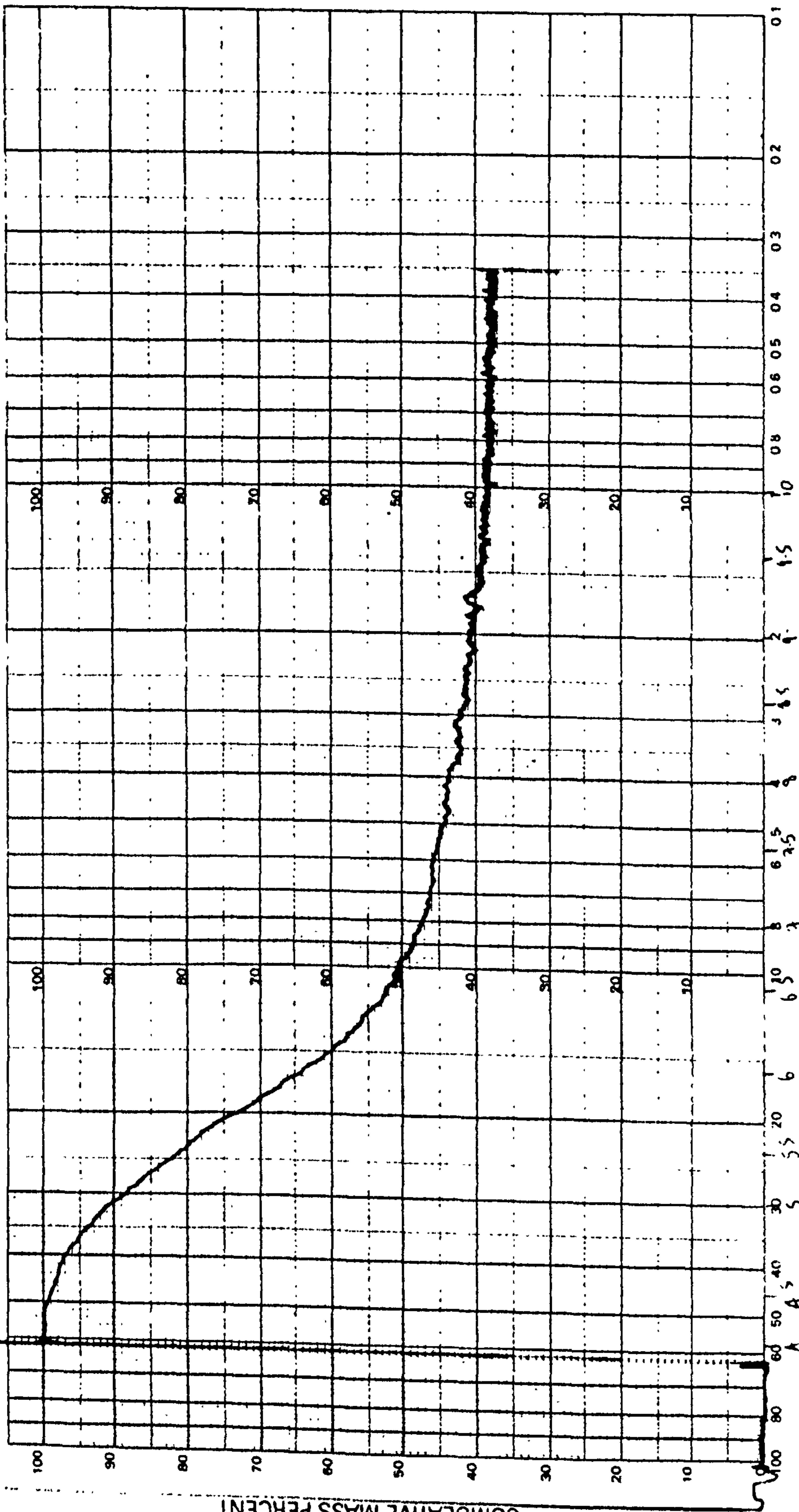
COULTER ELECTRONICS
LIMITED

PART NO 5930012

Figure A.6. X-ray diffraction analysis of sample RDC96.8.i.

PARTICLE SIZE DISTRIBUTION

SAMPLE IDENTIFICATION: RDC96.8.ii DATE: 22 10 96
 Density: 1.05 g/cc LIQUID Viscosity: 1.0 cP BY: ---
 Preparation: --- TEMPERATURE: 22 °C RATE: 1.1 START DIA: --- μm



EQUIVALENT SPHERICAL DIAMETER, μm

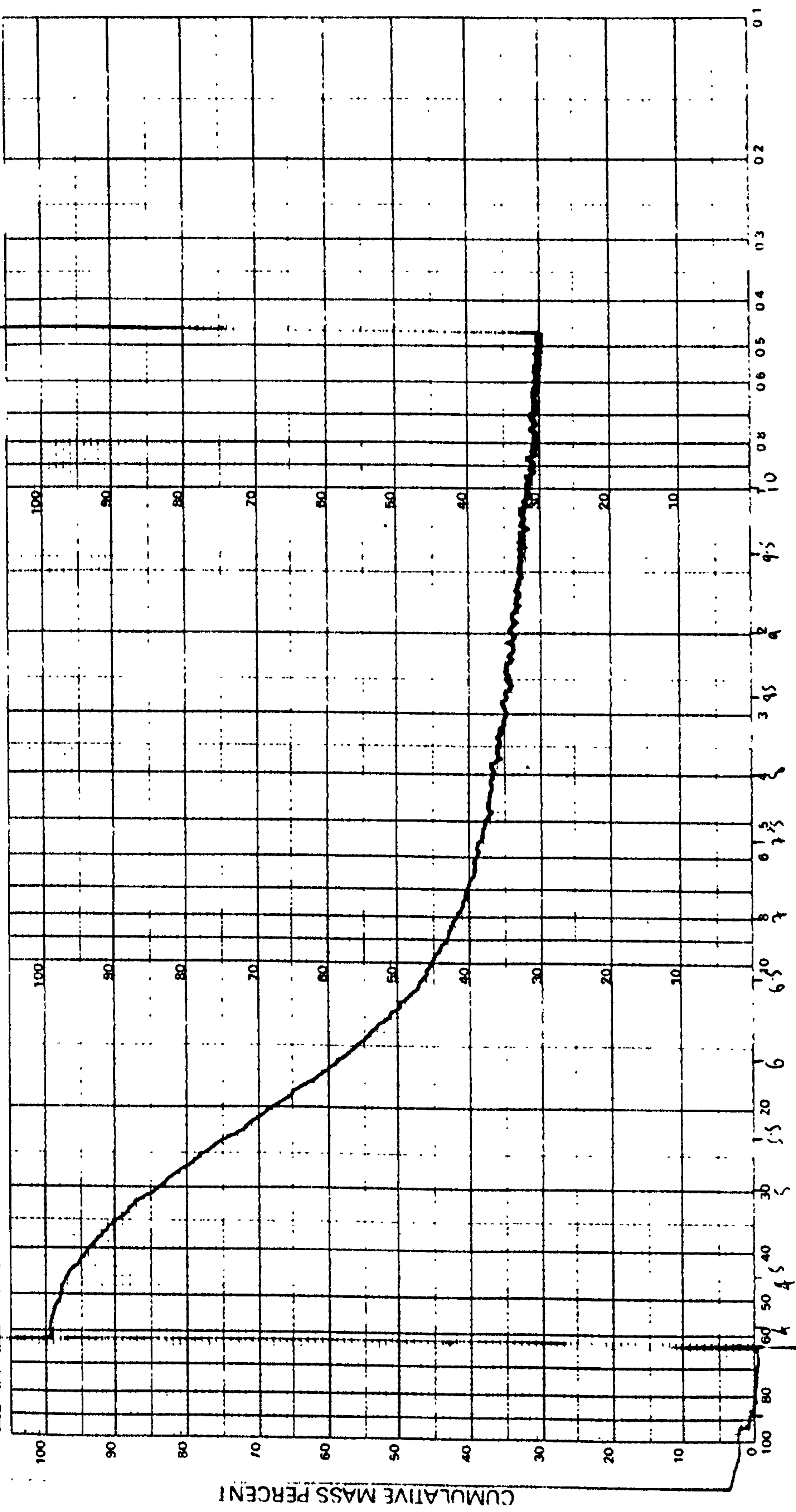
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Figure A.7. X-ray diffraction analysis of sample RDC96.8.ii.

PARTICLE SIZE DISTRIBUTION

SAMPLE IDENTIFICATION RDC 96-8 DATE 28.10.86
 Density g/cc 1.25 g/cc Viscosity cp
 Preparation 11/86 TEMPERATURE 22
 RATE 7/4 START DIA 8 μm



EQUIVALENT SPHERICAL DIAMETER μm



Figure A.8. X-ray diffraction analysis of sample RDC96.8.iii.

SAMPLE IDENTIFICATION

Density

Q10000

Density

Viscosity

(b)

人

15

Preparation

اسماء بنت ابی بکر

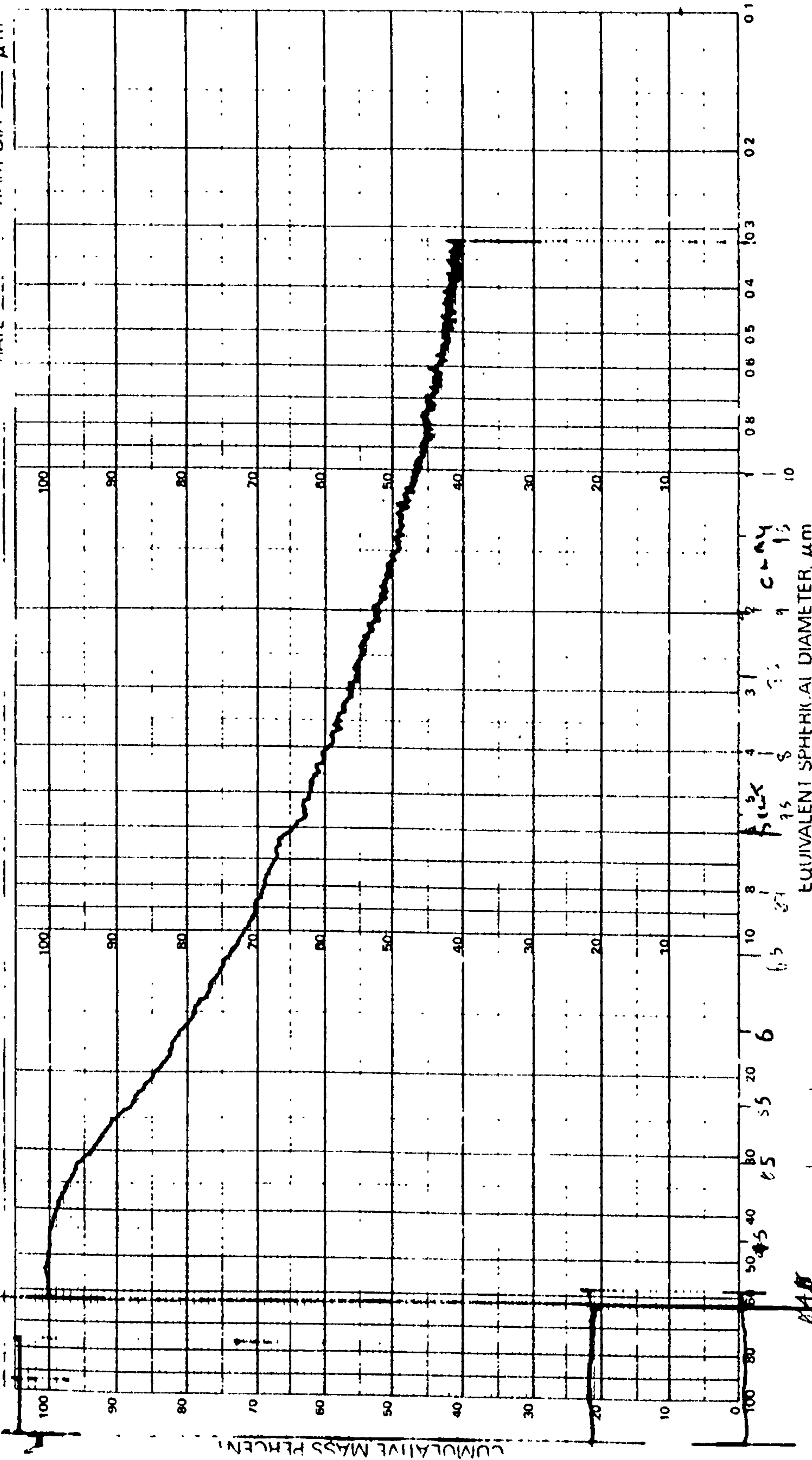
•

77

25

714-1104

SIARI DIA 6-11-11



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LIMITED**

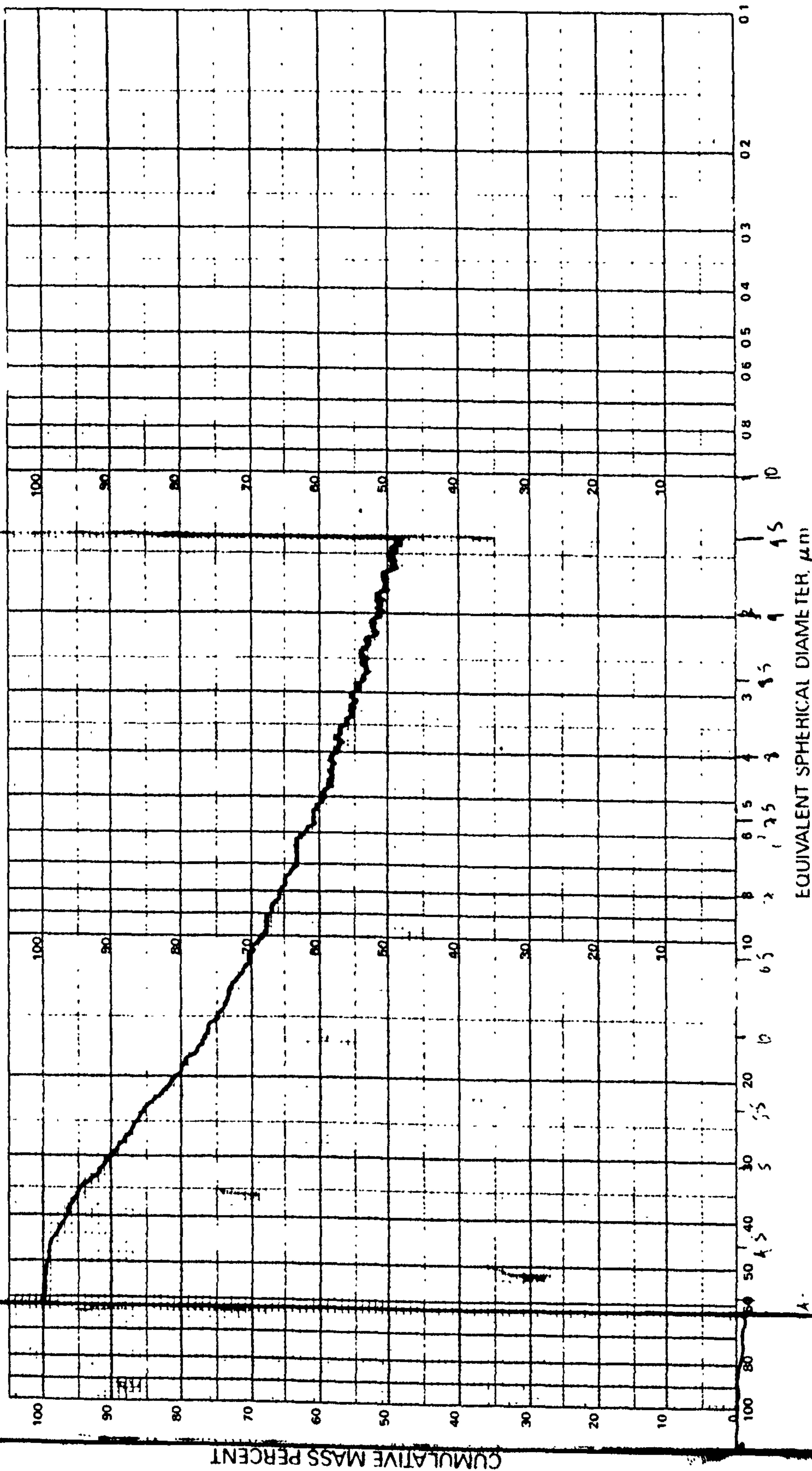
Figure A.9. X-ray diffraction analysis of sample RDC96.14.i.

PARTICLE SIZE DISTRIBUTION

SAMPLE IDENTIFICATION RDC'96/14 (1) DATE 24.11.96

Density 5.96 g/cc LIQUID Density 2.65 g/cc Viscosity 14.3 cP BY ---

Preparation 5% Li-gan TEMPERATURE 22 °C RATE 1/14 START DIA 2 μm



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Figure A.10. X-ray diffraction analysis of sample RDC96.14.ii.

PARTICLE SIZE DISTRIBUTION

SAMPLE IDENTIFICATION RX '96 14 iii

DATE 4/1/93

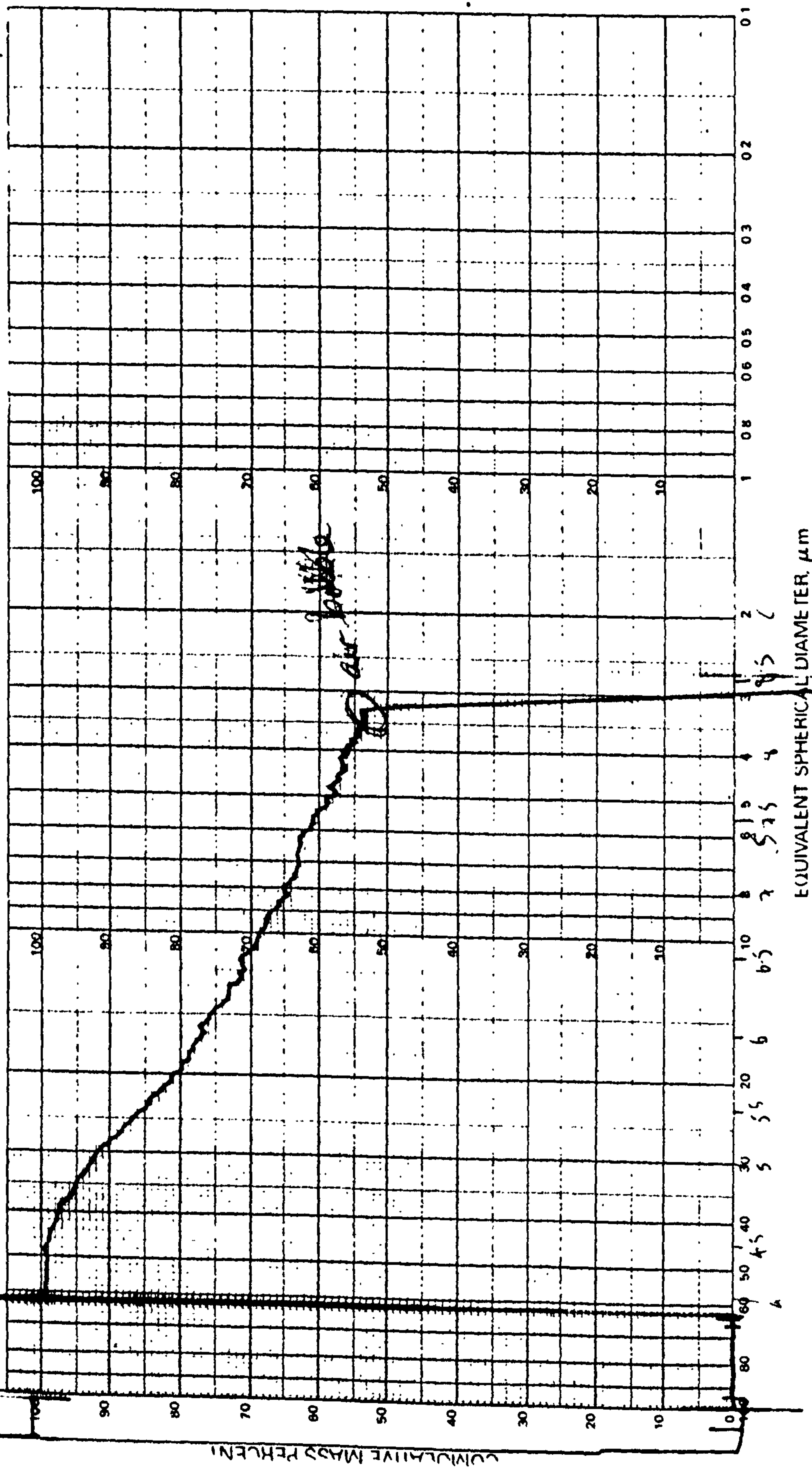
Density 1.65 g/cc LIQUID 570 g/cc

Preparation 570 g/cc (water) 1000 g/cc

BY ---

TEMPERATURE ---

RATE 114 START DIA 5 μm



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instrument corporation

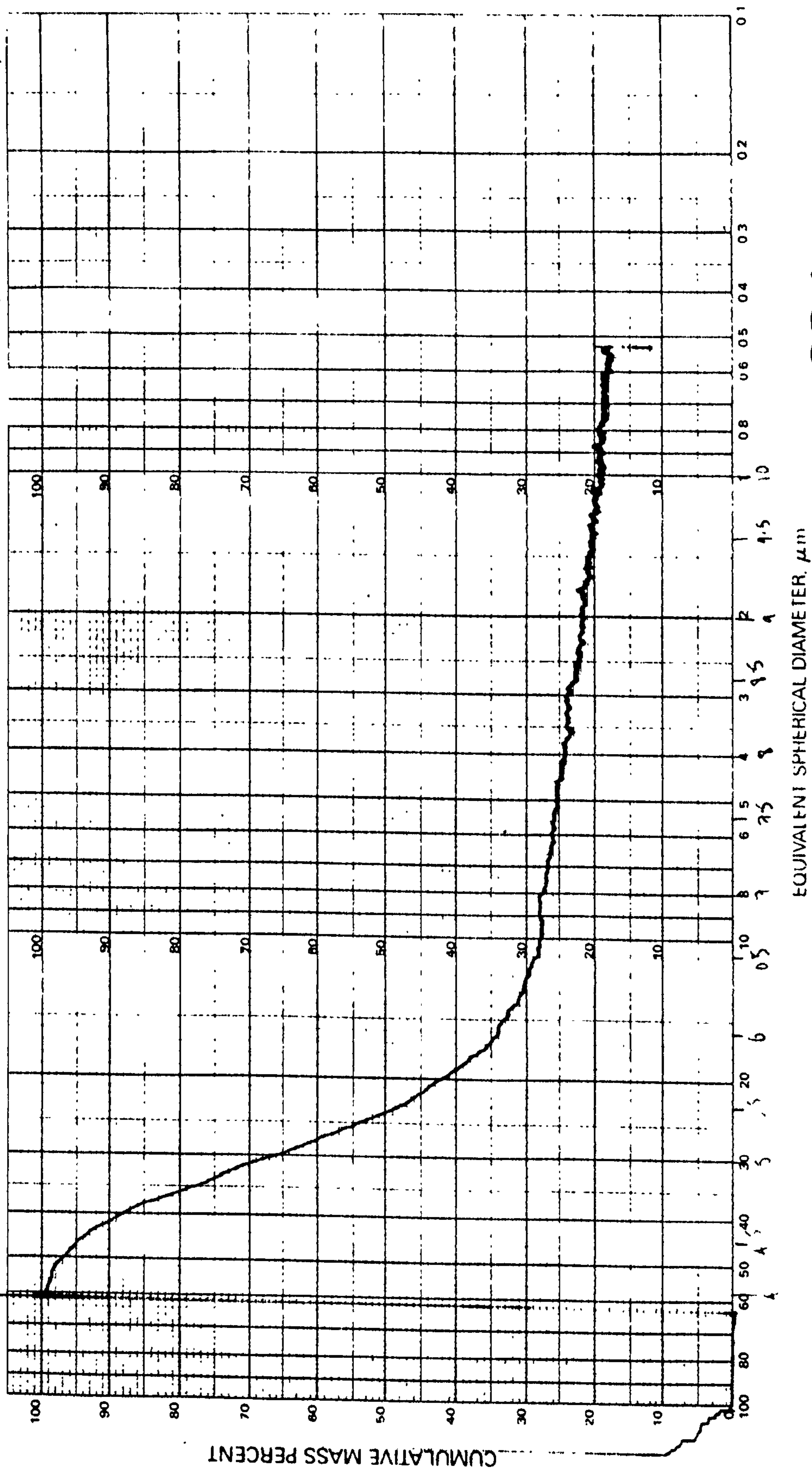


Figure A.11. X-ray defraction analysis of sample RDC96.14.iii.

PARTICLE SIZE DISTRIBUTION

SAMPLE IDENTIFICATION RFT'95.62.i DATE 28.11.92

Density g/cc 2.65 Viscosity cp BY 32
 Preparation 10 Calgon TEMPERATURE 714 RATE START DIA. 52 μm



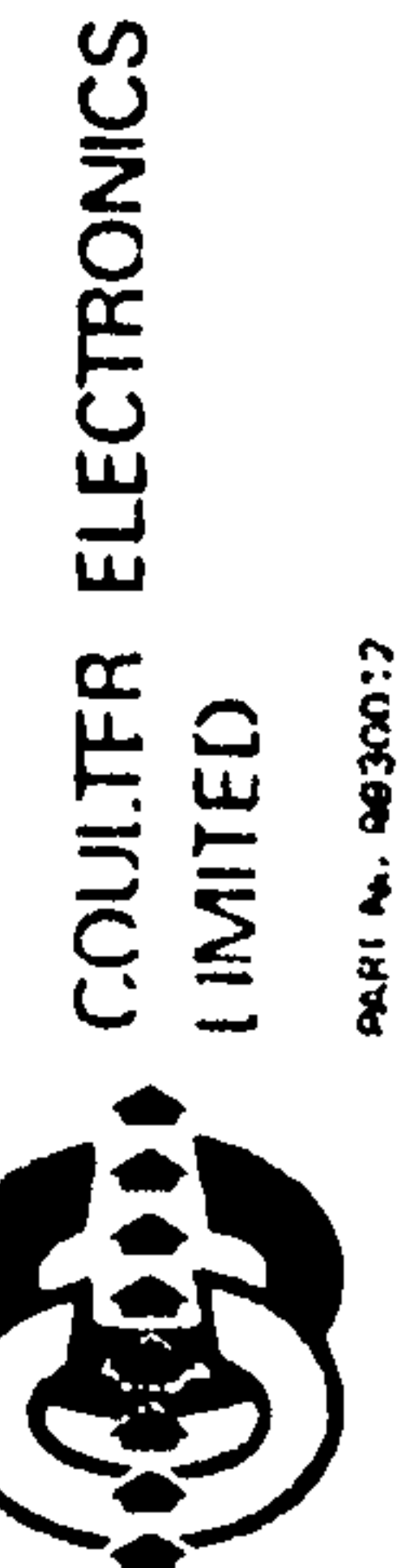
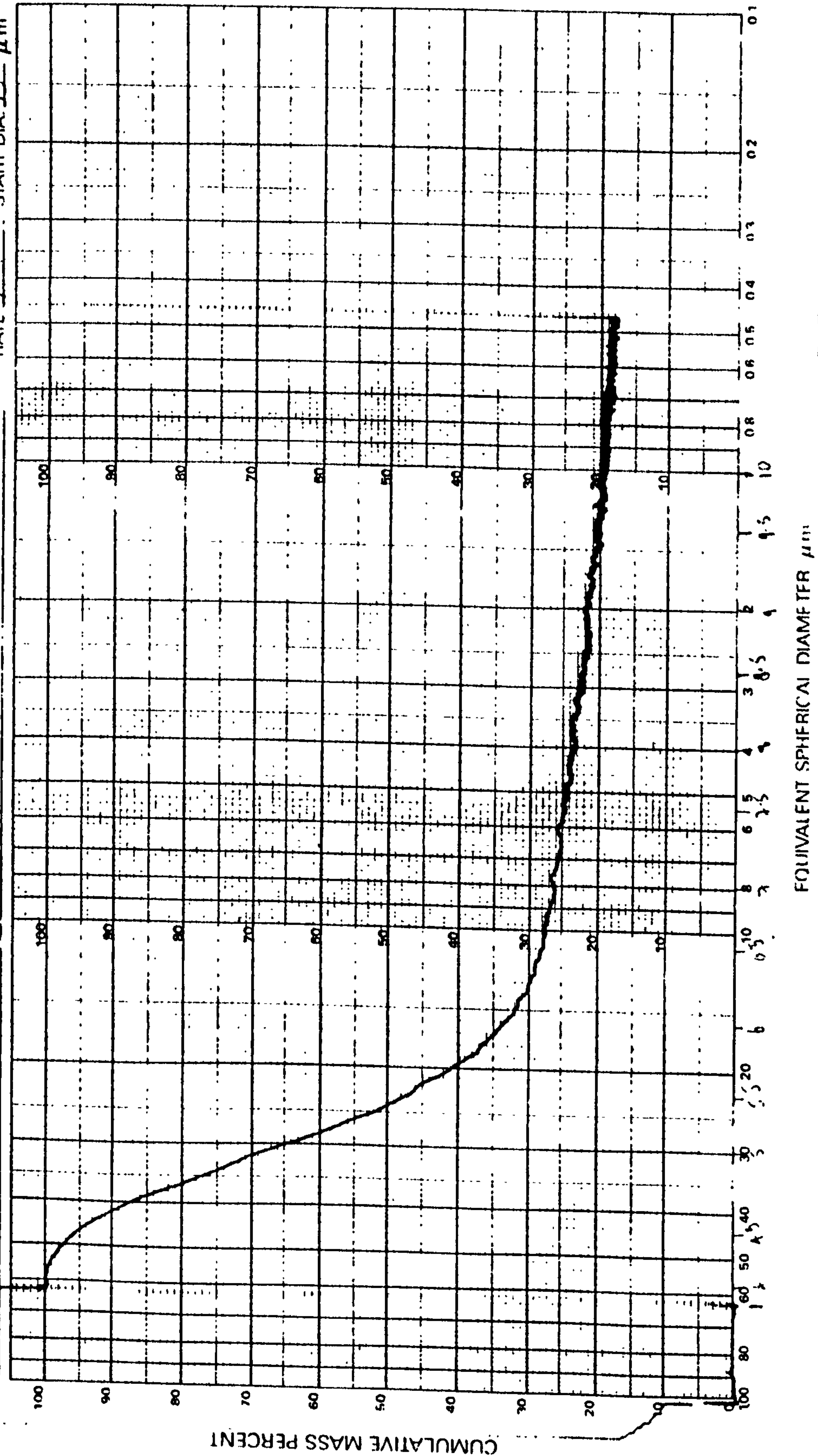
m **micromeritics**
instrument corporation



Figure A.12. X-ray defraction analysis of sample RFT95.62.i.

PARTICLE SIZE DISTRIBUTION

SAMPLE IDENTIFICATION FT'95.62 (ii) DATE 28.11.95
 Density 590 g/cc LIQUID 2.65 g/cc Viscosity --- BY ---
 Preparation 590 g/cc TEMPERATURE --- C
 RATE 3/4 START DIA 33 μ m



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 instrument corporation

Figure A.13. X-ray diffraction analysis of sample RFT95.62.ii.

PARTICLE SIZE DISTRIBUTION

SAMPLE IDENTIFICATION

Density g/cc LIQUID

Preparation

Density g/cc

Viscosity

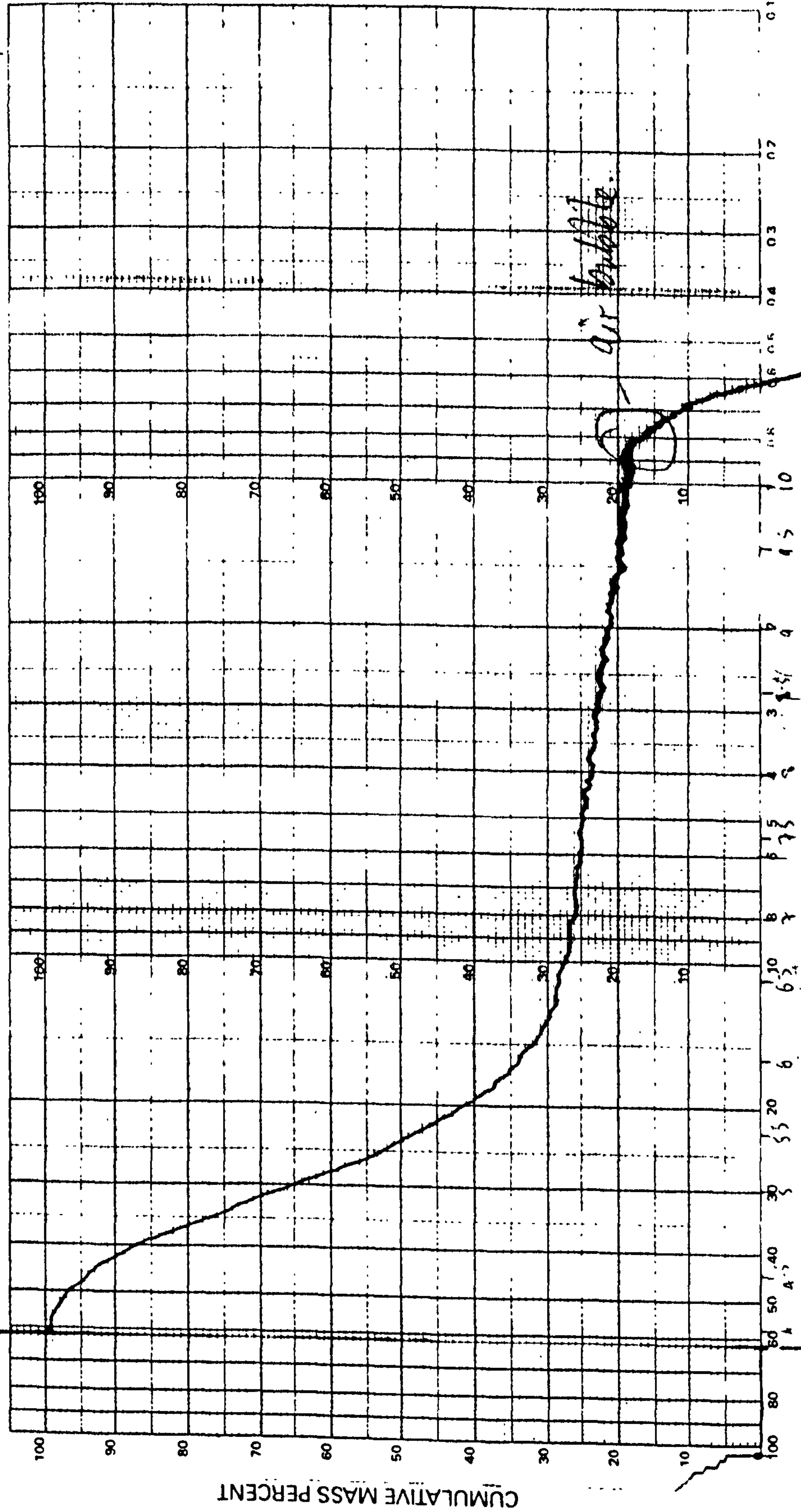
DATE

BY

TEMPERATURE °C

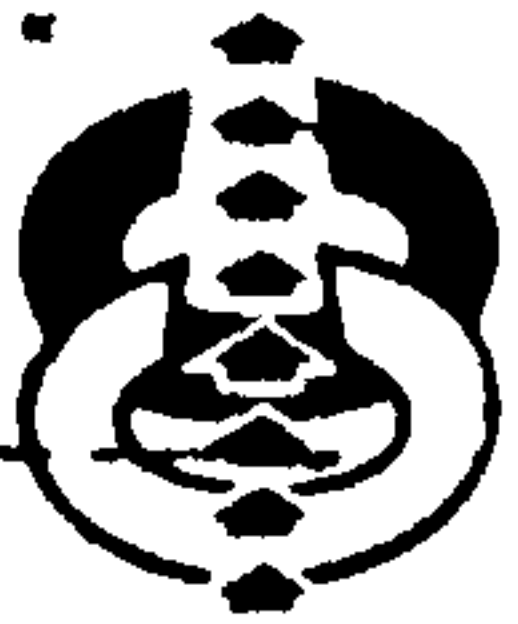
RATE

START DIA μm



EQUIVALENT SPHERICAL DIAMETER, μm

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Figure A.14. X-ray defraction analysis of sample RFT95.62.iii.

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