THE DISCOVERY PROGRAMME: INITIATION, CONSOLIDATION AND DEVELOPMENT

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(1868-1945)

In Ireland, the scope of archaeological enquiry is wide. While this country does not have a Palaeolithic, nevertheless, the study of human endeavour extends back for about 10,000 years. Ireland also has a long tradition of archaeological scholarship which has advanced enormously our understanding of the early inhabitants. The Discovery Programme, being dedicated to full-time research, will further advance this understanding. The Discovery Programme is an archaeological research institution whose main function is to enhance our knowledge of Ireland's past through archaeological and related methods. The Programme was established by Mr. Charles J. Haughey, then Taoiseach (Prime Minister), and inaugurated by him on the 11th May 1991. The work of the Discovery Programme is being carried out at the highest scientific level, using and developing in its research the most up-to-date methods. The fruits of this research are being made available not only to scholars but also to the wider public, including school children, through popular publications, exhibitions and educational material. In fact it is the aim of the Discovery Programme to disseminate the results of its research as widely as possible. Funding is provided by the State.

On the establishment of the Discovery Programme the Taoiseach appointed a Panel of eleven experts to oversee and implement the work. One of the first tasks of the Panel was to set out and identify major issues and problems that would form the basis of the first programme of study. In order to do that, consultation took place with various bodies and individuals and a report largely based on the responses was published in 1992, *The Discovery Programme. Strategies and Questions*. This report led to the isolation of a number of outstanding questions and the identification of potential major subjects worthy of investigation. In so doing it paved the way for the formulation of an integrated research strategy to address these questions. To a large extent this took the

form of a discussion document. In it was set out the aims of the Programme, the general strategy that could be adopted and a proposed infrastructure, all being in the context of a brief review of Irish archaeology. Major research questions which could be addressed were outlined. Arising out of all of this, an aspect that became clear was the dearth of information on many aspects of settlement in virtually every period. Accordingly, regardless of which problem or problems became the focus of study, it was considered that the habitation aspect of settlement should constitute the principal concern of the Programme and, from the point of view of general strategy, it was agreed that the Programme should begin its work by focusing on a particular core period. Many possibilities presented themselves, stretching chronologically from the Mesolithic to the Middle Ages and thematically from such monuments as upland habitation sites to deserted medieval villages, from megalithic tombs to tower houses. Such topics remain the concern of the Discovery Programme but for the initial five year programme attention concentrated on aspects of the later prehistoric period. In Ireland the "later prehistoric period" can be defined as stretching from about 1300 B.C. - 550 A.D., effectively the Later Bronze Age and Iron Age. This was a time of change and innovation in Irish society. Important developments took place in the field of manufacture, long distance external exchange networks were established and there is the possibility that a hierarchical society - Celtic-speaking at least in its later stages - emerged. Despite the array of artefacts, especially for the Later Bronze Age, our knowledge of the people that produced them is sparse. For instance detailed information about where people lived and socio-economic matters is limited. The study of these matters alone presented a considerable challenge.

Within the period chosen the Panel considered and agreed on a number of Projects. These were varied but yet cohesive and had a broad geographical spread. Four main interdisciplinary projects and two smaller projects were initiated. The main projects were -

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(i)   Western Stone Forts
(ii) Ballyhoura Hills
(iii) North Munster
(iv) Tara

Regarding the smaller projects one of these is complementary to
iv. above - it is a study of Tara from the literary - historical point
of view. The other smaller project dealt with the palaeo-ecology
of the north Louth area. Before embarking upon a description of
the principal findings which have emerged from the research to
date, perhaps it might be opportune to look at some of the more
specific issues relating to the structure, organisation and funding
of the Discovery Programme.

The Discovery Programme was established on a non-statutory
basis under the auspices of the Department of the Taoiseach.
With the formation of a new Government in January 1993, a
Department of Arts, Culture and the Gaeltacht was created, and
as a consequence responsibility for the Discovery Programme was
transferred to the new Department. The creation of a structure
that would achieve permanent status for the Programme had
always been kept in mind by the Panel. This was raised with the
new Minister, Deputy Michael D. Higgins, who after reviewing
the situation agreed to initiate an examination of how that might
be achieved. As a result of the ensuing examination it was consid-
ered that the appropriate way forward was to establish an inde-
pendent and autonomous body under the Companies Acts 1963
to 1990, the Company to be known as the Discovery Programme
Limited. From its inception, the Programme has been able to
achieve political support at the highest level for its research,
something which is perhaps quite unusual in an international
context. Successive governments have each reiterated their sup-
port for the Discovery Programme and its research philosophy.
An important point has been accepted, this is that long-term, in-
tegrated archaeological research is valuable, not just in academic

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terms, but in national and popular terms because of the contribution it makes towards a greater understanding of our own identity and the foundations of modern society. Not only have our politicians accepted this point, they have proved themselves willing and able to support it by directly funding just such an integrated programme of archaeological research. Without political support, the Discovery Programme could not have been born, and without political support it would not be here today, six years later, embarking upon a new phase of research. Such political support is probably unprecedented. Furthermore the research programme of the Discovery Programme is decided upon, freely and unhindered by *archaeologists*. This independence has been copperfastened by the new structure of Discovery Programme, a structure that came into effect on 15 January, 1996. On that date, the Discovery Programme became an autonomous, private, nonprofitmaking company, limited by guarantee, and funded by the State.

The structure of the Discovery Programme
The move to a private company inevitably brought changes for the Discovery Programme. The Panel of experts, which had guided the affairs of the Programme since 1991, was replaced by a *Directorate*, themselves appointed in part by a new body, the *Council*. Let us look at the Council first:

The Council is made up of representatives of third level institutions and public/professional bodies working in the field of archaeology, both inside and outside Ireland. At present, there are fourteen members, including two members from overseas, one from Great Britain and one from the Netherlands. The Articles of Association of the company provide that Councils will serve for five-year terms of office, although for administrative reasons the first Council will serve for only three years. The main functions of the Council are to nominate five members of the eight-person Directorate; to review the work of that Directorate; to

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make proposals for formal consideration by the Directorate; and to co-opt persons of international repute to help guide the work of the Discovery Programme.

The Directorate, on the other hand, actually run the Company, acting in every way like the Board of Directors of any other private company, and serving like the Council for five-year terms of office. As already explained, five members of the Directorate are appointed by the Council; the remaining three members are appointed by the Heritage Council, a statutory body with wide-ranging responsibilities, established by the Government in 1988 and placed on a statutory footing in 1995. In addition to managing the affairs of the Discovery Programme and ensuring that its research objectives are achieved, the Directorate also appoint the members of all future Councils. This is done on the basis of nominations received from the various representative archaeological bodies. In this way, through "cross-pollination" of bodies, it is hoped to instil a sense of cohesion, continuity and unity to the Discovery Programme. The Chairman of the Directorate is appointed by the Heritage Council, with the approval of the relevant Government Minister, that is the Minister for Arts, Culture and the Gaeltacht. Membership of the Directorate and Council is completely voluntary - no payment of any kind is made to any member, except in respect of legitimate expenses.

The internal structure of the Discovery Programme is quite simple: we have a Programme Manager, who effectively carries out the functions of a Chief Executive, looking after company affairs and reporting directly to the Directorate; each research project is led by a Project Director, making use of support staff as and when required; we have one longterm Research Fellow, examining aspects of Irish early literature; we have two short-term Research Fellows at present, investigating new research directions for the company; we have a GIS manager, whose function is to manipulate and develop the company's geographical information system; we have a surveyor; and we have one administrator.

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All in all, the present full-time staff complement numbers 12 in total. In the main, all staff of the Discovery Programme are employees of the company, rather than self-employed contractors recruited to carry out a specific task. People may be employed for short or long periods, depending on the nature of their work - most of the staff have been with us since 1992. Excavation teams are assembled as required, from year to year, and one enormous assistance to us in this regard has been the Government's *Students Summer Jobs Scheme*, which allows us to take on students during the summer months and reclaim the costs of their salaries directly from the Government. Obviously this has enabled us to stretch our annual grant allocation much further than might be expected.

Decision making

The major decisions affecting the work of the Discovery Programme are taken by the Directorate, particularly in respect of the day-to-day running of the company. Strictly speaking, in terms of deciding on new research directions, the power to decide also lies with the Directorate. However, the policy has been to seek to arrive at such decisions by consensus, in consultation with the Council. Our new research directions, of which I will speak in more detail later, were agreed by consensus at a joint meeting of Council and Directorate in September 1996. Two potential themes were chosen, *ie Lake Settlement* and *Medieval Rural Settlement*. The next stage here will be the preparation of feasibility studies on the potential for research and these will be examined, again by Council and Directorate, and decisions taken about how best to proceed. At a more detailed level, in terms of the running of the research projects themselves, individual project Directors maintain a good deal of autonomy in deciding how best to proceed, within the constraints of their own budgets and the timescale laid down for each project. Projects are reviewed regularly by the Directorate and if necessary specific guidance can be given.

Research Policy

The Discovery Programme has adopted a wide, broadly based approach to research. In general, however, we try to concentrate our efforts on areas and questions where our particular approach can make the maximum contribution. In terms of the framework for that research, the Discovery Programme sees this as covering the *entire* period of human settlement in Ireland, up to modern times. We do not impose any particular cut-off point in time upon the subject matter of the research. In terms of scale of projects, the Discovery Programme has shown that its research can be managed effectively at many different levels, combining largescale, longterm projects with much smaller "cameo" projects, designed to tackle a particular issue quickly and effectively. This mix allows the Discovery Programme's research to remain relevant to the widest possible field, and to ensure that everybody can see that the substantial investment of public funds is yielding results.

The Discovery Programme is using and developing the most up-to-date techniques. For instance, at Tara the geophysical component of the survey is the largest undertaken in Ireland. Again, as part of the Ballyhoura Hills Project extensive topographical surveys were carried out. These involved geophysical, resistance and magnetometer surveys as well as ground radar probing. As each technique responds to different properties of underlying soils, all of these techniques more or less complement one another to produce a more comprehensive picture of the underlying archaeological remains. The processing of data from all these surveys has broken new ground in Irish and British archaeology.

Dissemination of Information

An important aspect of the Discovery Programme's work is the dissemination of information. From its outset, the Programme set itself the objective of not just carrying out research, but of formulating the results in a manner which could be communicat-

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ed to experts and the general public alike. Inevitably, the principal means by which we have attempted to do this is through the field of publication. In order to retain control and to ensure that the highest standards were achieved and maintained, the Programme decided to establish its own publication series entitled *Discovery Programme Reports*. The publication of these *Reports* commenced in 1992 and to date five volumes have been published. A volume may contain a series of interim accounts of the work in progress or final reports such as Martin Doody's enclosures at Conva, Co. Cork, (*Discovery Programme Reports* 2 (1995), 24-38) and David Weir's palynological study of landscape and agricultural development in Co. Louth from the second millennium B.C. to the first millennium A.D., *Discovery Programme Reports* 2 (1995), 77 - 126. Conversely, volumes 3 and 5 are monographs devoted solely to the Tara investigations. Volume 3 by Edel Bhreathnach is entitled *Tara a Select Bibliography*, 1995; Volume 5 by Conor Newman is entitled *Tara: The Monuments*, 1997. We work closely with a specialist publisher, the Royal Irish Academy, to produce, copy-edit and distribute these reports. Since an over-riding objective of the Discovery Programme is to make archaeological information available and accessible to the widest possible audience, these reports are sold at cost or below-cost price. In addition to these publications members of the staff have published numerous papers in various external journals. (See pp. 59-62)

These have all been detailed academic publications but the Discovery Programme is acutely aware that its role does not end there: we have a duty to make our discoveries available to everybody, young and old, who may be interested in our past. Accordingly, the Discovery Programme is anxious and committed to serve this wider public. As part of this commitment, what might be described as a "popular" guide to Tara by Edel Bhreathnach and Conor Newman has been published in conjunction with the Office of Public Works in 1995 and this has been most successful as it is widely used by visitors to the site. For

schools an educational poster also dealing with Tara has been produced while an education pack, devised to meet the needs of the newly extended Irish history curriculum in schools, is at an advanced stage and will be published soon. This pack deals exclusively with the Bronze Age, looking at different aspects of Irish society during this period, and encouraging teachers and school children to explore the many questions that arise, through teaching suggestions and work cards. In accordance with our policy to disseminate information as widely as possible, copies of this education pack will be distributed free-of-charge to all schools in the State. A major travelling exhibition is currently been organised. This will deal with the overall work of the Discovery Programme highlighting the fruits of its research and including interactive elements along with replica tools and weapons for practical experimentation. A world-wide-web site is up and running on the Internet, capitalising on a medium for contact and exchange of information that is increasingly available to schools, third level institutions and individuals. In order to encourage debate and discussion not only on the work of the Programme but also on a wider range of archaeological questions, regular seminars take place at headquarters as well as an annual symposium, where aspects of the research are presented and discussed. The research staff lecture widely and are in high demand. However, more can be done in this field; we are continuing to explore new ways of communicating with the public through more popular publications, joint ventures, TV, CD-Rom etc.

Funding

Naturally, all this activity needs to be paid for. The Discovery Programme receives its funding from the State by way of an annual grant from the Heritage Council, a statutory body with a far-reaching role in the area of Ireland's heritage in the broadest sense. Currently the grant is £550,000, something of the order of 1.5 million guilders. Out of this, in 1997, the company has to pay all staff, run six projects, pay for materials, insurance and accom-

modation, develop information technology and publish. Over 70% of our funding is channelled into research and publication. Administration costs are kept to a minimum - currently around 9% of total expenditure.

The Discovery Programme has also actively pursued the possibility of commercial sponsorship. Though this has been of limited success. Small, but important contributions have been secured. The problem, as always, lies in the time and effort that must be expended in order to secure even small amounts of commercial, sometimes conditional sponsorship. Nevertheless, we remain confident that this source holds the potential for substantial funding.

One source of funding which is currently being investigated with interest and which promises much for future research is the whole area of European Union funding, particularly the nascent *Raphael Programme*. For the next phase of research it is hoped to match national funds with European funds, and through the development of partnership ventures with other European institutes, we hope to bring a whole new international perspective to our work.

THE PROJECTS

As already mentioned four major projects and two smaller projects comprised the initial programme of research, all focusing on aspects of habitation in the Late Bronze Age and Iron Age (Fig. 1). While this work is part of an integrated whole, nevertheless, it is of value to briefly review the achievements of each Project.

(Director - Ms. Claire Cotter)

INITIATION

The role of this project is to investigate the nature and the chronology of the stone forts which are predominantly found along the western seaboard. The main objective is to compile a corpus of sites and to carry out intensive field-work at a selected number of these. Broader aspects of the work include an examination of the distribution of the forts in terms of settlement, geography and economic subsistence, and an analysis of both current and new evidence for their chronology and function.

Initially, definition constituted a problem so a broad working classification had to be established. The large stone forts are distinguished from the smaller examples by the massiveness of their enclosing wall or walls and by a number of other characteristics such as flights of stairs and internal terraces, intramural chambers or passageways and sometimes *cheveaux de frise*. This said, the research in hand is showing that these forts did not constitute a homogeneous group morphologically. There are contrasts in the size of the area enclosed and in the complexity of the defences. Some can be classified as hill-forts, Grianán of Aileach for instance, others as promontory forts, Dún Dúchathair, Inishmore for instance, while others are unclassifiable, Dún Chonchuir for instance.

As the work progressed the study became more focused on the large stone forts. The more intensive field work and excavations have been confined to the Aran Islands in Galway Bay, where seven large stone forts exist (Figs. 3 - 4). Even in this limited area the forts vary both in size and in the complexity of their defences. Dún Eoghanachta, a univallate cashel on Inis Mór, is the simplest. The famous fort of Dún Aonghasa, being multi-vallate, is more elaborate in ground plan with a most striking location,

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on the edge of a sheer cliff overlooking the Atlantic ocean 87m below, commanding distant views up and down the coast. There are three main walls, enclosing an area somewhat U-shaped in plan, of 5.7 hectares (14 acres). The enclosing walls are made from local limestone. The inner (no. 1) is the most impressive, being almost 5m in maximum height and up to 6m in maximum thickness at the base. Two terraces occur on the inner face, access being provided by flights of steps. The lintelled entrance passage is on the north-eastern side. The three outer walls (nos. 2, 3 & 4) are less spectacular. A band of *chevaux de frise*, on the outside of wall 3, encircles the monument. Dún Aonghasa is, indeed, an extraordinary monument but, as will be shown, the current research is showing that it is even more extraordinary than anticipated. It has been established by excavation that the site was first occupied in the Late Bronze Age, many centuries before the conventional Iron Age date often quoted for the visible structure. The primary aim, when initiating the excavation, was to establish if any archaeological deposits were preserved *in situ* within the inner wall area and if so whether such deposits might provide some dating evidence for the extant structural elements. The excavations, which extended over one third of the inner enclosure and also in areas beyond it, established that there was a considerable archaeological deposit over most of the western third of the inner enclosed area while patches occurred outside the wall. It can be shown that there was a sequence of activities, of considerable importance is the fact that this activity took place during the Late Bronze Age and that it is stratagraphically earlier than the inner (No. 1) wall of the fort.

Late Bronze Age. The principal evidence for occupation is provided by a living area defined by a spread of occupation debris. It is not possible to define precisely the area of occupation but evidence for a spread is found over an area that measures at least 150m by 75m. The best evidence occurs in about the western third of the later inner enclosure (wall 1) but also in some areas

outside it. There is positive evidence of at least four huts and an indication of a further four; where clear evidence is available all were circular (Fig. 2). The earliest activity, based on stratagraphic evidence, focused on an area surrounding a hollow in the bedrock. This may have been a dump of domestic refuse and amongst artifacts that it contained were pottery and objects made from bone (pins, needle, points, awl) and bronze (chisel). This dump was overlain by one of the huts (No. 1). Wheat was grown and the domestic animals included cattle and sheep. Sea resources were also utilised for food, especially periwinkles and limpets. Wider activities also took place, a significant aspect being an industrial area where bronze objects, such as swords and bracelets, were manufactured. It is possible that the settlement was enclosed by a wall. It appears that this was somewhat U-shaped in plan, wall 2A is the best surviving portion. The western portion has been largely destroyed or incorporated into the western portion of the inner wall (wall 1).

The Stone Fort. This consisted of more than one member, an inner "citadel" (Wall 1, *the chevaux de frise*, the reuse of portion of wall 2 and the extension of it in a curved fashion westward and south-westward). Wall 1 was of complex construction and had up to two inner faces. As mentioned it appears to have incorporated a portion of the Late Bronze Age wall, to which additional skins of masonry were added. Apart from having established that the inner wall post-dates the Later Bronze Age settlement, the date of the construction of the fort remains unknown but it may have been some time during the Iron Age. Limited activity took place during the Early Christian stage (*c.* 8th - 9th centuries A.D.) but there was no evidence of permanent settlement at that time.

RESULTS

The investigations at Dún Aonghasa have been important for a number of reasons -

(i) they revealed hitherto, unknown evidence for occupation during the final phase of the Late Bronze Age.

(ii) important structural evidence came to light, in particular it has been established that the upstanding walls have different structured phases. The large stone wall is a later feature.

It is now possible to put forward a model for enclosure development which started during the Late Bronze Age but which subsequently became more elaborate. On a wider front, this programme of research has established that the stone forts constitute a significant element of the archaeology of "Atlantic" Ireland. As is the case with many of the ring-forts, the small stone forts may have served as protected farmsteads. The large stone forts, which differ in size, could have served a different purpose (Fig. 3). It may be speculated that they were the homesteads of prominent families or even tribal leaders. The Aran islands are relatively small in area yet seven large stone forts are present, four on the main island. It is unlikely that such a small area would have simultaneously supported seven chieftains. Of course, it may well have been that stone-fort building extended over many centuries. Limited investigations at Dún Eoghanachta indicate that the site dates from the latter half of the 1st millennium A.D. Not all forts need have been in contemporary use.

A most significant aspect of this research has been the discovery of a substantial Late Bronze Age area of settlement; if not a small village, at least a hamlet. This was protected by an enclosing wall or walls. This provides clear evidence for a prosperous, prominent and self-contained family at least on Inis Mór, but if there was one, there may have been more such families on the Aran Islands.

INITIATION

The Ballyhoura Hills are situated in the Munster Counties of Cork and Limerick and form the foothills of the Galty mountains to the east. The study area incorporates three different landscape types, the extensive tillage areas of the Blackwater Valley, the mountainous topography of the Ballyhoura Hills and the relatively undisturbed pasture lands to the north. In addition it affords an opportunity to study a variety of archaeological sites, some of which had not hitherto been studied in detail. Except for Lough Gur (Ó Ríordáin 1954; Grogan & Eogan 1987) few definite Bronze Age sites have been recorded and even less investigated in Munster. This may be due to the absence of a concentrated programme of research aimed at locating them. The principal aim of the Ballyhoura Hills Project was to draw on the results of recent air reconnaissance and archaeological surveys in the study area, in an attempt to identify sites which might belong to the core period. Potential sites within the area include hillforts, linear earthworks, barrows, large crop-mark enclosures, and rectangular enclosures of a type which does not readily fit into any recognisable classification. The work was carried out over an extensive area and as a result a number of sites were recorded. Extensive topographic and geographical surveys took place at a number of these, e.g. the inland promontory fort at Castle Gale, Co. Limerick (Fig. 6), while excavation was carried out at three monuments and monument complexes - Chancellorsland, Claidh Dubh and Conva.

INVESTIGATIONS

Chancellorsland, Co. Tipperary is a monument complex comprising four main elements characterised by earthworks, Sites A - D. The entire field (3.72 hectares) in which the monuments were located was surveyed topographically with detailed geophysical surveys in selected areas. Excavation was confined to Sites A and C.

Site A is oval in plan and measures 60 by 50m. It is enclosed by a double ditch, which appeared to be dug in three stages and it was used for habitation purposes. Traces of at least ten structures came to light. Some were rectangular in plan, others were circular. The inner ditch had a broad U-shaped profile 2m across at the top, 70 - 90cm in width at the base and 1.1m deep. The finds mainly came from the ditch fills. Pottery predominated but artifacts in the form of struck flint and chert were also found. Pieces of utilised wood were plentiful in the inner ditch. Site A seems to have been a prominent habitation site, dating to the Middle Bronze Age. While it is likely that some structures were contemporary, there is also evidence for structure renewal. Farming was the economic basis and cattle, sheep and pigs were kept.

Site C is a circular earthwork about 40m in diameter enclosed by a ditch with a broad U-shaped profile, 2.9m in width at the mouth. More than one stage of activity was recorded. The initial use of that Site began during the Middle Bronze Age but it was also in use during the Iron Age and Early Christian times. While Site A was clearly domestic in nature, some unresolved questions remain as to the function of Site C.

Conva, a series of crop-marks in the form of enclosures, were revealed by aerial photography. The excavation, very limited in extent, was an attempt to assess the archaeological significance of the features. The area had been extensively levelled by repeated ploughing. Despite that, a three-dimensional topographic survey was carried out initially as an attempt to determine the nature of the various enclosures. In addition, a combination of resistance magnetometer survey and ground radar was employed. Due to the presence of ploughed soil and related factors only limited information came to light. Excavation was concentrated on a complex of three enclosures which varied in shape and size. A series of large pits in the area were also revealed.

It is difficult to establish the relative chronology of the enclosures and pits. However, it appears that the various features may have developed in quick succession. Finds were few and undiagnostic, iron slag and furnace bottoms being the most common. The function and purpose of the sites is also problematical although it is possible that Enclosure 2 was a small ringfort. The radiocarbon dating evidence ranges through Early Christian and Medieval times.

The Claidh Dubh (Fig. 5), a linear earthwork in north Co. Cork, can be traced for a distance of 22 kilometres (14 miles). The entire earthwork was surveyed, 800m of it in detail and limited excavation also took place. The purpose of the excavation was to examine the morphology of the earthwork and to attempt to retrieve dating evidence. This work has shown that the earthwork varies considerably in its construction, such as in the number and positions of the ditches and the height and nature of the bank. In places, the bank which consisted of rubble was flanked by shallow ditches. Parallel to the bank, on the eastern side and seemingly contemporary with it, was a trackway. Dates are uncertain, but a C14 date indicates that a growth of peat was forming over the trackway around 100 A.D. It may well be that both earth-work and track date from Iron Age times.

Castle Gale (Fig. 6) is an inland promontory fort, somewhat triangular in plan. A detailed three-dimensional survey revealed that the site consisted of two banks with the entrance at the southern side but steep slopes provide natural defence especially on the north side. It is one of three intervisible hill-forts strategically placed in this part of the valley of the river Blackwater. The other two being Caherdrinny and Carn Tigherna. Before survey, the structural features of the forts were not readily visible due to the rugged terrain and extensive vegetation cover.

RESULTS

An important result of the Chancellorsland investigations has been the recognition of a new Bronze Age monument type, the sub-rectangular earthwork. Such structures are sometimes associated with round barrow cemeteries. The recognition of this monument type vastly increases the visibility of the Bronze Age landscape in Munster and indicates a more widespread settlement pattern than had hitherto been suspected. Survival of organic remains in the ditches provides complementary evidence to that from the dry-land site of Dún Aonghasa. The Iron Age date obtained for the Claidh Dubh is the first evidence we have for the placing of that earthwork in a chronological context. The study of the three hillforts, Castle Gale, Caherdrinny and Carn Tigherna, overlooking the Blackwater Valley and their juxtaposition in relation to the Claidh Dubh, which closes off the valley, floor to the west, at least raises the possibility of the contemporaneity of both earthwork and hillforts. The results also complement the picture that has been emerging regarding linear earthworks and their function in the Emain Macha (Navan) area of Co. Armagh.

Dating apparently to a later period, the surveys and excavations of crop-marks in the Blackwater valley demonstrates and confirms a greater intensity of archaeological activity than had hitherto been suspected in that fertile farming area.

INITIATION

The study area consists of the North Munster counties of Clare and Limerick and portions of counties Kerry and Tipperary all of which adjoin the lower reaches of the river Shannon which may have formed the principal axis. The main aim of the project, starting with the known archaeological record as a foundation, was to assess the nature and range of settlement in a regional framework and thereby to achieve a detailed view of the processes and changes involved within the relevant time scale. The significance of the archaeological record within its national and international setting is of particular concern. The archaeological data available for North Munster indicated that a complex and wealthy society emerged during the final phase of the Bronze Age. This area has a distinct regional character (e.g. Eogan 1974), but its evaluation relied principally on artefact studies because the study of field monuments was limited (Raftery 1942). It had already been highlighted as a significant area in terms of the specialised bronze and gold work recovered, the high degree of craftsmanship involved in the manufacture of individual items, and the size of some of the assemblages of Late Bronze Age material such as the gold hoard from Mooghaun of over 147 objects (Eogan 1983, 69-72). However, little was known of the regional settlement or economic context and there was only slight evidence for ritual other than the probably ceremonial deposition of hoards. It is important to evaluate why this important cultural province emerged. Another important issue is the transition to the Iron Age. There is a concentration of metal objects of Late Bronze Age date in the core area and this contrasts with the distribution of the smaller quantity of Iron Age material. The latter mainly comes from the northern part of the area. These contrasting distributions provide a difficulty in assessing the nature of the Late Bronze Age – Iron

Age transition in the region as well as in understanding the developments during the Iron Age itself.

Initially, the work consisted of assembling and collating the relevant data, for both monuments and artifacts, from various sources such as records in the Office of Public Works and National Museum. Aerial photographs and the printed literature were also scrutinised. A preliminary analysis of the distribution patterns of the artefacts was also carried out as that evidence might assist in the location of unknown settlement foci. The study was structured along sub-regional lines which were part of the larger unit. These landblocks facilitated an overall and integrated study. They produced an important context for the identification of possible multivariate settlement patterns and enabled the integrated study and interpretation of associated themes such as material, social, economic and ritual development to take place (Fig. 7). The Mooghaun block is to the north of the river Shannon; research has also proceeded in two further blocks to the south of the river, around Lough Gur in east county Limerick and Ballylin to the west.

<h3 style="text-align:center">INVESTIGATIONS</h3>

Previous excavations, during the laying of a gas pipeline, in an area in the south of the region suggested ritual activity during the Middle to Late Bronze Age. As a follow up, excavation was carried out on four barrows at Mitchelstowndown West, Co. Limerick. Positive evidence regarding use and date was not forthcoming but, as has been suggested for similar sites in the area, these barrows may also have a Middle to Late Bronze Age date. It was in the Mooghaun landblock that much of the work was concentrated mainly because there is a variety of landscape types and an extensive range of monuments in the area and also an impressive concentration of Late Bronze Age finds. More specifically the area was chosen to permit the investigation of the wider aspects of the Mooghaun hillfort and the gold ornament hoard found

nearby. The research involved detailed fieldwork and landscape analysis, excavations at Mooghaun as well as an intensive study of the late prehistoric artefacts.

Excavation was carried out in selected parts of the area of Mooghaun hillfort. This is a large trivallate monument, the ramparts consist of limestone rubble, enclosing an area of about 12 hectares (27 acres). Evidence for settlement during the Late Bronze Age came to light on the hill-top. Finds consisted of pottery but evidence for structures was limited to two small circular or sub-circular houses. Bones show that cattle and pig were kept. Remains of the occupation layer has been picked up at different points on the hilltop but it was discontinuous, being best preserved near or under the fort ramparts. The discontinuous nature of the occupation material appear to have been caused by the subsequent scraping up of material for the final stages of rampart construction. It may very well be that the Late Bronze Age settlement extended over an extensive area. In view of this the settlement was probably an important one, the homestead of a prominent person or family. Indeed it might well have been here that the owner of the Mooghaun gold hoard lived. The hill-fort aspect suggests that Mooghaun appears to form the focal site of an important sub-regional territory in south-east Clare. Some 25 other hillforts have been identified in the course of this research within North Munster and of these Ballylin, Co. Limerick, Fermoyle, Co. Clare, Knockadigeen and Laghtea, Co. Tipperary seem, from their commanding locations, their area (all are over 7 hectare), and the nature and size of their defenses, to represent similar high status centres. The remaining hillforts are less than half the size of the more prominent ones and may form subsiduary sites within a settlement hierarchy.

As part of the settlement studies a number of less impressive fortified hilltop enclosures were also identified. Like the hillforts these also concentrate in the core of the Late Bronze Age focus of

the North Munster province. Their occupants might have belonged to a lower social rank than those of the hillforts. To test this hypothesis one such earthwork was investigated. The site at Clenagh, about 93m by 75m, consists of a ditch with an inner and outer bank. Excavation in the interior and a cutting across the bank-ditches provided some evidence for habitation including some post-holes and animal bone from the ditch fill. Although considerable damage was caused in the interior by cultivation, complicating the assessment of function and date, it does appear that the site had been abandoned by the end of the fourth century AD.

In addition, smaller enclosed habitation sites, less than 500m^2 in area, have been identified throughout the study area. Examples at Lough Gur and Aughinish within North Munster have yielded evidence for Late Bronze Age occupation and the sites seem to cluster within areas of intensive settlement of the period. Other sites within these Late Bronze Age concentrations include barrows, standing stones and *fulachta fiadh*. It is also evident that while the artefacts tend also to cluster in these areas, the distribution of objects is wider than that of the more distinctive monuments. This pattern of close association between the various settlement and ceremonial or ritual sites is repeated within the major core areas of activity, principally at Mooghaun, Ballylin, Knocklong and Lough Gur in Co. Limerick, Cullen and Knockadigeen, Co. Tipperary, and the Cashen estuary in Co. Kerry. Each of these areas has a distinctive character in terms of the patterning of this evidence although the artefacts, and especially the high status ornaments, provide a unifying factor within the region as a whole. Aspects of the artefactual record, the gold ornaments for instance, may provide information that will help to evaluate the social context of production, use and deposition.

During the Late Bronze Age the importance of the Mooghaun area increased. The distribution of sites, monuments and arte-

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facts is now concentrated within an area of about 176km² characterised by low hills, small lakes, and raised bog. This is somewhat unexpected as this lakeland zone consists mainly of marginal land. However, it appears that during later prehistory a more varied and flexible economy emerged that availed not only of the land but also other resources that were offered by the lake shore, river banks and estuary marsh. In order to test this theory an inter-tidal survey of the Shannon-Fergus estuary was initiated under the directorship of Aidan O'Sullivan. This was the first such survey in Ireland and it has demonstrated that a landscape, previously untapped by archaeological investigation, exists in the estuaries. The evidence that has emerged is throwing light on early landscapes and their environment and on human activities, in particular fishing. At Carrigdirty, Co. Limerick a cluster of vertical posts dated to 1678 - 1521 cal. B.C., might be the remains of simple huts or shelters that stood in a sedge fen or alder carr. Occupation might have been seasonal, possibly confined to the summer months. At Islandmagrath, there are a series of posts with panels of hurdle work which have been dated to 793 - 553 cal. B.C. These might have been part of a causeway that provided access to the lower part of the shore or even a form of boat jetty. These inter-tidal surveys are producing a picture of Later Bronze Age people utilising and exploiting the mudflats, marshlands and adjacent hinterland along the estuary coastline as well as the adjoining uplands. The inter-tidal survey is also making an important contribution to the understanding of environmental developments. For instance, evidence for submerged forests confirm the view that a rise in sea-level took place. Indeed, it appears that freshwater wetlands were been incorporated into estuarine wetlands. This may have had a wider effect as drainage patterns, not only in the estuary but extending inland, could have been effected in later prehistoric times.

A large number of new sites have been identified and a tentative model of later prehistoric settlement patterns can be put forward. This model suggests a four-tier hierarchy of occupation sites: substantial sub-regional centres represented by the larger hillforts, lesser local foci in the form of smaller hillforts, the hilltop enclosures and the enclosed habitations. This patterning is supported by the distribution of funerary and ceremonial sites including places used for the ritual deposition of hoards and single artefacts. Thus the artefacts are not just objects in isolation but form an important part of the wider Late Bronze Age landscape. Assessment of this patterning has been carried out in a number of areas and a preliminary evaluation has been published for the Mooghaun area. In addition the work at Mooghaun provides, for the first time, significant settlement evidence. At least at that site a very substantial area was utilised, this clearly demonstrates the presence of a considerable population and human cohesion. But apart from the secular side of the story ritual was also of significance. Some of the hoards could have been deposited for spiritual reasons and that could include the previously mentioned deposits at Mooghaun and the bog of Cullen and metal objects from Lough Gur.

Pollen analytical work (by Karen Molloy) currently in progress is indicating that wholesale removal of woodland from the environs of Mooghaun lake took place around the later stages of the Bronze Age. A corresponding expansion of herbaceous taxa, which provides indications for the presence of pastoral, and to a lesser extent arable, farming took place. Pollen analysis is also taking place at the Bog of Cullen.

The overall evidence shows that the emergence of an important Late Bronze Age cultural province in North Munster. This is characterised by homogeneity in settlement and social organisation, as well as common traditions in high status objects and

ritual customs. Much of these developments have their origins in the gradual developments in earlier prehistory within the region itself. Some aspects of the distinctive character of the area, however, owe much to stimulus from outside the region: contact and perhaps trade with other core areas in Late Bronze Age Ireland, such as the midlands and the north-east, are evident as are wider influences most evidently from along the Atlantic seaboard of Europe.

TARA PROJECT
(Director - Mr. Conor Newman)

INITIATION

The Hill of Tara is a long low ridge orientated roughly north-south. The hill rises gently from the south to a height of 154 metres (405 feet) but drops away fairly steeply on the other sides. There is an extensive view from the summit, sites in up to a dozen counties, about a fifth of the area of Ireland, being visible (Fenwick 1997). Tara is one of the best-known and important ancient sites in Ireland. Despite the potential richness of the site the state of scholarship has remained largely static and as a result an understanding and appreciation of the site is limited. The object of this project is to ameliorate that situation. Archaeologically, there are a number of monuments visible on the hill-top and limited excavations during the 1950s have demonstrated that important activity took place on the site from Neolithic times onwards. In addition to archaeology there is a large body of documentary material available for study. As a result the Tara project has dual components - archaeological and literary. The archaeological work has a two fold purpose -
(i)   to undertake the most detailed modern survey of one of the most famous monument complexes in the country.
(ii) to introduce a range of modern geophysical and other survey techniques rarely, if ever, used in Irish archaeology.

During the initial years, research has concentrated on carrying out a detailed archaeological survey of the hill and its environs so as to establish a base-line for all subsequent archaeological work. The measurements obtained by the field survey were then fed into a computer which compiled detailed contour drawings or profiles. This automated topographic survey has successfully recorded even sites which have almost disappeared at ground level. By stretching these plans vertically on screen, it is possible to

create in relief their original outline. In this survey four different methods were used -

>   topographic surveys
>   aerial photographic surveys
>   geophysical surveys
>   geochemical surveys

The latter three techniques have provided evidence for human activity, where no surface evidence exists at present. Artifact research was also carried out.

INVESTIGATIONS

The overall survey has made a major contribution to the archaeology of the site. Its geophysical components are the largest carried out in Ireland and from the outset this technique proved positive as it located an unexpected number of features (Fig. 8). The work is, therefore, something of a watershed in Irish archaeology. As already mentioned, geophysics was only one of a range of archaeological techniques used in the survey. A significant aspect of the project is the integration of these data sets, most of which has been accomplished through the medium of a geographical information system (GIS). After testing successfully the potential of geophysical prospection techniques at Tara and the proposed strategy of combining data from a range of different survey techniques in GIS, in the first year of survey, this strategy was pursued for a further two years.

RESULTS

An outstanding aspect of the research is the evidence that has emerged for a major increase in the number of monuments on the hilltop; the number has doubled from thirty to sixty. Although the highest number of monuments occurs there, another most significant development has been the establishment of the fact that the hill is a core, albeit a most significant one in view of the

number of monuments it contains, and that there is a concentration of monuments in the immediate hinterland. The frontiers of the complex have now been extended into the surrounding landscape. In this Tara complex, there is a range of monuments varying from large-scale sites like Ráith na Riogh to small earthworks. While at least one ringfort exists, Tech Cormaic, the majority of the sites appears to be barrows and ringditches. It therefore seems that there is a high ratio of ritual monuments. Another important aspect of the work has been the development of the proposition for an eight stage/phase development of the core of the complex over a period of three to four thousand years. This is based on the study of the physical relationship between monuments. Without a comprehensive dating programme, such as excavation, the sequence of monument construction or the duration of that work cannot be accurately determined. However, from the slender evidence available, activity took place during the Neolithic, as testified by the construction of the passage tomb known as the Mound of the Hostages (Duma na nGiall), and may have continued into to the first millennium AD as is evidenced at Ráith na Seanad.

The initial programme of research has demonstrated the value of the utilisation of scientific non-invasive means to locate sites. It has been established that virtually the entire hilltop is carpeted with sites. It has not yet been established if monument construction continued steadily from the Neolithic onwards or if a peak or peaks in building occurred. As most of the monuments are of the ring-barrow/ring-work type, perhaps the main period of earthwork building took place during later prehistory.

One of the more problematical aspects of any such survey concerns the identification of the catchment area defined as an economic and socio-religious entity. For the purposes of the Discovery Programme survey, an area of about 100km^2 around the Hill of Tara was examined. Even though this was defined at

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the start of the survey, before detailed familiarity with the area and its monuments was gained, there are grounds for suggesting that it approximates to the natural catchment area of the Hill of Tara and so provides a useful working model. About eleven potentially prehistoric ritual monuments are known in this area. Although this is by no means a small tally, nevertheless, it does serve to highlight the great concentration there is of monuments on the Hill of Tara itself, indicating that it was the primary focus of activity. But despite this we now have to consider the hill as only part of a wider complex, a complex that embraced the immediate hinterland. Therefore, Tara is much more significant and more extensive in area than has hitherto been realised or anticipated. Perhaps this entire area constituted a ritual landscape but even so it could only have flourished as part of a materially developed farming society. But the importance of Tara is not only testified archaeologically, its importance is confirmed by the historical/literary evidence.

THE LITERARY AND HISTORICAL STUDY OF TARA
(Research Fellow - Edel Bhreathnach)

INITIATION

This is part of the wider study of Tara that is being carried out parallel to the archaeological research. Since George Petrie wrote his essay 'On the history and antiquities of Tara Hill' *(Transactions of the Royal Irish Academy 18 (1839), 25-232)*, over one hundred and fifty years ago, critical analysis of the historical and literary sources relating to Tara has been slow to advance. While important texts have been edited and translated enabling historians and mythographers to disentangle fact from fiction in the literature associated with Tara, much elementary work on the documentary sources remains to be tackled. The purpose of the Bibliography is two-fold. The introduction is a historiographical survey of texts which are most relevant to our understanding of Tara and of the main themes which have been the focus of scholarship. It contains a general thematic assessment of the published material presented in the Bibliography and may be read independently of the Bibliography itself. The latter is an annotated and select bibliography of the published material relating to Tara, divided between primary and secondary sources and subdivided into a series of categories. A wide range of material is included so as to give an extensive impression of scholarly conclusions concerning Tara. An indication is given of the relevance of each entry to Tara. The Bibliography provides a guide to the most important publications on Tara and attempts to establish a chronological framework for the primary texts and secondary works which are included.

INVESTIGATION

This aspect of the Tara Project involves a full survey and analysis of the literary and historical sources relating to Tara. It is a contribution to the provision of a contextual and chronological framework for the origins and development of this important

"Royal" site. The documentation is extensive and combines a variety of data - history, myth, legend. In early sagas, dating from the 8th century onwards, Tara is portrayed as the domain of gods and goddesses, of heroes and semi-divine kings, a centre of priest-kings and a place inhabited by beings from the Other world. The political importance of the title *rex Temro* 'King of Tara' is reflected in sources from the 7th century insofar as any king who acquired this title held a pre-eminent position in Ireland during the early medieval period. This literary and historical research has merits in its own right, but must also be regarded as a study parallel to the archaeological project which seeks to elicit information about Tara utilising different disciplines and material.

RESULTS

There are a number of questions to be answered such as who were the inhabitants of Tara in early historic times, what dynasties held Tara and its hinterland, were kings still being inaugurated there during early historic times? Information on these questions can be sought in a wide range of documentary sources - annals, genealogies, hagiographies, sagas and others. In examining these sources it must be kept in mind that not only is Tara a place, it is also a concept or symbol of power. The initial task was to survey the published material so as to produce a bibliography from already published sources (see above). This would facilitate further work as these references, if elucidated systematically, shed light on the dynastic claims to the kingship of Tara among the rival dynasties of early historic Ireland such as Ulaid and Uí Néill. As kings of a region of primary economic and political importance, the kings of Tara were on occasion the most powerful kings in Ireland and sought to dominate other kingdoms. During the 10th century, however, the rise of Viking Dublin eclipsed Tara. Nonetheless Tara continued to appear in the literature of the 11th and 12th centuries as a symbol of strength, nobility and legitimacy of power. Critical analysis of the sources is continuing. As yet archaeology is silent on these later stages of Tara, nevertheless the

documentary evidence indicates that Tara may have been inhabited, or if not at least played a role, during the early historic period.

A PALYNOLOGICAL STUDY OF LANDSCAPE AND AGRICULTURAL DEVELOPMENT IN COUNTY LOUTH FROM THE SECOND MILLENNIUM B.C. TO THE FIRST MILLENNIUM A.D.

(Research Fellow - David Weir)

INITIATION

In addition to the four main projects, minor projects were also initiated. The main purpose of these studies is to identify potential areas of more extensive research in the future or to study in detail a limited problem. The Tara literary historical study was one; this palynological study was another. The latter is a study of landscape and agricultural development in Co. Louth from the second millennium B.C. to the first millennium A.D. The potential of this area for palynological studies has already been established by Professors Mitchell and Watts who have shown that at one site, the Redbog, several phases of agricultural expansion and retraction can be identified but, in particular, that an increase in cereals occurs during the first millennium B.C. It should also be noted that Irish palynological studies tended to concentrate on areas which to-day have a poor agricultural potential. Therefore, for this Programme it was considered necessary to study areas of high agricultural potential as such areas would probably be the most productive in expanding our knowledge of the picture that is already available for the more marginal areas. It was also hoped that the results obtained would provide a wider environmental setting for the core period projects. The main objectives of the research were -

(i)   defining what vegetational changes took place in early times.
(ii) the assessment of the development and scale of arable agriculture.
(iii) the evaluation of the issue of agricultural expansion or contraction, climatic change and population change.

Other problems evalued were -

(i)   were fluctuations in the total arboreal/non-arboreal pollen
      values across the last millennium B.C. and the first millen-
      nium A.D. related to increases or decreases in the general-
      population?

(ii) were fluctuations related to periods of ameliorating or dete-
      riorating climate?

INVESTIGATION

Three sites were selected for study. These were a raised bog,
Redbog, and two former lake sites, Essexford Lough and
Whiterath bog. In general detailed analysis demonstrated that -

(i)   increasing clearance pressure was exerted on the woodlands
      from the Early Bronze Age onwards.

(ii) several phases of woodland contraction or expansion were
      defined. These can be linked to developments elsewhere.

The analysis showed that detailed differences existed between the
three sites but nevertheless, a broad correlation was established.
The evidence provided by the Redbog is the more detailed. In
the main this shows that during the Neolithic and Bronze Age,
the woodland was being continuously disturbed. An intensifica-
tion of forest clearance and agricultural activity about 2300 cal
B.C. could coincide with the introduction of the metal axe.
Despite the clearances from Neolithic to the end of the Middle
Bronze Age agricultural practices would have been conducted
within a predominately forested landscape; for most of the pre-
historic period woodland clearance was largely to create grassland
areas.

From the point of view of the core research of the Discovery
Programme it appears that from the beginning of the Later
Bronze Age (c. 1300-1200 B.C.) intensification in clearance took
place as well as an intensification of farming activity. The arable
aspect of the economy appears to have reached its height between

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about 1300 - 800 B.C. Increase in grassland was pronounced, particularly in the couple of centuries after 1000 B.C. (Dowris phase). It is for that stage that the most intensive clearance is recorded in the pollen record. From the end of the Bronze Age (c. 800 - 700 B.C.) and during the remainder of the first millennium B.C., all three sites indicate that woodland regeneration took place, it appears that there was reduced human activity and agricultural practices. However, both Essexford and Whiterath indicate that around the end of the millennium forest clearance was taking place and that the area of grassland was again increasing, another pastoral phase was emerging.

From early in the first millennium A.D. a major clearance phase took place, the area of grassland increased and mixed agriculture was practised, indeed a high level of agricultural activity was apparently maintained. This would have been a significant economic stage but around 500 A.D. or so this period of apparent widespread farming activities was curtailed and woodland regeneration took place.

RESULTS

It has been demonstrated that in the north Louth area considerable changes in the vegetational history took place during prehistoric and early historic times. Regarding the core period of study there was intensive forest clearance during the Late Bronze Age and again during the later Iron Age. But the Early Iron Age was characterised by forest regeneration. The results of the research have wider implications. The horizons which have been isolated, can be broadly correlated across a wide area so change that took place can be considered as approximately contemporary. Like the woodland, perhaps at those times there was also an expansion or contraction in human settlement.

(Chief Surveyor - Barry Masterson)

INTRODUCTION

Since its inception, the Discovery Programme has made it a policy to utilise technology to the fullest extent possible, most noticeably in the fields of GIS and Surveying. In this regard, the Discovery Programme has been at the leading edge in adopting technologies that were relatively new to Irish archaeology and indeed archaeology in general, in that the use of the technology has been an integral part of the research strategies of the Programme. It must be noted, however, that the technologies are by no means new in their own right, it is merely their everyday use within the context of a research programme, such as the Discovery Programme, that is relatively unique. In addition to using the latest technology, the Discovery Programme has also had the benefit of having personnel specialising in the use of survey instrumentation and methods. Over the past five years, the survey department of the Discovery Programme has built up an expertise in the recording, processing and analysis of highly detailed surveys of a variety of monument types. The advantages of having a qualified survey team dedicated to providing for the needs of the research archaeologist are two-fold. The archaeologist is free to carry out true research work, while professional surveyors, experienced in archaeological survey techniques, provide high quality measurement data and support for most technical matters.

Advantages of Survey technology:
The merits of using such techniques speak for themselves:

- A detailed record can provide valuable information to aid in the interpretation of a particular site, or allow the identification of diagnostic features for a site class.
- In the case of excavation, the detail survey should be consider-

ed a pre-requisite, as it provides a permanent and precise record of the site at a time before the disturbance caused by excavation. Such a survey will also aid in the interpretation of the association between excavated features and surface details.

- The digital survey is more than just a map. The record of the site is a dynamic one, defining a mathematical model of a surface. It is possible to apply functions to the data in order to extract further information; volume calculations for example.
- The number of ways in which the data can be represented is only limited by the imagination of the end-user, due to the digital nature of the data.
- When controlled correctly, other digital data sources are directly compatible with the digital survey data. This enables combinations which may ease interpretations. Geo-physical data is a prime candidate for this kind of treatment.
- It is possible to link this data to a national or global control system, thus easing its entry into the GIS environment.
- Most importantly, the integrity of the original data-set is always maintained, providing a permanent, and detailed, record of the site as it existed at the time of the survey.

How is it used?

There are many options open to the archaeologist when it comes to choosing a survey method. The preferred method of detail survey used by the Discovery Programme is the use of the total station, an instrument combining the electronic theodolite and Electromagnetic Distance Measurement (EDM) unit. When combined with a field-computer, or data-logger, this enables the collection of large amounts of measurement data at speed. All of this data is, of course, in digital form, providing the archaeologist with a comprehensive record of the site as it existed when the survey was carried out.

In carrying out a topographical survey of a monument, the 3-dimensional (x, y, z) co-ordinates of points on the surface of the mo-

nument are recorded. Measurements are taken in relation to fixed control points over which the instrument is positioned and sample points are chosen to define changes in surface morphology, such as breaks in slope. On completion of the survey, the data is down-loaded onto a PC for processing through a survey software package to reduce the measurements to a basic linework plan and a listing of 3-dimensional co-ordinates. From the co-ordinate listings, a mathematical model of the ground surface, or Digital Terrain Model (DTM), is generated which often forms the basis for subsequent representations and analysis. This may be in a variety of formats, both graphical and numerical.

There are many methods available for DTM generation. In basic terms, a grid is calculated from the sample points distribution with the height for each grid intersection point interpolated from the surrounding spotheights. Perspective views of this 3-dimensional grid can be generated by varying view-points to produce an illustrative graphic of the site. This provides a simple method for visualising site context and morphology. In addition, this technique has the advantage that some of the parameters of the model can be varied to aid in the visualisation process. For example, the vertical axis of the DTM can be exaggerated to highlight low relief features that might otherwise go unnoticed. As well as being useful for visualisation purposes, the DTM forms the framework for creating the traditional style contour plan. These can be generated to any desired contour interval; although attention should be paid to the accuracy of the original measurements when generating very small intervals. A small contour interval will display the finer details of monument morphology, similar to exaggerating the vertical axis of a DTM. While the contour plan may not always provide the same ease of visualisation as a perspective view of a DTM, it presents a geometrically correct graphical model from which dimensions and relative height differences can be scaled (see Fig. 5 for an example of a DTM and Contour model).

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A third form of visualisation is the hill-shaded model, where the DTM is treated as a solid surface, rather than a wire mesh. It is then possible to render the surface and simulate the rays of light from a virtual sun within the computer environment. This has the effect of creating an image that falls into our pre-conceptions of reality more readily than the more abstract visualisations provided by either the wire-mesh DTM or contour plan. The hill-shaded model can be presented either in plan form, for a scaleable representation, or as a perspective view for general visualisation (see Fig. 6).

In an archaeological context, this means that the size, morphology, local setting and structural features of a site can be represented in a variety of formats, simplifying visualisation and thus conveying more information. In addition to this basic prerequisite, the digital model of the monument or landscape can provide additional information through proper interrogation and manipulation of the data. Volume analysis, profile generation, intervisability studies, re-construction and de-construction are all possible using the digital model.

To date, the Discovery Programme has carried out detailed surveys on over 120 separate sites, including the vast complex of the Hill of Tara. In association with the various projects, other sites range in size from entire hillforts, such as Carn Tigherna, Co. Cork, and the stone forts of the Aran Islands, through medium sized complexes of enclosures and field systems, to small scale sites such as *fulachta fiadh* ("burnt mounds"). Compared to the majority of general survey tasks, archaeological monuments require a special attention to detail to guarantee correct representation. Every site has had its unique challenges which have helped in the development of the survey teams techniques. New approaches to detailed survey have been created by the Discovery Programme over the past number of years, due to the subtle nature of most archaeological monuments. This has meant an

increase in efficiency and better quality results. To this end, the Discovery Programme survey team endeavours to perfect the art behind the science of archaeological survey.

GEOGRAPHICAL INFORMATION SYSTEMS
(Manager - Paul Synnott)

The development of a geographic information system in Irish archaeology is in its infancy and we are only beginning to understand its potential as a research tool. The Discovery Programme is exploring different archaeological problems with GIS by means of integrating, manipulating and analysing relevant information in a way that will help us understand and address many of the questions that are posed in Irish archaeology today. Consequently it is at the forefront of this development in Ireland. A brief examination of some of the modelling and research activities will serve to illustrate how GIS is currently applied in an archaeological research capacity. Various areas of activity which have greatly influenced archaeological research in this country will be briefly discussed.

(a) Data mapping

There are two aspects to the mapping requirements of the Discovery Programme. Firstly, archaeologists are concerned with identifying and analysing patterns of behaviour apparent in the spatial and temporal distribution of past material remains. Consequently the ability to map not only individual sources of information but also to link numerous data-sets together is of vital importance. Secondly, working in a research capacity one is constantly looking for new ways of representing archaeological information. Archaeology, while not readily recognised as a multi-media profession, by nature of its definition is a subject which encourages participants to work in an environment which constantly draws on information from multiple sources. Currently information from many different government and commercial organisations as well as specialist information is utilised. It stands to reason then that a primary requirement is to have the ability to extract from these various sources relevant information enabling the creation of in-house multi-data mapping.

This approach to interactive mapping is enabling archaeologists to view their material in different forms, and, to look at new ways of utilising archaeological information in order to gain maximum benefit from the combined effect of various data sources. The traditional two dimensional map has now been complemented by adding a third dimension to the information thus providing the archaeologist with greater insight to the surface characteristics of archaeological sites and their context. Three dimensional mapping enables the archaeologist to stand back and analyse spatial and topographic information in a dynamic environment.

One of the main features of a geographical information system is its ability to link graphic information to an underlying textual database. The archaeologist can now not only generate maps from vector or raster-based sources but can create maps directly from attribute information from individual or combined data sets. The archaeologist not only interprets the graphical content of archaeological information but also has the ability through mapping to access information contained in multiple databases.

(b) Data Manipulation
Surface modelling is deployed on two levels: firstly, at the macro or regional level where archaeology is viewed in the wider context of the landscape and the real world. Secondly, at a micro or site-specific level where more detail about a particular site and its environs is required in order to manipulate and analyse information at a local scale. Landscapes and regional zones are modelled from the 100ft (32m) contour information on the ordnance survey 6″ (1:10560) mapping. In addition, this information is augmented with spot elevations from the same mapping thus providing a basis for landscape modelling. Other geo-referenced datasets: soils, geology, aerial photography *etc.*, are draped over the surface model to portray information in three dimensions. However, more importantly this type of landscape modelling visually de-

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scribes to the archaeologist the physical nature of a study zone or region (highlands, lowlands, river basins, catchment areas *etc.*) and also describes the spatial relationship between these features.

At the more detailed level of site-specific manipulation and analysis sites are surveyed at varying degrees of detail depending on the archaeological requirement. At this level the information is again utilized in many different ways from simple graphical illustrations of the site (contours, 3D models, sections and profiles) to intense manipulation and analysis of the underlying micro-topography (low profile sites, siting/terrain relationships). As previously noted hill shading techniques play a vital role in analysing the micro-topography of a particular site or landscape.

The Discovery Programme has recently embarked upon a programme of geophysical manipulation and interpretation and as a result has opened up a whole new area of archaeological exploration. Archaeologists have always looked to the geophysicist for information relating to the subterranean world of archaeology. By manipulating the information first hand a range of images of the same data is produced thus optimising the archaeological interpretation. The raw data is being integrated into the GIS by firstly, writing a programme to convert the data from its raw form into a readable format and secondly by manipulating this information using the powerful raster processing tools of the GIS.

The geophysical data simply becomes an additional dataset for manipulation, analysis and mapping. The raster images on topographic models were overlaid so as to enable the archaeologist to compare and contrast the relationship between subterranean features and those features which bear a physical presence on the terrain. It was also possible to take the geophysical data and computed through much the same process as terrain modelling to produce a three dimensional geophysical model. This enables the

archaeologist to ascertain some of the morphological details of subterranean archaeological features.

(c) Data Analysis
A fundamental requirement of the Discovery Programme is not only to have the ability to create colourful maps nor to constantly manipulate our information into new forms and ideas but moreover to have the ability to analyse in depth the degree and nature of the archaeological information acquired from third parties or generated in-house.

Site Catchment Analysis is a method of obtaining and comparing information about the area surrounding a site rather than the site as a point. It is assumed that the placement of sites by past communities was made with an understanding of the surrounding landscape and the choices made in placing sites reflect that knowledge and priorities of the community. Since the advantages of site catchment analysis over less formal interrogation of the landscape lie in standardisation, integration, and the ability to compare wide bodies of data a GIS has obvious advantages for its implementation.

Spatial assessment of data, in the form of map examination, is a mainstay of most archaeological research. When working at a regional and sub-regional level our accuracy is such that we can move from assessment to more formal analysis. Once again the ability of the GIS to hold and manipulate large bodies of data make it ideally suited for this task.

Descriptive analysis fall into two classes; the first, essentially a graphic technique, allows the archaeologist to identify general trends in the data and also highlights areas where the distribution is anomalous. The second is a statistical technique that compares certain aspects of the distribution to those for a distribution whose properties are known. As a result archaeologists can com-

pare the distribution with a random pattern, a clustered pattern, an entirely regular pattern or a combination of these. The similarities and differences give archaeologists a closer description of the distribution of archaeological information.

In order to analyse sites as more than points on a plane it is necessary to use more complicated modelling techniques. The basic idea behind any modelling procedure is to examine what the distribution of sites would be if they were placed according to the principles which the archaeologist considers are important. A simple model might compare the distribution of a certain site type to a single soil type. If the soil is important in the placing of the sites then there should be broad coincidence between the two. GIS allows models to have many more variables and include non-environmental variables such as significant sites and spatial tendencies described by the techniques above. It is intended to apply GIS technology to archaeological excavation in 1997. The very nature of information relating to excavation presents a more detailed approach to development, whereby the process of manipulation involves more complex procedures for database query and geographic analysis.

CONCLUSION

The Discovery Programme is now fully aware of what can be achieved by exploiting the techniques and tools of a GIS. The unique ability of a GIS to incorporate and manage large quantities of spatially distributed archaeological and environmental data has proved to be a major boon to archaeological studies. These early successes in the Discovery Programme have met with an enthusiastic response from the archaeological community at large and even, at this early stage, it is apparent that GIS technology has broadened the parameters of archaeological research in this country. It is envisaged that, in time, this technology will become a standard aspect of archaeological research.

The System

Software: ESRI's ArcInfo rev 7.0.3, supplied by Paradigm Technology, Paradigm House, Dundrum Office Park, Dundrum, Dublin 14. Tel: 01-2690155; Fax: 01-2960080; eMail: mail@paradigm.ie.

Hardware : The core GIS, databases and mapping are held on a Dell PowerEdge 2100/200 file server with 3x4.0 Gbyte SCSI-2 disk storage, which is connected to a Dell Optiplex GXpro200 NT workstation. A local NT network supports 12 pentium PC's and one Apple Power Mac 8500 of which we run five ArcView v3.0 seats. The system also supports an A0 digitising tablet and A4 flatbed scanner. Hard-copy output is provided by six laser printers, one A4 colour laser printer, one A4/A3 Inkjet printer and one A0 eight colour pen plotter.

The establishment of the Discovery Programme was a visionary and academically adventurous initiative. As was stated in an editorial in the distinguished and influential international archaeological journal, *Antiquity*, Volume 66 (1992), 823 this "remarkable initiative comes at a time when integrated archaeological research is wasting away in Europe, ... this makes the bold and enlightened Irish initiative all the more remarkable".

The Discovery Programme is a significant affirmation of the importance that we attach to our heritage, not only from the point of view of pure research but on account of its relevance to current educational, cultural and commercial activities. Further understanding of this heritage, however, can only be achieved through research. Without research our understanding of this heritage would remain at a low level and consequently be devalued. The Discovery Programme values innovation and experimentation and is committed to setting and maintaining the highest scientific standards in archaeological and related research and to promptly making the results available in published form. It is hoped that the first programme of research has made important contributions to pure research but also to methodology and theory. The continuing assistance that the Discovery Programme receives from the Government, specifically from the Department of Arts, Culture and the Gaeltacht but also other branches, in particular the Office of Public Works, as well as the Heritage Council is a remarkable affirmation of the importance that the State attaches to our archaeological inheritance and, equally important, the value that it sees in study and research in this area. The support given by the State for pure research in archaeology and for the provision of conditions for long-term programmes to address fundamental questions is most welcome. The establishment of the Discovery Programme renders it possible to formulate coherent and long-term research strategies, to address specific questions and to make a concentrated attempt to solve

many of the puzzles of the past. It is also policy to foster and promote the development of the Irish archaeological infrastructure. In doing this, the international dimension will remain in the forefront. In all aspects of the work an open-minded approach will be adopted, the Programme will not be guided solely by tradition or by the perceived wisdom of the day.

As is clear from the published reports of the various projects, whenever possible the Discovery Programme adopts an interdisciplinary approach and applies the skills of a wide range of specialists. The integration of artifact and landscape studies is an integral element. Important aspects of research procedures include computerised data storage and retrieval systems. These facilitate analysis of archival material as well as the varied sorts of data required for regional surveys. The research is contributing to the development of theoretical approaches to such aspects of study as archaeological landscapes. It also has wider significance. As a result of the success of the geophysical survey of Tara, another royal site Rathcroghan mound, reputed seat of the Kings of Connaught in the west of the country, is now the subject of a very detailed geophysical and topographic survey (*Archaeology Ireland* 10, No. 3 (1996), 20-23). With the Discovery Programme initiating this form of investigation at Tara, Ireland has become a leader in archaeological geophysics. Since the initial results of the Discovery Programme's survey at Tara were first announced in late 1992, there has been an exponential increase in the use of geophysical techniques in both development sector and research archaeology and a parallel increase in the number of Irish firms and institutional units offering archaeogeophysical survey. The Discovery Programme is justifiably proud of its role as a catalyst in the development of this and other aspects of archaeological survey in Ireland because it measures its success not only in terms of how much it has contributed to the sum of archaeological data, but also what it can contribute to archaeological methodology, both practical and theoretical.

But surveys and techniques are only means to an end and that end is a fuller understanding of Irish society in all its aspects. Taking the results of the first five years of the Programme as a whole, it can be stated that a better understanding of a range of sites, habitation and ritual, has been achieved but more important these integrated research projects have thrown light on the day-to-day activities of Later Bronze Age and Iron Age society, especially on their achievements and their social setting.

The Discovery Programme's first phase of research is now nearing completion. For *Tara*, both the archaeological and literary surveys have been completed and are now published; the remaining three projects, *North Munster*, *Ballyhoura Hills* and *Western Stone Forts* are all at analysis stage with first drafts of the final publications expected by mid-1998. The *Palynology Study* will follow a similar schedule. However, this should not mislead anyone into believing that the momentum of our research is slackening off. On the contrary, in fact.

The Discovery Programme has already embarked upon its next phase of research. As outlined already, the Discovery Programme, while maintaining its focus upon settlement, has decided to adopt a thematic approach to its new research. It is proposed to investigate two new themes, *Lacustrine Settlement* and *Medieval Rural Settlement*. As the first step, feasibility studies on the potential for research in both these areas have been commissioned. These studies will provide an overview of the current state of research in each area, both in Ireland and elsewhere; they will examine the character of the existing database and the opportunities and problems which this presents; they will prepare options for new research, including the possibilities for co-operation with other like-minded European institutions. The Discovery Programme regards both feasibility studies as important pieces of research in their own right and will make them available, hoping in this way to foster debate and focus attention on these two themes. The next stage will be to adopt a detailed plan of action, based on the recommendations stemming from these two reports and to start work in 1998.

The Tara investigations will also move into a new phase, thanks to a specific allocation from the Irish Government in this year's Budget, further evidence - if more were needed - of the continu-

ing political support which the Discovery Programme has won. The study of the early literature surrounding Tara has already advanced into a new phase; this new allocation and the promise of continued support allows us now to consider for the first time a focused campaign of excavation at Tara itself.

In the field of publication we can now look forward to reaping the benefit of five year's research. As many as five new publications will go to press in 1997, with a further three at least planned for 1998. Work will continue towards serving the wider public and not just an academic audience. In 1997, there will be a particular focus on schools, with a new education pack and parallel exhibitions. We are experimenting with the production of replica tools and weapons, with the intention of creating a body of material that can be handled by students and used to teach and bring to life the often dry description of archaeological text. There will be many other ways in which we can reach out to our wider public, through TV, radio and computer applications and these are being explored.

Experimentation with new technology in the field of survey and GIS will continue and we are committed to the sharing of our skills and knowledge. While continuing to expand the parametres of research the Discovery Programme has wider functions, one being its role as a centre for debate and discussion where people can come to visit, learn and teach. We look forward with confidence and anticipation to the full publication of the results of the research on the projects to hand and to the initiation of the second main programme of research. As a result it is hoped that the Discovery Programme will continue to play a pivotal role in contributing to the creation of a comprehensive picture of early Irish society in both its national and international setting.

ACKNOWLEDGEMENTS

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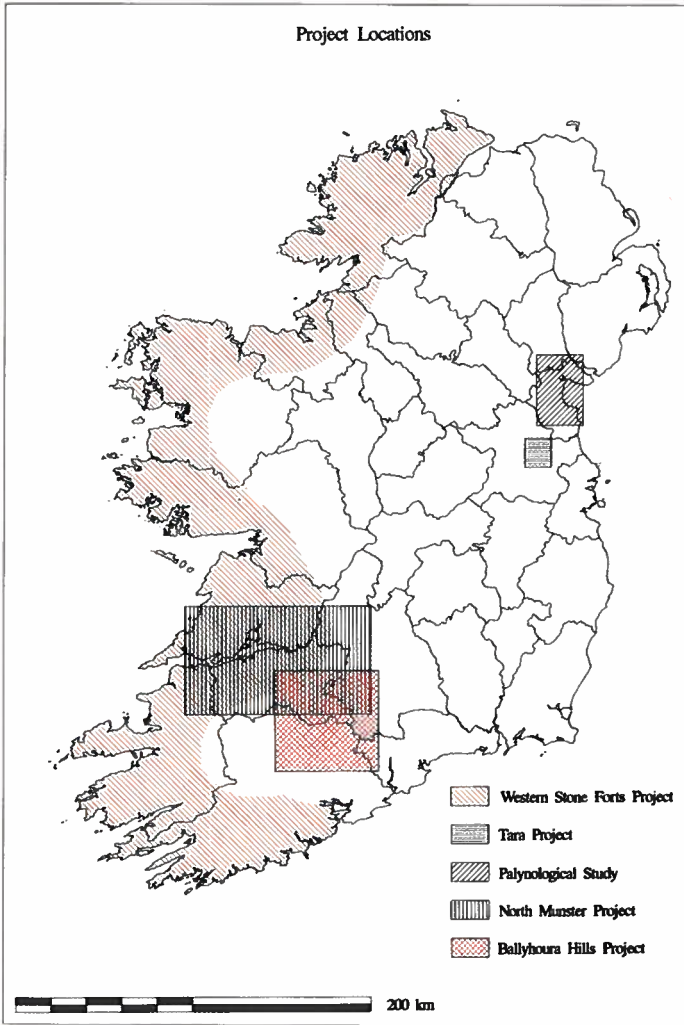
Fig. 1.

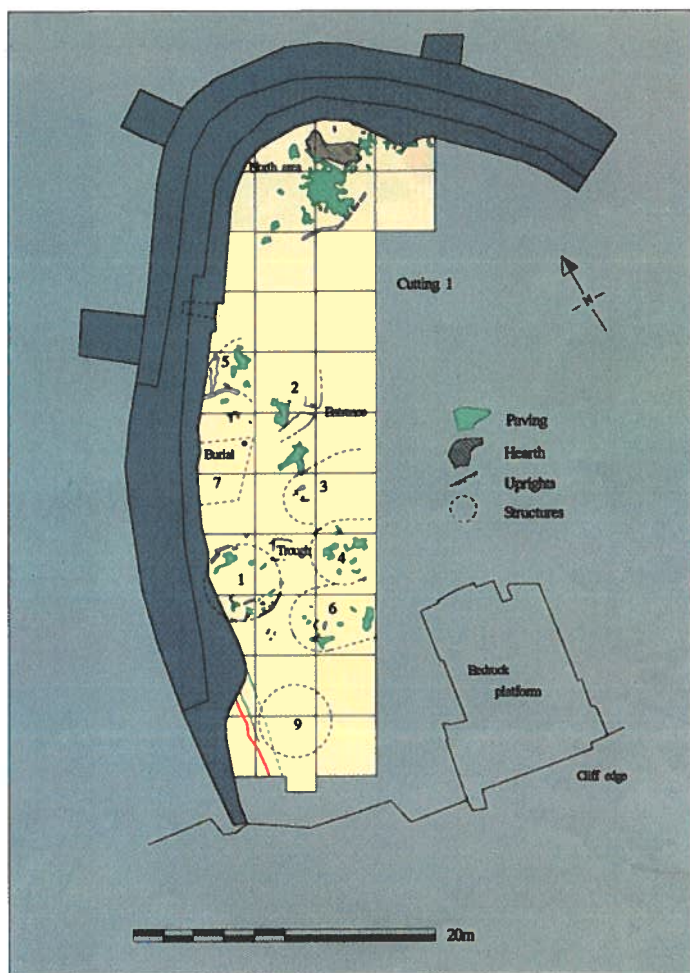Map of Ireland showing location of Projects.

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Fig. 2.

Dún Aonghasa, Aran Islands. Part of Late Bronze Age occupation area. The feature in grey is part of the inner stone wall of the fort. From Cotter *Discovery Programme Reports* 4, Fig. 2.
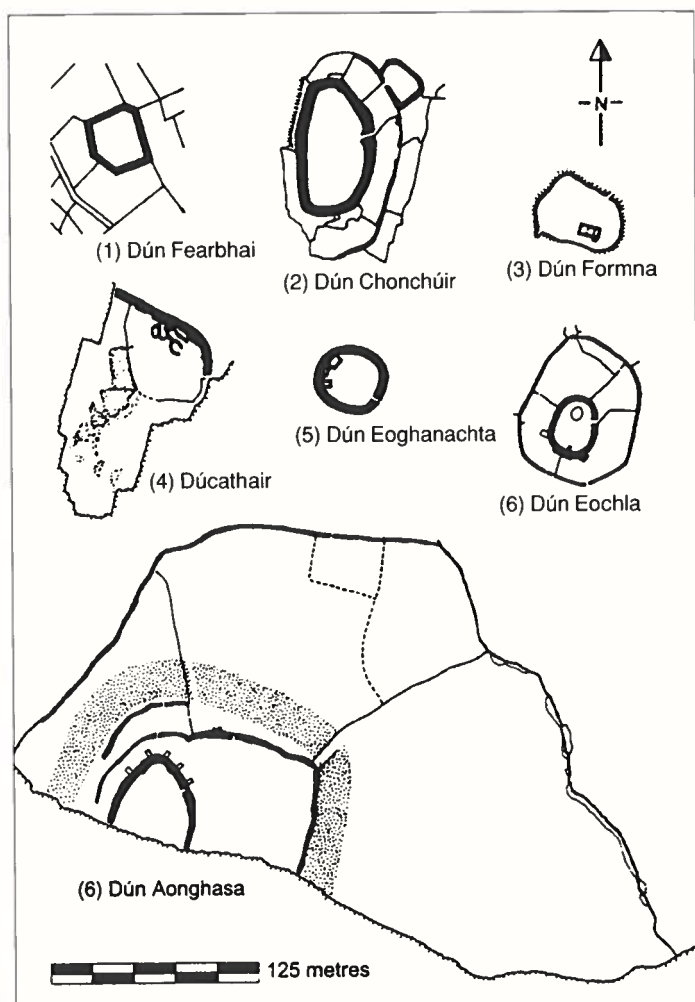
66

Fig. 3.

Comparative size of seven large stone forts on the Aran Islands. From Cotter, *Discovery Programme Reports* 1, Fig. 2.
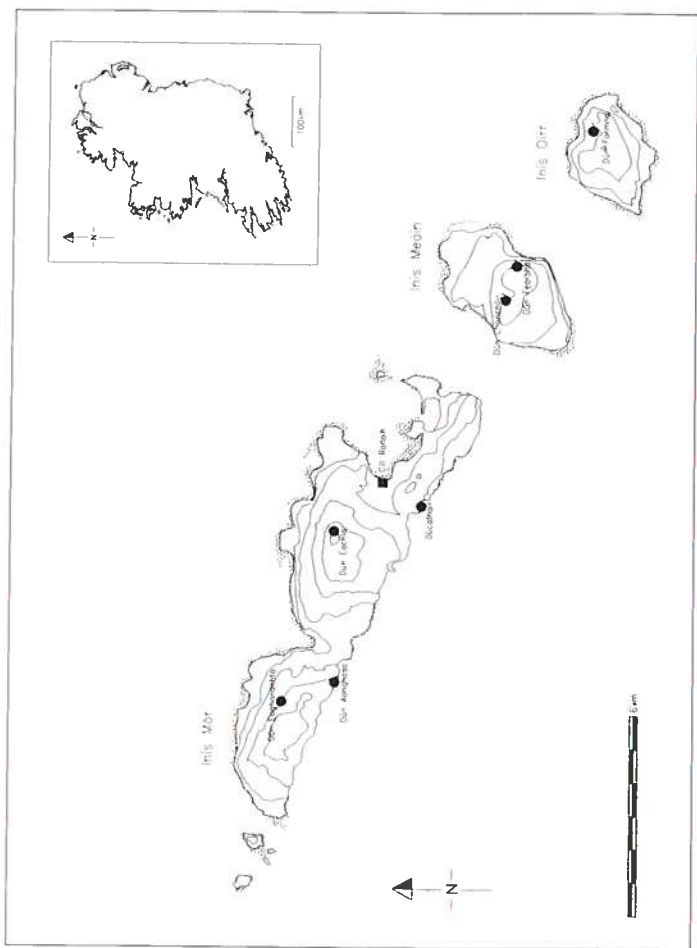
The figure includes the following labelled forts:

(1) Dún Fearbhai
(2) Dún Chonchúir
(3) Dún Formna
(4) Dúcathair
(5) Dún Eoghanachta
(6) Dún Eochla
(6) Dún Aonghasa

125 metres

Fig. 4.

The Aran Islands, Co. Galway: location of the seven large stone forts. From Cotter, *Discovery Programme Reports* 1, Fig. 1.

Digital terrain model

Contour plan

Contour interval: 0.1m   20m
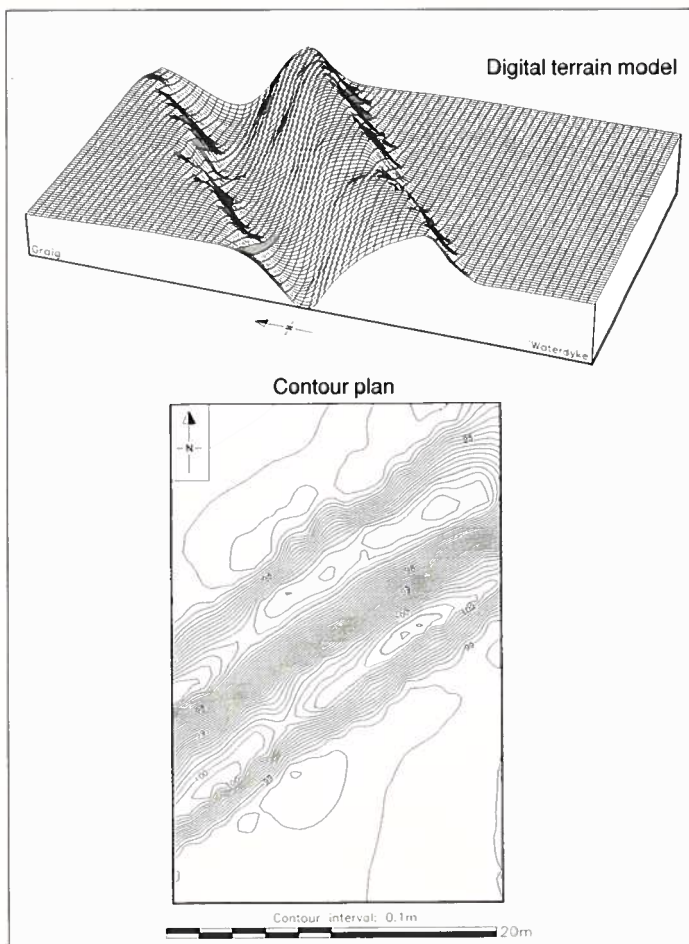
Fig. 5.

The Claidh Dubh at Waterdyke, Co. Cork. From Doody, *Discovery Programme Reports* 4, Fig. 12.

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CASTLE GALE HILLFORT

cairn

North Rampart

Outer Rampart

Entrance

Inner Rampart

A perspective view of **Castle Gale Hillfort** viewed from south-easterly direction. The observer is placed at an azimuth of 135°, an altitude of 35° and a distance of 200 meters from the summit of the hill.
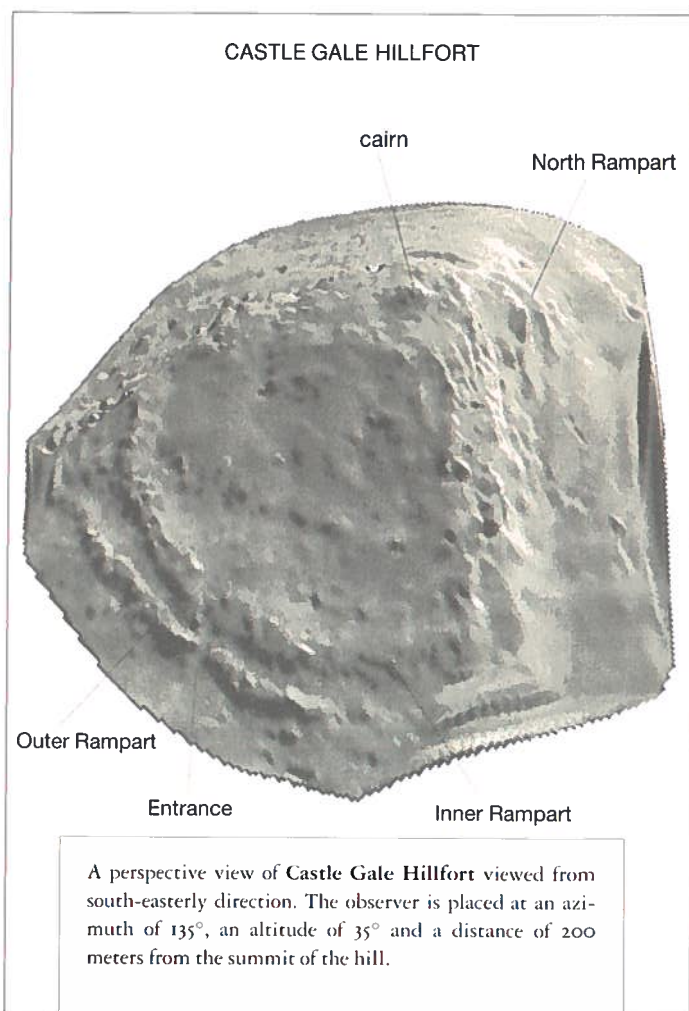
Fig. 6.

A perspective view of Castle Gale Hillfort, Co. Limerick. From Doody, *Discovery Programme Reports* 2, Pl. 15.
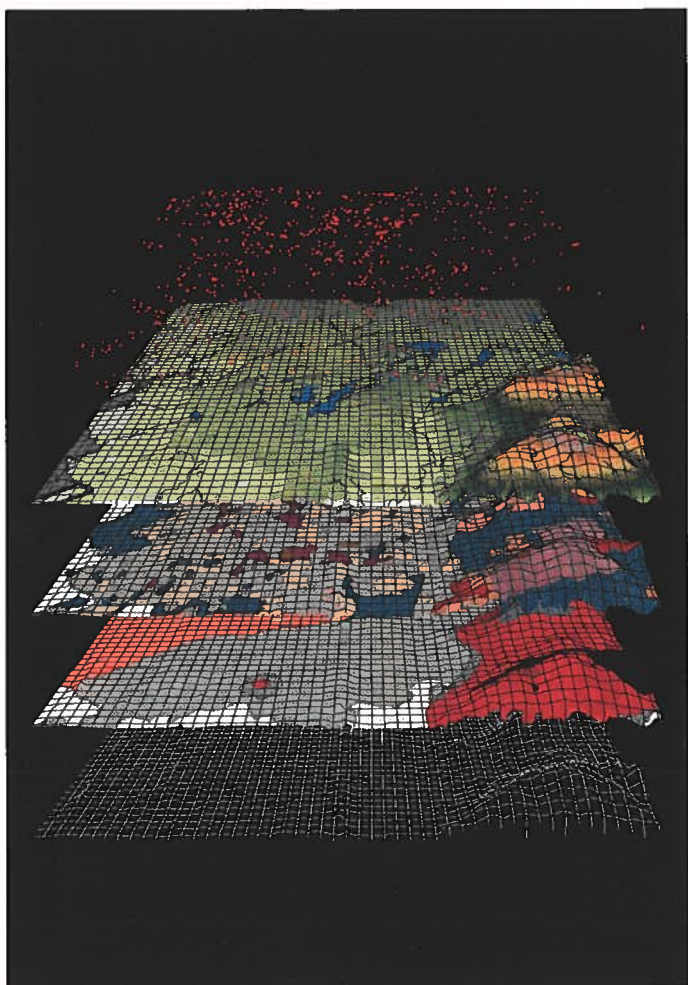
Fig. 7.

The Mooghaun Landblock, Co. Clare.   From *Discovery Programme Reports* 4, Frontispiece.

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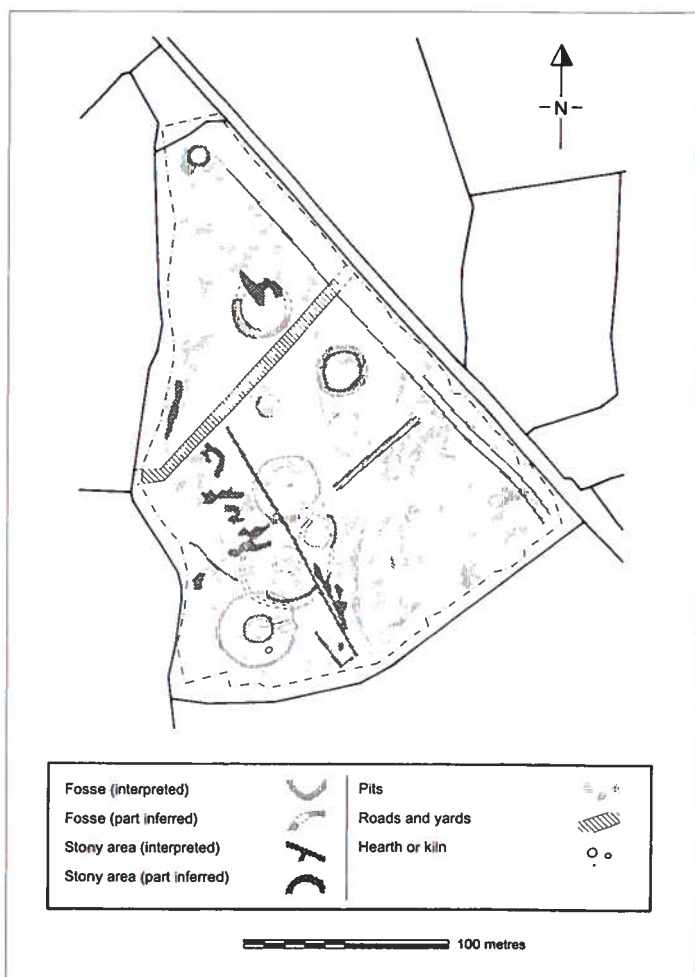
Fig. 8.

Tara, Co. Meath. Archaeological interpretation of geophysical map of area of hill near Ráith Ghráinne. From Newman *Discovery Programme Reports* 1, Fig. 55.