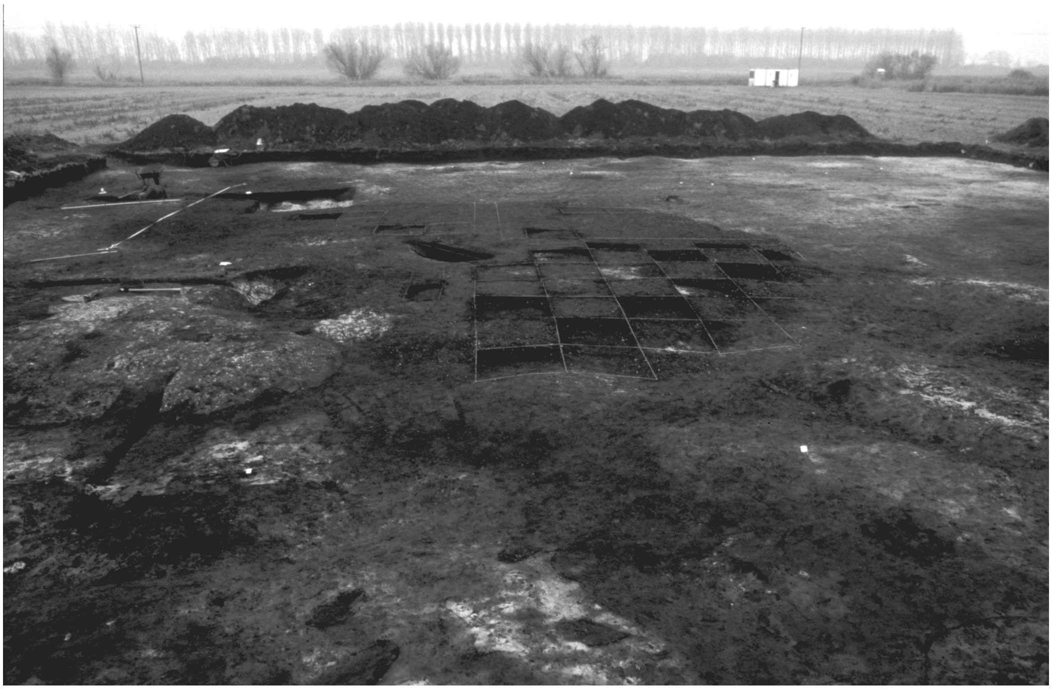
EAST ANGLIAN ARCHAEOLOGY



Frontispiece
The burnt mound after sampling. Photo: Andy Crowson

Hot rocks in the Norfolk Fens: the excavation of a burnt flint mound at Northwold, 1994–5

by Andy Crowson

with contributions by
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Cover illustration
Alder planks lining the base of the central pit. *Photo*: Neil Moss

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Summary

A burnt flint mound in a damp woodland clearing on the Norfolk Fen-edge was associated with a number of waterlogged features. A well and a central pit lined at the base with alder planks produced sherds of Bronze Age Beaker and Food Vessel Urn. A tight sequence of radiocarbon dates was established for the well stratified sequence of activity which occurred over a short period of time starting in cal BC 2265-2165 (at 95% probability) and ending in cal BC 2140-2065 (at 95% probability). The mound overlay earlier pits and ditches of possible Early Neolithic date.

Résumé

Ces fouilles ont permis de découvrir qu'un monticule de silex brûlés situé dans une région de bois humides débouchant dans le Norfolk à la limite du Fen possédait certaines caractéristiques d'un milieu gorgé d'eau. On a également mis à jour des tessons campaniformes (de type Beaker) de l'âge du bronze ainsi qu'une Food Vessel Urn dans un puits et dans une fosse centrale dont le fond contenait des planches en aulne. Il a été possible d'établir une datation serrée au carbone 14 pour une série d'activités, correspondant à des couches stratigraphiques bien définies, qui se sont produites pendant une courte période comprise entre cal BC 2265-2165 (avec un degré de certitude de 95 %) et cal BC 2140-2065 (avec le même degré de certitude). Le monticule recouvrait des fosses et des fossés plus anciens qui remontent peut-être au début du néolitique.

(Traduction: Didier Don)

Zusammenfassung

Ein Hügel aus angeziegelten Feuersteinen in einer feuchten Waldlichtung am Rand des Norfolk Fen stand mit einer Reihe vernässter Strukturen in Verbindung. Ein Brunnen und eine zentrale, mit Erlenplanken ausgelegte Grube enthielten Scherben bronzezeitlicher Urnen aus der Becher- und der Food-Vessel-Kultur. Für eine gut stratifizierte Abfolge menschlicher Aktivität ergab sich eine dichte Radiokarbonmessreihe, die diese Aktivität auf eine relativ kurze Periode eingrenzte, beginnend mit 2265–2165 cal BC (95 % Wahrscheinlichkeit) und endend mit 2140–2065 cal BC (95 % Wahrscheinlichkeit). Der Hügel bedeckte frühere Gruben und Gräben, wahrscheinlich aus dem frühere Neolithikum.

(Übersetzung: Gerlinde Krug)

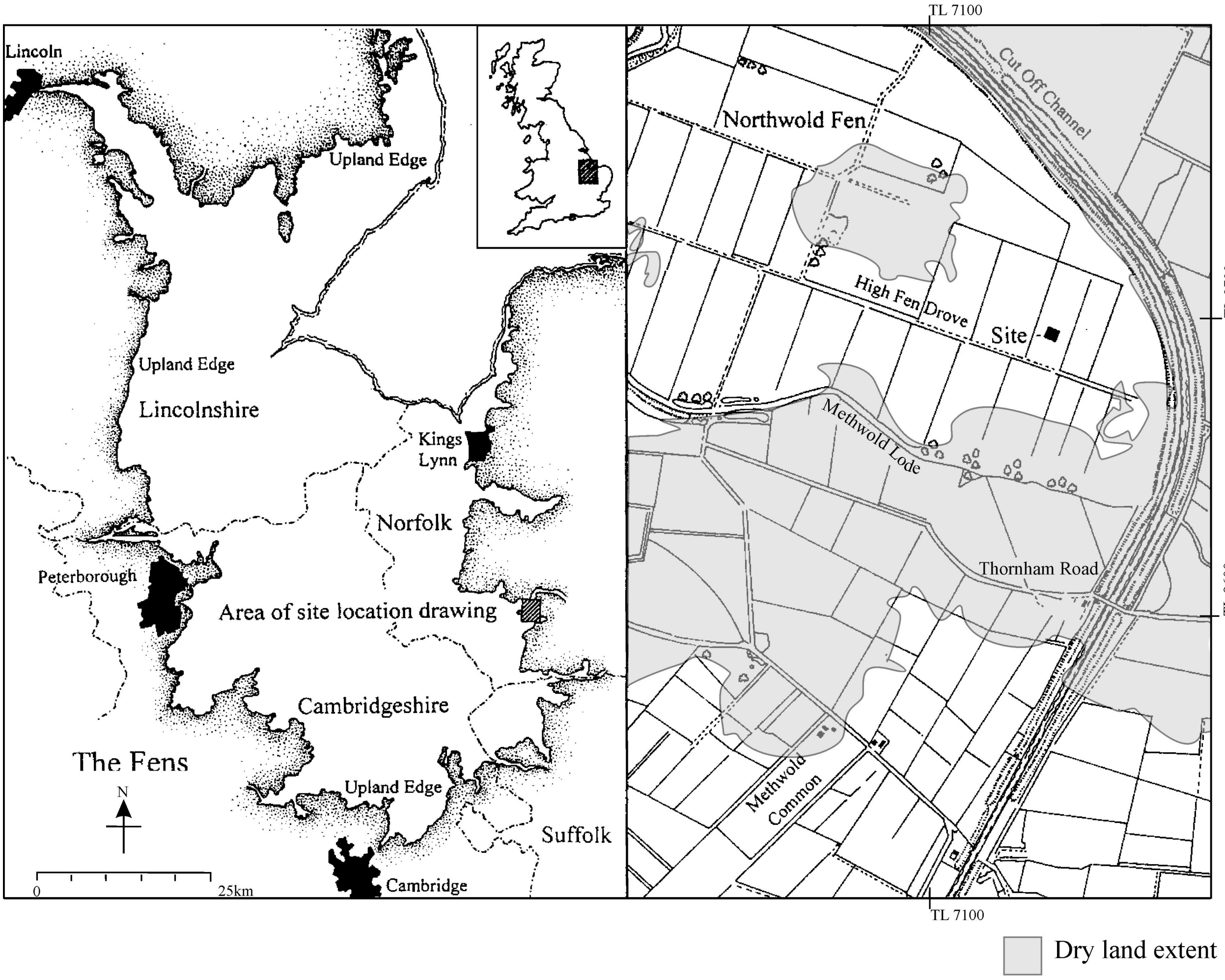


Figure 1 Location map

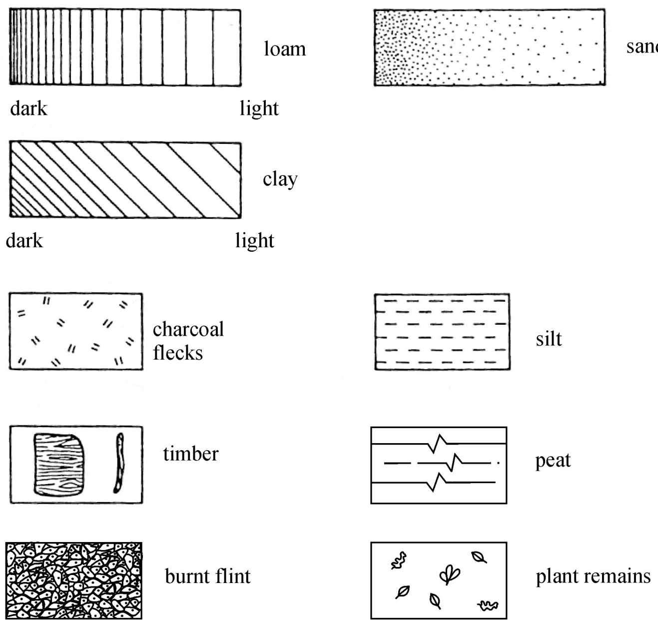


Figure 2 Conventions used in section drawings

Chapter 1. Introduction

I. The site

(Fig. 1)

The Fenland Project

Over a period of thirty years English Heritage funded a series of regional surveys, evaluations and excavations in England's four principal remaining areas of former wetlands: beginning in the Somerset Levels, followed by the East Anglian Fens, the moors and mosses of Shropshire and the North-West, and finally the Levels around the river Humber and the Lincolnshire coastal marsh. The Fenland Project was born out of this developing programme and between 1981–95 its Field Officers conducted fieldwork in the peat- and silt-lands adjacent to the Wash in Lincolnshire, Cambridgeshire, Norfolk and Suffolk. Through collaboration with county archaeological units and successive incarnations of Survey, Evaluation and Management the Project investigated and recorded the Fenland landscape, archaeology and environment over the past 6,000 years. Approximately 60% of the Fenlands' 420,000ha was covered by the Survey, identifying over 2,500 new archaeological sites (Walker and de Rouffignac 2000).

The results of this work have so far been published in eleven volumes of the *East Anglian Archaeology* series, numerous national and regional journals and periodicals, and have been summarised collectively in an English Heritage monograph (Hall and Coles 1994). Other synthetic and thematic volumes from the later phases of the Project have been published in the *Lincolnshire Heritage and Archaeological Reports* series whilst papers on the remaining fieldwork are nearing completion.

Following close on the heels of the Fenland Survey, the Fenland Evaluation Project (FEP) was instigated to appraise the management needs of a representative selection of sites across the Fenland counties. One hundred and forty eight sites considered to be of national importance were included in a programme of additional survey, sub-surface investigation and environmental sampling supported by documentary and photographic study. Assessments of surviving archaeological potential and long-term stability were made against issues of current land use, drainage and the impact of future development or improvement. A summary report of the Evaluation Project data (Coles 1990) presented recommendations on appropriate management responses for each site, those being either *in situ* preservation or archaeological recording. In total, some 51 of the original 148 sites were deemed to require archaeological excavation and recording to a greater or lesser extent. The third phase of the Fenland Project, the Fenland Management Project (FMP), would be the instrument through which the work was conducted.

Excavation of the burnt mound at High Fen Drove, Northwold, between November 1994 and January 1995 was the final piece of fieldwork under the Fenland Project banner (Crowson 1995, 2000a) and the culmination of intermittent work on the feature throughout the Project's lifetime. The site was originally identified through field walking during the Fenland Survey as an exposure of small, burnt flints on a sand ridge emerging through peat ploughsoil (Silvester 1991, 71). Based on specific selection criteria including rarity, fragility, group value and potential, the site was chosen for further investigation during the FEP. This comprised additional field walking, sondage excavation (feature *9* on Fig. 7), environmental sample retrieval and auger traverses over the mound. Although no datable finds were recovered the exercise established survival of stratified burnt flint deposits above a damp buried soil. The groundwater table was recorded at 0.80m below the surface (*c.*0.86m OD), emphasising potential for wet preservation (Leah and Matthews 1990).

In spite of the apparent degree of preservation, active peat wastage and agricultural erosion of the archaeological record were visibly ongoing processes. Intact deposits would be exposed in the near future and further lowering of the water table would cause the site to dry out completely. Long term monitoring of the local hydrology was not a tool used frequently by the FMP and repeatedly assessing the degradation of the mound would have required repeated intrusive sample excavation. Besides, the Project had a shelf-life, was instilled with a sense of purpose to preserve where it could and record where it could not, and with these considerations in mind it was determined that the mound warranted prompt attention. Choice had to be made from three possible responses, restricted by the difficulties of devising effective preservation strategies for such a site within an area of intensive arable land-use.

Firstly, preservation *in situ* through application for Scheduled Ancient Monument status was deemed inappropriate because continued farming of adjacent land would perpetuate damage to perhaps the most valuable aspect of the site — its environmental and organic remains — through reduction of water tables with concomitant land shrinkage and deposit deflation. Secondly, curatorial management to arrest the processes of vertical erosion and decay through conversion of arable to pasture was dismissed for the same reason of inability to control hydrology over a wider area. Thirdly, complete excavation as part of the FMP (Crowson 1995, 2000 a), remained as the only viable alternative.

Research aims

Project aims

The rationale for the Northwold mound excavation must be seen within the broader ambitions of the Fenland Project (Hall and Coles 1994) to which the objectives of individual excavations were expected to contribute. *The Fenland Project: From Mapping to Management* (English Heritage 1992, 5–7) sets out the aims and objectives of the FMP archaeological recording project, stating that 'the primary objective of the project is to secure … a record of the Fenland archaeological landscape as a whole, linked to environmental studies, prior to the destruction of important remains'. It is not appropriate to reiterate here the project design specification contained in *From*

Mapping to Management, and it is suggested that reference to this document be made for a fuller account of the guiding aims and objectives.

In summary, though, the FMP excavations shared common aims set within national research frameworks and priorities. Most significantly for FMP, the document *Exploring our past* (English Heritage 1991) underlined the importance of investigating wetland settlements, environments and landscapes. Using a grouped or themed period approach to site selection, FMP aimed to significantly increase the quantity and quality of research data available to answer particular academic questions identified by the archaeological profession via *Exploring our past*. These included issues concerning land organisation and exploitation through time, questions of subsistence, food production and industry and the shifting economic, social and environmental factors that shaped communities from the earliest times.

The aims would be achieved by providing information on sites subjected to similar processes of decay and disturbance and the rate and intensity of this disruption. It was envisaged that the work would produce more coherent initiatives for future management of the historic wetland landscape, and the fruits of this labour are being drawn upon to formulate new strategies today (see *English Heritage wetland strategy* 2002). In the event, however, 'Fenland Management Project' proved to be something of a misnomer: though it was never intended to be a curatorial body, the advanced state of erosion, desiccation and decay of the majority of Norfolk sites revealed by both FEP and FMP undeniably altered the perception of 'managing' these sites. Irretrievable disruption was all too often the depressing reality — and this on what had been previously determined to be among the best-preserved examples. The 'Management Project' became more of a 'Sampling Project' (a fact acknowledged by Hall and Coles in their summary of the *Fenland Management Project Excavations 1991–1995*, Hall and Coles 2000), as in many cases it attempted to recover what was left. Evaluation trenches often turned into mini-excavations as it became evident that it would be the only investigation many sites would ever survive to see. Managing the problem of site deterioration rapidly extended beyond the scope of the Project: it was eminently difficult to consider the management of sites in isolation when what was needed was to effect control over soil and water over much wider areas.

Site specific aims

Fundamental to the excavation-specific aims was gathering data (structural, artefactual, environmental) that would provide interpretations of how a burnt mound functioned and the purpose of the work. This depended upon successful:

– identification of structural features and their organisation across the mound
– recovery of diagnostic flint and ceramic assemblages
– environmental information surviving in plant and animal remains from the buried soil and any cut features.

Within the context of prehistoric exploitation of fen-edge environments the excavation aimed to answer questions concerning:

– environmental conditions/constraints governing the location, seasonality and duration of occupation
– site activities, operating processes and their function/objectives
– consequent economic modification of the local landscape
– status and economy of the site and its role in the local settlement pattern
– its specific chronology
– comparison of sites of similar period and function within and without the Fenland.

II. Background

Palaeogeography

Northwold is situated in the south-west corner of Norfolk and takes its name from its position in respect to Methwold and Hockwold and 'its situation in an open champaign [sic] country' (Blomefield 1807, 210). Its solid geology is predominantly Cretaceous Middle and Lower Chalk with Gault in the extreme west (British Geological Survey 1985). The parish straddles upland and fen zones, extending principally over Breckland in the east and a number of small stretches of former peat fen in the west. Chalky and sandy ridges and hills fringe the fen and extend out into the peat. The burnt mound is situated adjacent to such a sand ridge close to the present fen-edge (TL 7141 9696).

The surface soils of Fenland are the product of diachronous marine transgressions and freshwater flooding episodes that have in-filled the glacial Fenland Basin over the past 10,000 years or so (Waller 1994, 6–17). These events dynamically affected the type and range of available habitats and hence contemporary settlement opportunities. During the earlier Neolithic the low, undulating landscape of the upland periphery was exposed, partially wooded and partially wet. Settlement activity occurred on the mineral ridges and islands protruding above lower-lying areas and along the margins of a former channel of the river Wissey. Towards the end of the Neolithic, northern marine transgressions, which deposited inorganic clastic sediments, impacted on the formerly large Wissey breaking it down into a series of channels. Impeded drainage and intensified waterlogging created freshwater fen habitats and consequent peat generation. This initiated a shift in the pattern of settlement away from the increasingly isolated islands onto what was becoming a more recognisable fen-edge. The extent of the fen continued to grow during the Bronze Age, and ultimately peat formations submerged occupation sites closest to the upland limit.

Peat growth persisted intermittently throughout the historic period with some areas remaining as open meres (Silvester 1991, 12). Only in the seventeenth and eighteenth centuries was this development arrested by major land drainage and reclamation schemes. Land use in the southern Norfolk Fens in the post-medieval period has seen a concentration on arable farming. Today agricultural tillage, and concomitant drainage, is the single most potent threat to the integrity of archaeological deposits in Fenland. De-watering of the land destroys organic remains and environmental data, and the desiccated peat literally blows away, exposing formerly sealed sites to the plough. Although upland sheep arrive for autumn and winter grazing on vegetable tops, traditional fen pasture has largely been superseded. Root crops now dominate areas of peat with only occasional cereal crops and more recent diversification into market gardening and turf cultivation. At the time of excavation, the volume of burnt flint in the ploughsoil at High Fen Drove gave rise to fears that the site may have been considerably reduced and dried out in the short time since its original identification. Silvester's 'exposure' (Silvester 1991, 71) of burnt flints had rapidly become an expanse that was discovered through augering to be spread over a 30 x 30m area.

A company of mounds

Scatters, spreads and mounds of burnt and heat-affected stone are one of the most common elements of prehistoric landscapes. They are generally considered to be monuments of the Bronze Age, and though their currency extended at least from the later third millennium cal BC into the first half of the first millennium cal BC, regional date concentrations, differences and exceptions are apparent (see 'Dating' below). Use of hot stones has been recorded through to the medieval period and there are many modern ethnographic references of cooking with hot stones and leaves, often in pits, from the rainforests of Australia and Papua New Guinea. There is even a modern day American company named 'Hot Rocks' that manufactures saunas and steam systems. Given their relative abundance it is little surprising then that they can be found on sites of almost any date.

The Thesaurus of Monument Types defines burnt mounds as 'a mound of fire-cracked stones, normally accompanied by a trough or pit which may have been lined with wood, stone or clay' (RCHME and English Heritage 1998). The trough is normally identified as the container in which water is heated through the immersion of hot rocks. In spite of Nina Layard's preference in 1922 for 'heating stones', in Britain these artefacts are historically, most popularly, and perhaps inadequately, termed 'pot boilers'. This nomenclature assumes too much and is misleading in equal proportions. Norfolk's burnt flints appear as crazed or cracked white or grey fragments, the result of heating to relatively high temperatures followed by rapid cooling through immersion in cold water to produce steam and warm the water. During prehistory stones were presumably heated in a direct manner by burning wood or turf on top of them, with the embers raked off when the stones were glowing hot. Re-use of the stone shatters and reduces the size of each piece, but not necessarily its usefulness. Burnt mounds are invariably located near a water source, be it fen, stream or spring, without which there is no mound. They are particularly prevalent in northern Europe, but they are also known from many locations in the New World (see 'Distribution' below).

Pioneering study of burnt mounds began in Ireland in the 1800s, and in many senses the Irish still lead the way with over 4000 examples of *fulachta fiadh* (deer roasts) recorded to date (Buckley 1990, 9). Work during the earlier part of the last century by geological surveyors in Wales (Cantrill and Jones 1906; 1911), and the President of the Prehistoric Society of East Anglia in Norfolk (Layard 1922), continued analysis of these features and reinforced their interpretation as cooking places. This theory is still most favoured in Ireland and the assumption was never seriously challenged until the mid-1980s, when hypotheses of their use as bathing sites and saunas (Barfield and Hodder 1987) heightened the profile of burnt mounds and brought about a contentious archaeological issue. The scope of suggestions was already becoming broader, including steam and hot water for fulling (Jeffery 1991), a range of semi-industrial functions — including brine evaporation, brewing, leather working and metallurgy — and even uses for the burnt stone itself as pottery temper (Ashbee 1983, 95–6; Peterson and Healy 1986, 101). In a slightly more bizarre example, Jivaroan tribes of the Ecuadorian and Peruvian Amazon used hot stones to sear and seal the inside of victims shrunken heads <http://www.headhunter.com>. English Heritage's Monuments Protection Programme, however, has no time for head-hunters in its definition of burnt mounds, asserting 'most are best interpreted as sauna baths' <http://www.eng-h.gov.uk> (MPP Monument Class Descriptions).

In spite of the apparent upsurge in interest in burnt stone mounds, there are few published modern examples from lowland Britain. It is difficult to determine whether opportunities for their excavation have been genuinely limited, or whether in reality they are still viewed as an unattractive target for excavation. Numerous excavated examples are now known from Ireland, where particularly during the last ten years or so national road building campaigns have encountered many burnt mounds. Even so, these have been excavated because they were 'in the way' rather than chosen deliberately. Many examples are described at the excellent web site <http://www.excavations.ie>. North of the English border around 1,600 burnt mounds are listed in the National Monuments Records of Scotland, some of which have been dated by thermoluminescence (Anthony and Sanderson n.d.).

Outside Britain and Ireland, burnt mounds are known from many parts of the Old World and at certain native Indian sites in the New World from Arctic Canada down to Texas and across the Pacific in Oceania (Layard 1922; Binford 1972, 128). Northern Europe stands out, however, as the predominant study area. Survey of *skärvstenshögar* in Sweden has found them to be prolific in central and eastern provinces, with an impressive 6,000 examples (Larsson 1990). In Germany *splittersteinhügel* have been studied in the north (Buckley 1990, 9). Denmark have their *kogensrose*, Norway their *koksteinrøyser.*

At a local scale Norfolk is well-represented with burnt flint 'sites': more than 300 were located by the Fenland Survey on the wasting peat fen-edge from Northwold southwards to Hockwold (Silvester 1991, fig. 49). They are clustered primarily along the foot of the upland and occasionally around the islands in the deeper fen. In the outlying areas they are virtually the only site-type present. What was believed to be the best-preserved example was excavated by the FMP at Feltwell Anchor in late 1992 (Leah and Crowson 1994, Crowson 2000b). In the main, however, they are very limited in extent and more appropriately described as 'spreads' than 'mounds'. Some are clearly part of, or contemporary with, neighbouring prehistoric artefact concentrations, but in total they outnumber these sites by almost four to one. In keeping with studies throughout Europe, close dating of the Fenland burnt flint 'sites' has proved difficult. In the majority of cases all that can be said is that topographically they are situated in locations available to communities of the later third and second millennium cal BC. Exceptionally, a radiocarbon date has been obtained from the Feltwell excavation of 2460–2030 cal BC (GU-5574; 3370±50 BP) (Bates and Wiltshire 2000).

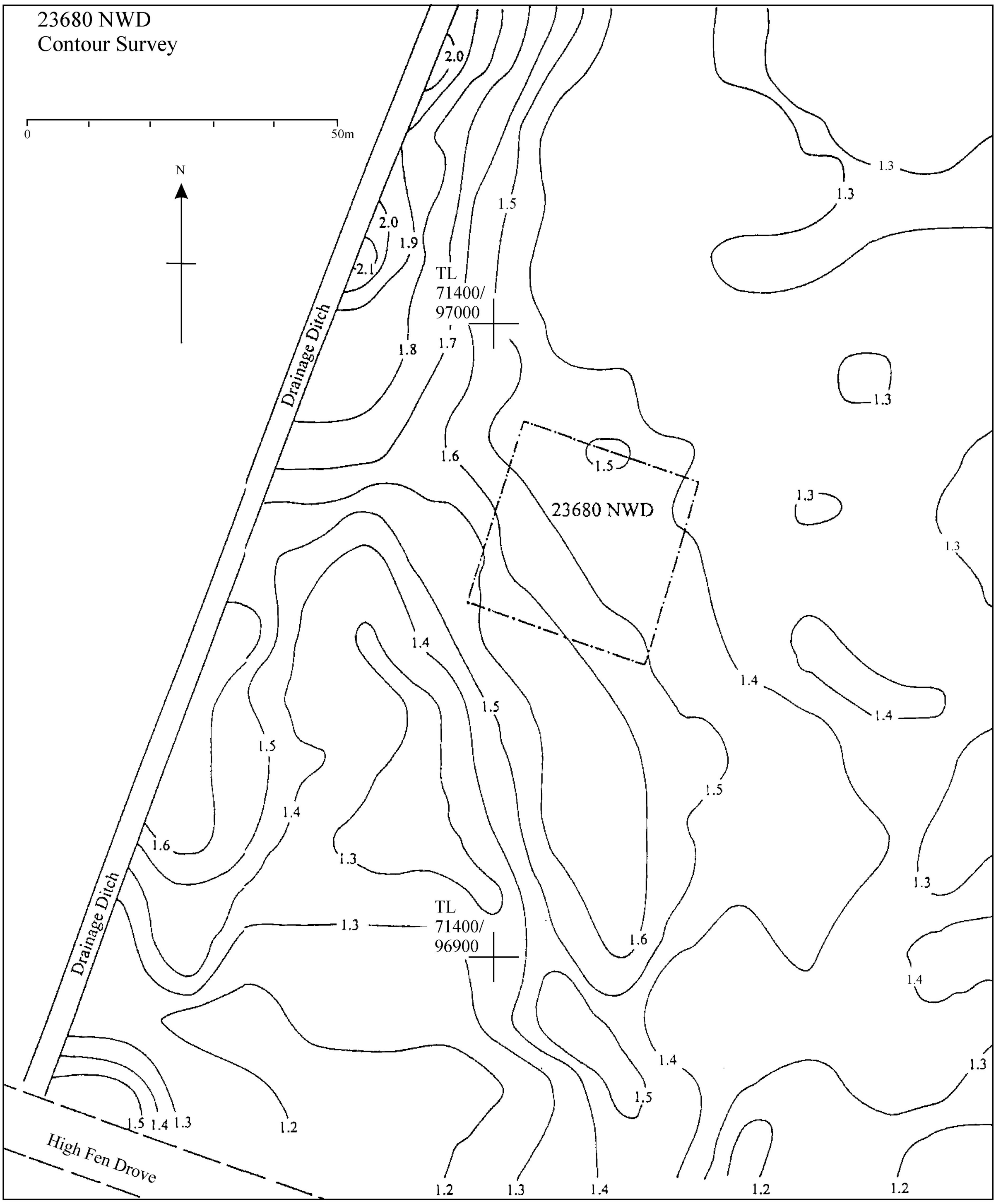


Figure 3 Contour survey (heights in metres). Scale 1:1000

Chapter 2. The Excavation

I. Methodology
(Fig. 3)

Pre-excavation work comprised field walking of $5m^2$ collection units, a comprehensive contour survey (Fig. 3), an auger survey over a regular grid and sieved ploughsoil test pits on and off the mound. A temporary bench mark was established at 1.78m OD and an area measuring 900 square metres centred on the heat-cracked flints was tied in to the National Grid.

Excavation methodology followed FMP practices (discussed in Evans 2000). The FMP maintained a flexible approach to the sampling of individual sites, employing linear trenches, grid-aligned test pit series and open area excavation as circumstances and the nature of the deposits required. This allowed for some inter-site comparison as well as for testing the efficacy of the methods themselves. At Northwold, pits and post-holes were initially half-sectioned and linear features sampled at a minimum of 10m intervals. One barrow-load of spoil from each feature (or 100% of small features) was hand-sieved. Environmental samples were taken where appropriate and stratified artefacts were recorded with three dimensional co-ordinates. Much of the site and nearly all the features were waterlogged throughout the excavation. Whilst at times this hindered identification of deposits, great care was taken to keep contexts, artefacts and environmental samples separate and uncontaminated.

The burnt mound was sub-divided into quadrants and sieved, sampled and excavated on a 1m grid (frontispiece). In the north-west quadrant alternate 1m grid squares were dry-sieved as an artefact check. In the other quadrants this practice was restricted to one representative sample from each of the central and outer parts of the mound. Over the whole of the mound, 30 litre soil samples were taken from alternate 1m squares for flotation. Charcoal fragments recovered from the samples were to be used in a structured programme of radiocarbon dating to investigate chronological sensitivity across the burnt mound and its precise period of use.

II. Geology and natural features

Underlying a peat-based ploughsoil *c.* 0.30m deep, parts of the site were sealed beneath extensive deposits of structured, though desiccated, alder wood peat that had formed since the site was abandoned. This material filled the hollows of an undulating and variable 'natural' subsoil (and, indeed, the upper profiles of the latest cultural features). The uneven subsoil was reflected in the widespread local variations detected through the modern ground surface contour survey. At higher points the woody peat layer had been ploughed away and tractor tyre and plough marks scarred the subsoil. This was most evident in the south-west corner of the site where a hillock of gritty sand was emerging through the peat cover. Elsewhere, grey sands, sandy silts, sticky clay and principally degraded chalk (solid geology) occurred. The surface of this chalk was extensively weathered: in places it was discoloured, loose and crumbly. A typical sequence through the ploughsoil and subsoil is shown in Figure 8.

In part, the range of natural soils reflected water activity on the surface of the solid geology. Moreover, the chalk was 'cut' by numerous pale grey features, ranging from discrete small forms to more extensive linear and curvilinear types. These were situated mainly in the west of the site and eight examples were sample excavated. Each was found to represent infilling of natural depressions, fissures and other irregularities in the chalk. Edges of the features had been softened or eroded by the movement of water. The majority contained laminated light grey clay-silt sediments, the result of water carrying fine material into the voids. Others were filled with accumulations of peaty sand, perhaps derived from tree rooting or indicating the presence of standing water.

III. Pre-mound activity
(Figs 4, 5 and 6, Pl. I)

The buried soil

Apart from the natural features, the earliest recognisable deposit was a pale grey-brown, damp sandy-silt with small flints and occasional organic flecks, context *178* (also *45*, *66*, *86*). Although its survival was patchy across the higher elements of the site, which were susceptible to plough damage, it extended intermittently over most of the excavated area. The deposit was best preserved beneath the protective covering of the later burnt mound, *30*. Typically it measured no more than 0.10m deep although this increased to as much as 0.20m where it filled dips in the natural surface. Its composition varied, seemingly dependent on the nature of the underlying 'natural': thus it was sandier on the lighter subsoil and stickier over chalk and clay. This fact called in to question whether the deposit represented an ancient land surface or merely disturbance and weathering of the subsoil surface, a problem that would be answered through soil micromorphological analysis (below).

Early features

Eighteen features were assigned to an initial, pre-mound, phase of activity. The bulk of this evidence was confined to the south-east quadrant of the site. It comprised a number of elongated pits, smaller pits or post-holes and sections of ditch. All were observed cutting the buried soil, *178*, or the 'natural' subsoil where the former no longer survived. In the vicinity of the burnt mound several early features were sealed beneath a reddish-brown amorphous peaty deposit (*33*, *205*) or cut by later features. Only occasionally was any stratigraphy recorded between the early features themselves. None of the features contained any artefacts, but all have been phased through stratigraphic appraisal and physical characterisation. The find of a single leaf-shaped arrowhead on the surface of the buried soil *may* indicate an earlier Neolithic date for the primary activity.

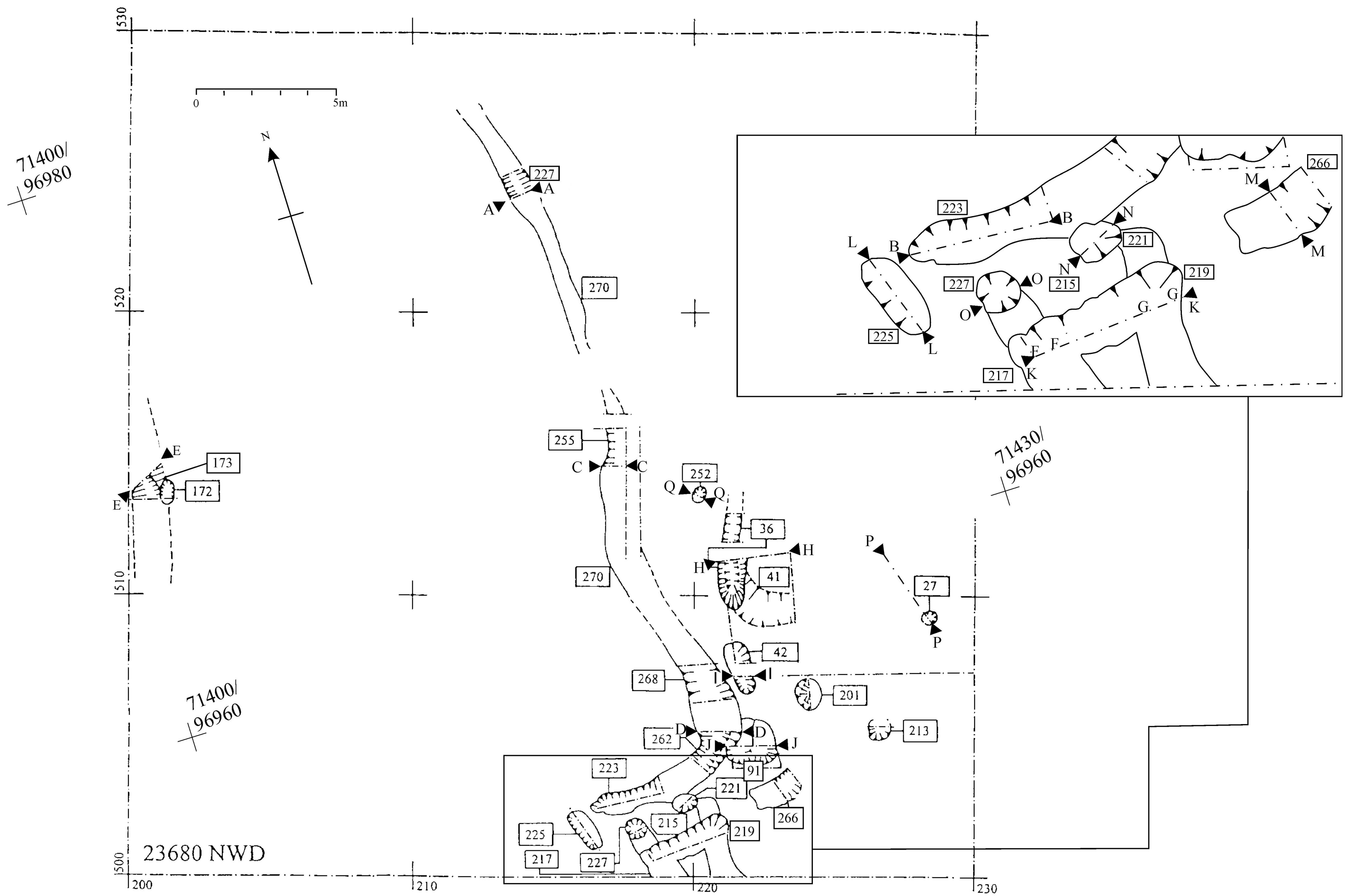


Figure 4 Plan of early features. Scale 1:200

Ditches

The most striking early feature was *270* (segments *131*, *223*, *255*, *262*, *268*), one of six ditches. Following a sinuous north-to-south alignment, it ran for some 30m. At the south end it turned an abrupt corner to the west and terminated. Depending upon relative ground level and its consequent degree of survival, the ditch measured between 0.80–1.50m across and between 0.20–0.70m deep with a moderately sloping profile and a rounded base. It had been filled through natural agencies and was characterised by brown-grey silts with variable sand and clay fractions. Where primary fills could be discerned these were of water-lain clays.

Approximately 17m to the west of *270*, and possibly running parallel with it, ditch *173* was exposed on a similar alignment. Measuring 1.40m across it possessed a comparable width to its eastern counterpart *270*, though it had a broader base and a very steep western edge. This ditch had also filled up naturally with coarse silts.

At the southern end of *270*, where it turned to the west, two adjacent ditch segments *217*, *219*, were recorded. They were between 1–2m apart, roughly on north-west to south-east lines. The position of the three features — inasmuch as they respect each other — suggests that all may have been at least partly open at the same time and therefore performed part of the same function of land division/drainage. Both of the small segments were filled by fine, dark grey-brown silts, and were c. 0.25m deep with gently rounded profiles. It is possible that one replaced the other and, later, each had a small pit cut through or close to its northern terminus and was also cut crossways by a lateral pit *215* (see Pits below).

Two ditches, *36*, *41*, were recorded underneath and to the south-east of the burnt mound, with the latter *41* cutting the former *36*. Ditch *36* appeared as a short section 4m long aligned north-to-south. Its terminus at the southern end was excavated to a depth of 0.47m but to the north it became progressively more shallow and lost beneath the amorphous peat deposit, *33*, that sealed it. The ditch contained accumulated dark, coarse silts. Above *36*, only a ‘corner’ of ditch *41* was observed, where it shifted from a north-to-south direction to east-to-west, the remainder of the feature proving untraceable. Although *41* was the latest of the early ditches, being the only one cut through the peaty formation, *33*, it had nonetheless been substantially cut away by the digging of later pit *23*. The ditch had a broad, shallow profile and peaty sand at its base indicated decaying plant material in standing water. Later features and activity around the mound had contaminated its upper fills.

Pits

The remaining twelve early features were pits, some of which may have been post-holes. Most of the pits lay in the area around the termini of ditches *217*, *219*, *270*. They essentially fell into two types: elongated and sub-circular.

Elongated pits *42*, *91*, *215*, *225*, *266*: the only example that demonstrably pre-dated the ditches was pit *91*, which was cut by ditch *270* (segment *262*) on its western edge. Measuring 1.85m long it had very steep sides and a predominantly flat base. Processes of infilling had created a vertical division between fills to the east and west. This can best be explained if deposit *243* represents the remains of a timber post and the other fills (*82*, *264*, *265*: re-

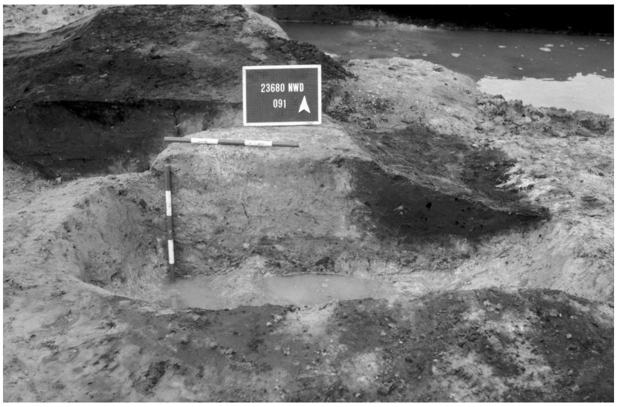


Plate I Early features: pit *91* and ditch *270*, segment *262*

deposited ‘natural’ sands) were layers of packing against it.

Immediately to the north another long, sharp-sided pit, *42*, had been dug close to ditch *270*. It was over half a metre deep and had filled up naturally with brown silty sands over organic ‘mud’ at its base. To the south of *91* a more shallow feature, but with otherwise similar dimensions, *266*, had also silted up with natural coarse, silty sediments. All three pits were considerably cut away by the later digging of pit *23*.

Pit *225* was cut at the southern terminus of ditch *270*. This was 1.5m in length, but little depth survived. The feature appeared to have remained open for only a short period before infilling rapidly with silts identical to those described above. Between *225* and *266* the fifth elongated pit *215* had been dug through the infilled ditches *217*, *219*. It was another steep-sided feature with a flat base and contained naturally-formed grey silts.

Two small round features, *221*, *227*, with diameters of *c*. 0.70m were situated to the north of pit *215* and also cut the infilled ditches. Although the latter had a steeper profile and flatter base, their dimensions were identical and each had been filled by dark grey-brown silts. Whether they served as post-holes or represent the truncated remains of pits is not clear. In the west of the site ovular pit *172* was also cut through early ditch (*173*) fills. It is more certain that this was a post-hole with straight-cut sides 0.37m deep and a vertical division of fills: an organic sand representing the post on the west side was clearly separated from ‘natural’ silts backfilled on the east.

The remaining four sub-circular pits had all been affected by later activity around the mound. Pits *201* and *213* were both extensively cut away during the digging of pit *23* and the creation of the associated bank (*55*) and ditch (*54*). Both had steeply-cut sides and concave/pointed bases and were filled with coarse, loamy sands. Small, shallow pits or post-holes *27* and *252* both contained more organic fills than the other early features. Located beneath the mound itself feature *252* had become contaminated with mound material moving through the soil profile. To the east, *27* was somewhat disturbed and it was not possible to ascertain whether its peat-based fill represented a decayed post or simply natural accumulation.

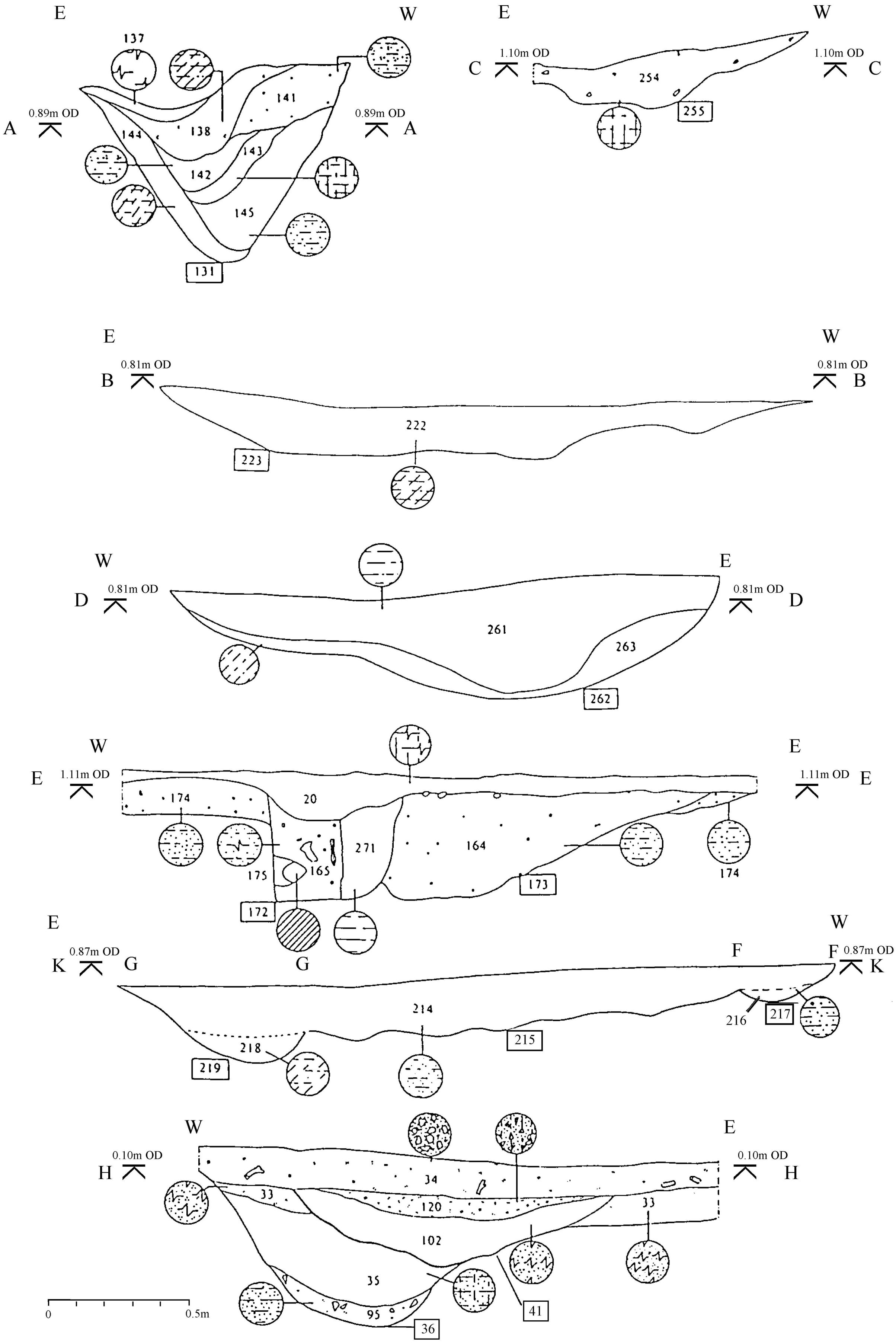


Figure 5 Sections of early ditches and pits *172* and *215*. Scale 1:20

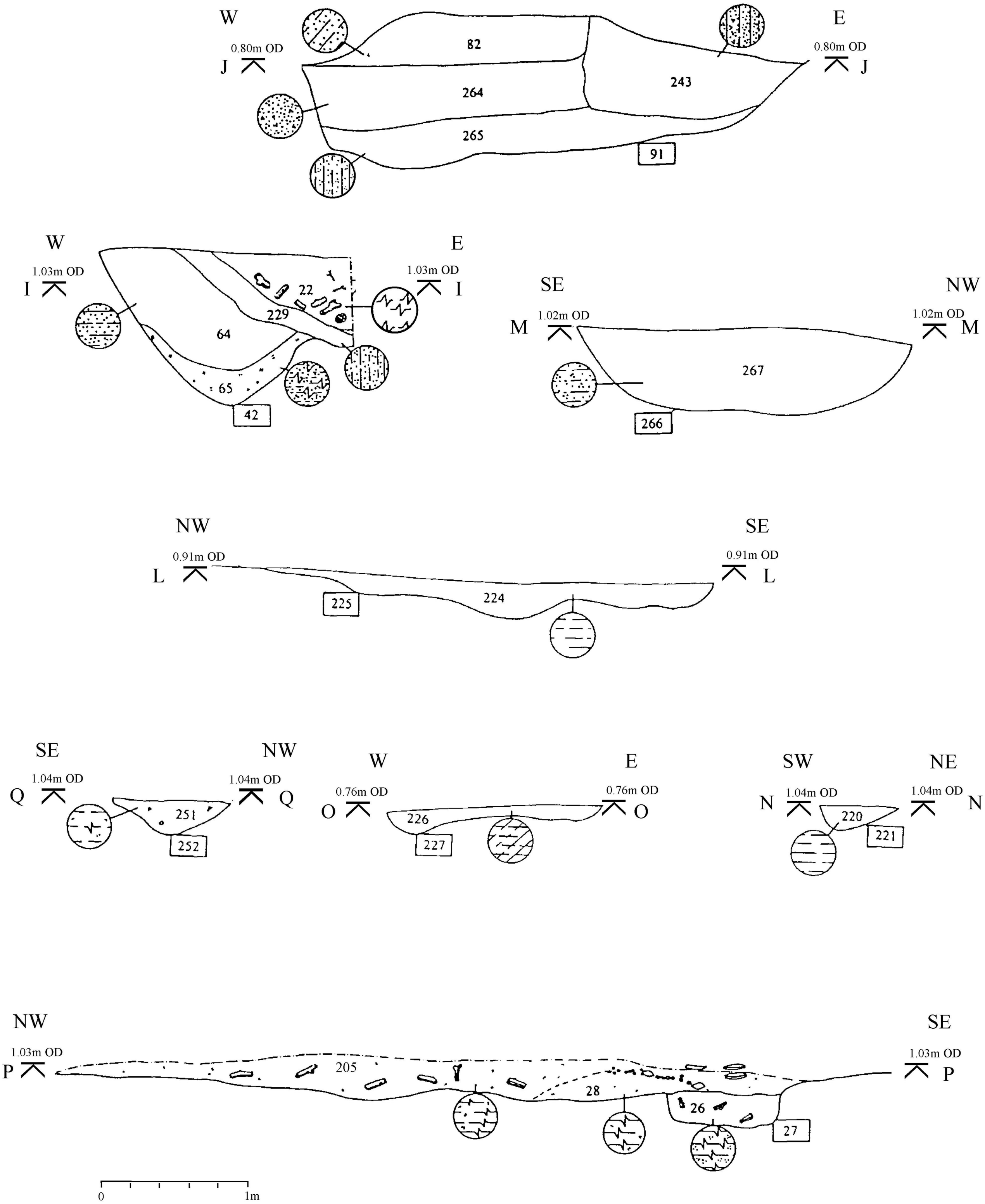


Figure 6 Sections of early pits. Scale 1:20

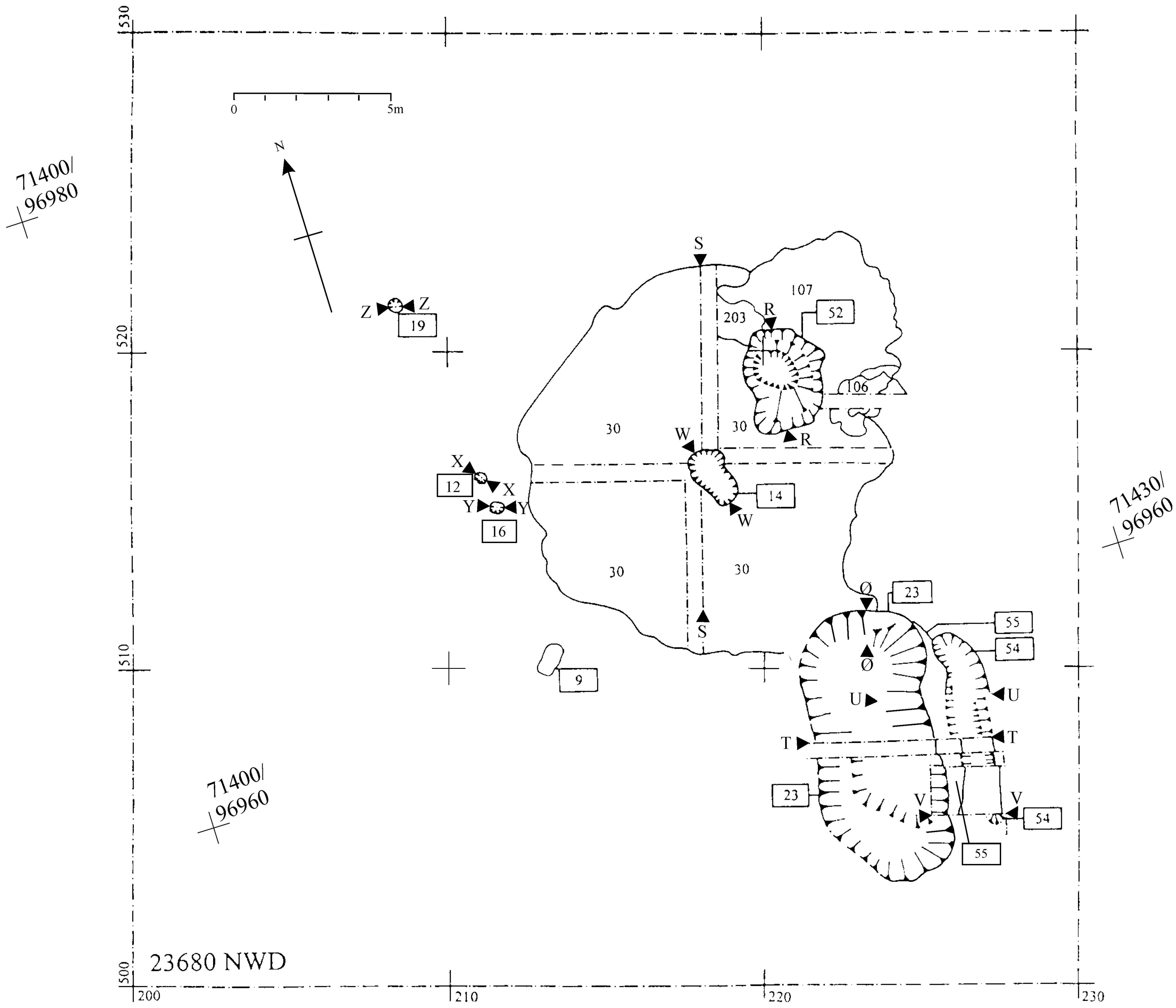


Figure 7 The burnt mound and associated features. Scale 1:200

IV. The burnt mound and associated features

(Figs 7–13; Pls II–IV)

The sequence

Cessation of earlier activity on the site was effectively marked by the development of the peaty layer, *33*, *205*, which sealed many of the early features and produced five sherds of Early Bronze Age pottery. In part it was possible to trace this deposit beyond the limits of the mound to other areas of the site, but elsewhere it was impossible to differentiate between this and later peats that had developed on top of it. This was the case just south of the mound with both an incomplete dog skeleton and a collection of water-rounded flints and quartzite pebbles found within indistinguishable peats alongside 100 Beaker pot sherds, *28* (Fig. 6). The composition of the peat suggests accumulation of woodland leaf litter under damp conditions. This provided the surface upon which the burnt mound, *30*, formed. Three pits were directly associated with activity generating the mound. Whilst it is evident that all three were open during the lifetime of the mound, the available stratigraphy indicates the following sequence, from earliest to latest:

i) a waterlogged shaft-like pit (*52*) in the north-east of the site
ii) commencement of burning/heating and mound generation
iii) a large, shallow pit (*23*) with revetted bank (*55*) and ditch (*54*) to the south-east
iv) a central pit (*14*) with timber planks on its base

Pit *52*

(Figs 7, 9; Pl. II)

Pit *52* was dug in the north-east of the site and cut the peaty layer *33*, *205*. The heating operation required a reliable water source and pit *52* seems likely to have served as such. The presence of duckweed and freshwater dwelling species of snail and beetle indicate that the pit held water, if not standing groundwater, throughout the period that both pit and mound were demonstrably operational. Water levels may have fluctuated seasonally. The pit's overall plan was an irregular rectangle *c*. 3.30 x 2.40m, stepped to the south with a shaft 1.40m deep off-centre to the north. It is likely that the shaft element was original with the stepping occurring at a later date as part of a cleaning or re-cutting exercise.

The earliest deposits of natural chalk and sand excavated for the well were thrown to the north and east of the hole (recorded as *256*, *257*, *258*, *259*). A large piece of timber, perhaps a whole tree trunk, *260*, was placed along the north-eastern edge of the pit and was partly covered with compacted upcast chalk to retain it in place. Some of these deposits were subsequently covered with burnt flint and charcoal as the burnt mound began to form.

The lowest fills of *52* were waterlogged minerogenic sediments. Degraded chalk and silt, *128*, was recorded at the base of the pit. This was the inevitable result of 'natural' soils crumbling from the sides into the open feature. Well-preserved surface material, including oak leaves, twigs and grass stems, had found its way into the pit at this early time. A number of hazel stakes with chisel points, *176*, were recovered. Occasional burnt flint fragments from the first heating activity were also observed. Above the primary fill, dark grey chalky silts, *179*, *181*, had accumulated. These, too, contained organic

Plate II Central shaft of pit *52*

material from the surface, increasing numbers of burnt flints and were divided by small bands of 'natural' sand and gravel, *180*, collapsed from the pit walls. Subsequently, the volumes of mound material, *182*, *183*, entering the pit increased dramatically. This was most likely due to collapse of the pit sides, and it appears that the pit was choked and required re-excavation or at very least cleaning.

Sand, chalk and clay were excavated from the pit, creating the stepped effect to the south. These deposits were primarily thrown to the west and north of *52* (as *106*, *107*, *203*), sealing earlier layers of the burnt mound. Further burning and heating subsequently buried the secondary upcast with more burnt flint, and this sequence is believed to represent seasonal maintenance. Reflecting the re-definition of the pit, its upper fills (*111* and later) contained significantly less burnt flint although charcoal was still washing or blowing in from the mound. *In situ* mound material was also recorded slumping over the eroded pit edge on the west side. At this point the pit was no longer being maintained and was allowed to infill. Disuse of *52* was indicated by peat growth in wet conditions towards the top of the open feature.

The burnt mound

(Fig. 7; Frontispiece)

The mound itself (*30*), was focused around pit *52*, producing a horned shape. Spreading out to the south-east, it averaged *c*. 12m in diameter. It comprised small, angular crazed and shattered flint fragments, often tightly packed, in a black, charcoal-rich loamy matrix. The soil itself was composed of fine organic material, the degraded residue from wood fires. Quartzite and river-rounded pebbles had occasionally been used in addition to the more usual irregular flint fragments. Reduction of the raw material to pieces generally no more than 20–30mm long showed considerable re-heating and cooling of the flint and probably some thermal fracture from surface weathering. Presumably each stone was used until it became just too small. The mass of shattered stone was discarded and mixed with the charcoal and burnt residue from fires lit within the limits of the mound, as there were no fire sites found outside its edges. Neither were there any prepared hearths on the mound, which shaped the interpretation that the stones were prepared in open bonfires. Regular sampling of the burnt soil aimed to locate any centres of burning through identifying charcoal concentrations.

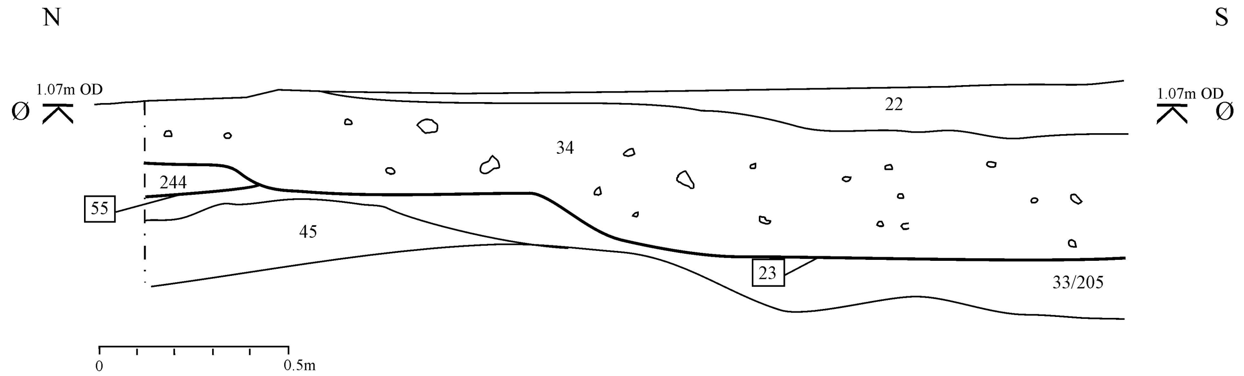


Figure 8 East-facing section through bank *55* and pit *23*, showing buried soil *45* (palaeosol *66)*

Targeted radiocarbon dating of the charcoal assemblages was designed to test the chronological make-up of the burnt mound.

The deposit survived *in situ* to a maximum depth of 0.35m. As the centre of the mound was set upon locally higher ground its crest had been reduced through the effects of tillage and the deposit thus appeared thickest in lower-lying areas towards the outer edges. The south-west quadrant, however, was severely eroded. Contemporary weathering of the mound and slumping of adjacent feature edges gradually introduced burnt flints and charcoal into all of its associated open features. Beaker pottery and worked flint were discarded by visitors to the mound and enveloped as it continued to amass. It may have become seasonally overgrown and required periodic clearance between heating sessions. However, except where it was clearly separated (*e.g.* by the successive upcast deposits of chalk subsoil from digging and cleaning pit *52*), the homogeneity of the burnt deposit was such that division between individual burning or dumping episodes was not possible. There was no lamination evident to help determine stratigraphically whether the mound was the result of numerous small burnings over a long period of time or a smaller number of larger heating events. Soil micromorphology and radiocarbon dating were employed to tackle this issue.

Pit *23*, bank *55* and ditch *54*

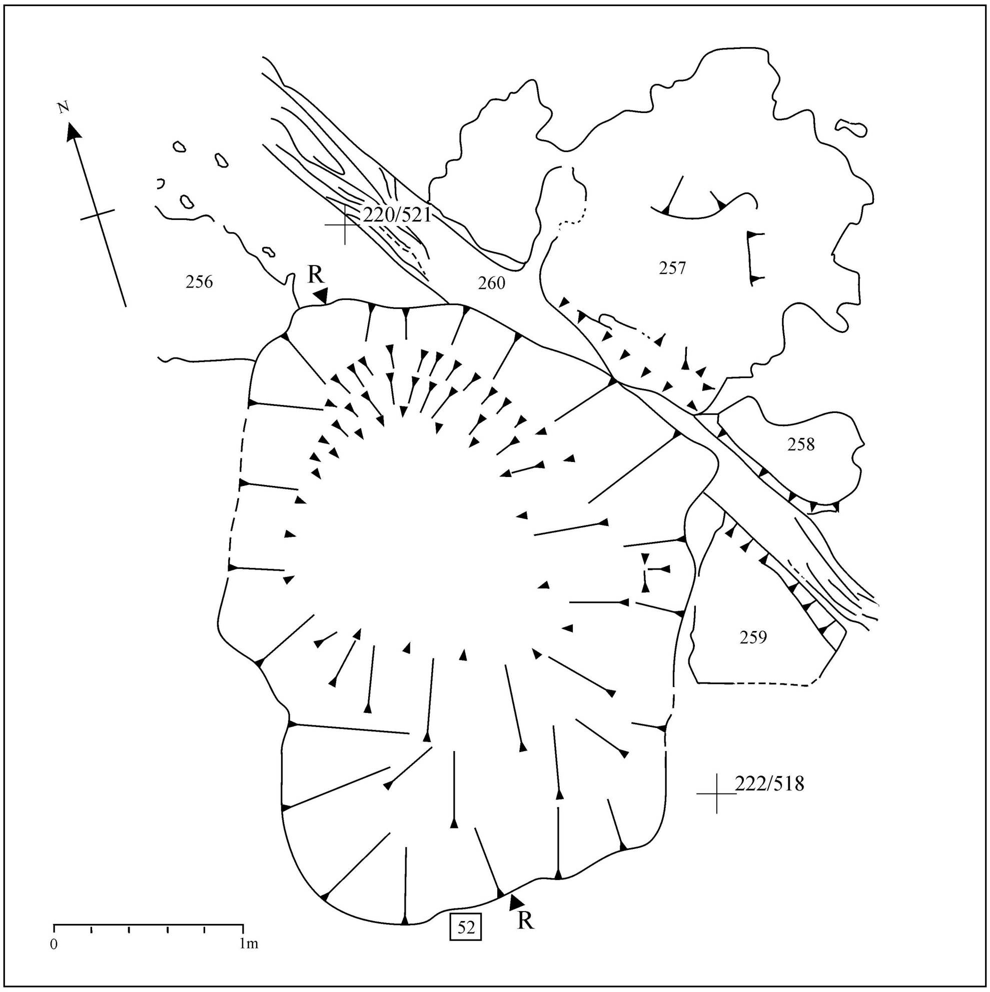
(Figs 7, 8, 11; Pl. III)

This related group of features was recorded at the south-east corner of the burnt mound and is contemporary with it. Pit *23* was a very large but shallow feature, *c*. 8.5 x 4.0 x 0.42m. Its western side cut through earlier cultural and natural deposits whilst its eastern side was formed by a low bank, *55*. The bank had been created from the upcast of a small parallel section of ditching, *54*, and probably material from the cutting of *23* itself.

Given the survival of the peaty formation *33*, *205*, beneath it, pit *23* may have incorporated an existing hollow. It also cut away the soft fills of numerous earlier cultural features along its western flank. Aligned north-to-south it was sub-rectangular in shape, with rounded corners and very gently sloping sides. Its base was fundamentally flattened to a consistent level. It is thought that this flattening may reflect use rather than design. Above a small primary deposit of grey sand on the southern and western edges (not recorded in section), burnt flints and charcoal (*34*) had entered the pit from the north-west corner and lay over much of its base. Nine sherds of Beaker pottery in this context may also have originated from the mound. Although it would have been suitable for containing standing water (and therefore serving as a reservoir), given its shallow profile the pit was never going to be subject to the same dramatic processes of infilling as *52*. There was no evidence for cleaning or re-cutting *23*, but whether it remained open and in good repair for any length of time is difficult to ascertain. The contemporary water table may have been consistently sufficiently high to keep the pit continually wet. Following the erosion of burnt flint into the feature it fell out of use, supporting plant growth and progressively filling with peat *22*. Ten Beaker sherds were recovered from the peat infill, but these may well be residual (S. Percival pers. comm.).

Parallel to pit *23* a ditch segment (*54*) measuring 6.50 x 1.20 x 0.58 was dug along its eastern edge. The ditch was roughly cut through the peaty layer *33*, *205* (or the buried soil, *178*, where the peat was either absent or not recognised) with steep sides, in places almost vertical. Because the land surface sloped down to the east it appears that the sole purpose of *54* was to provide sufficient spoil to effectively dam the eastern edge of *23*. The two features may well have been dug simultaneously. The product of this was a convoluted sequence of sandy and clayey deposits (collectively bank *55*) thrown up on the peaty layer *33*, *205*, between the two. Scraps of degraded wood coupled with a vertical separation of ditch fills indicated a series of timber stakes was set into the base of the ditch to revet the bank.

Plate III General shot of pit *23*, bank *55* and ditch *54* from the south



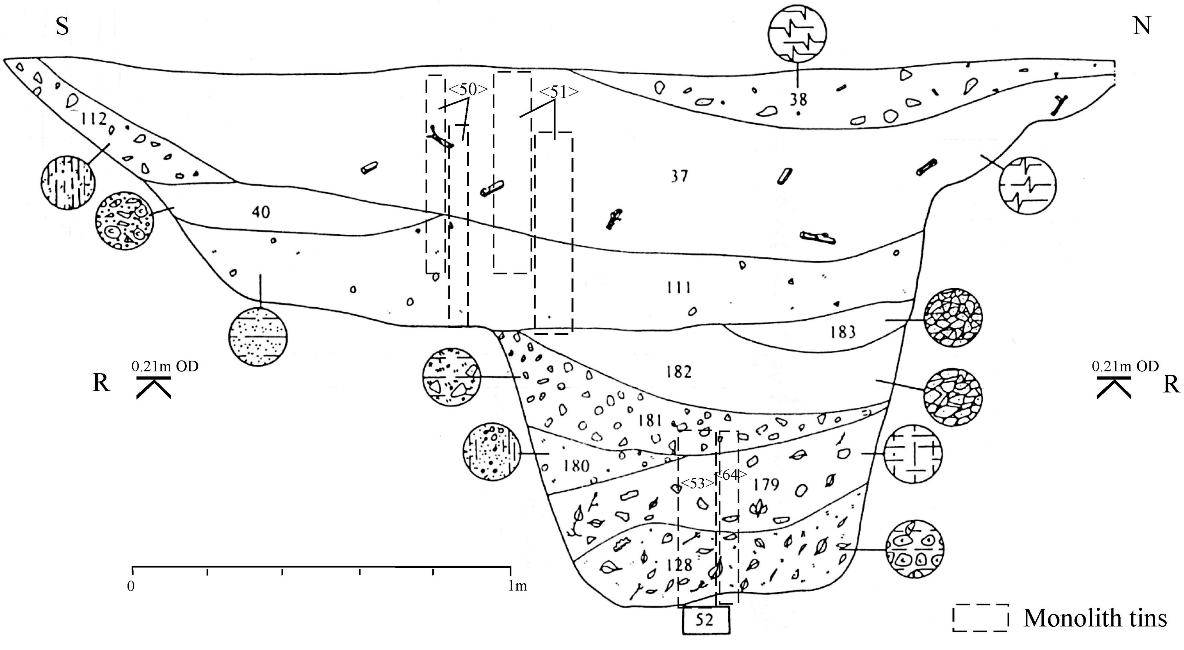


Figure 9 Plan and section of pit *52*. Scales 1:40 and 1:20

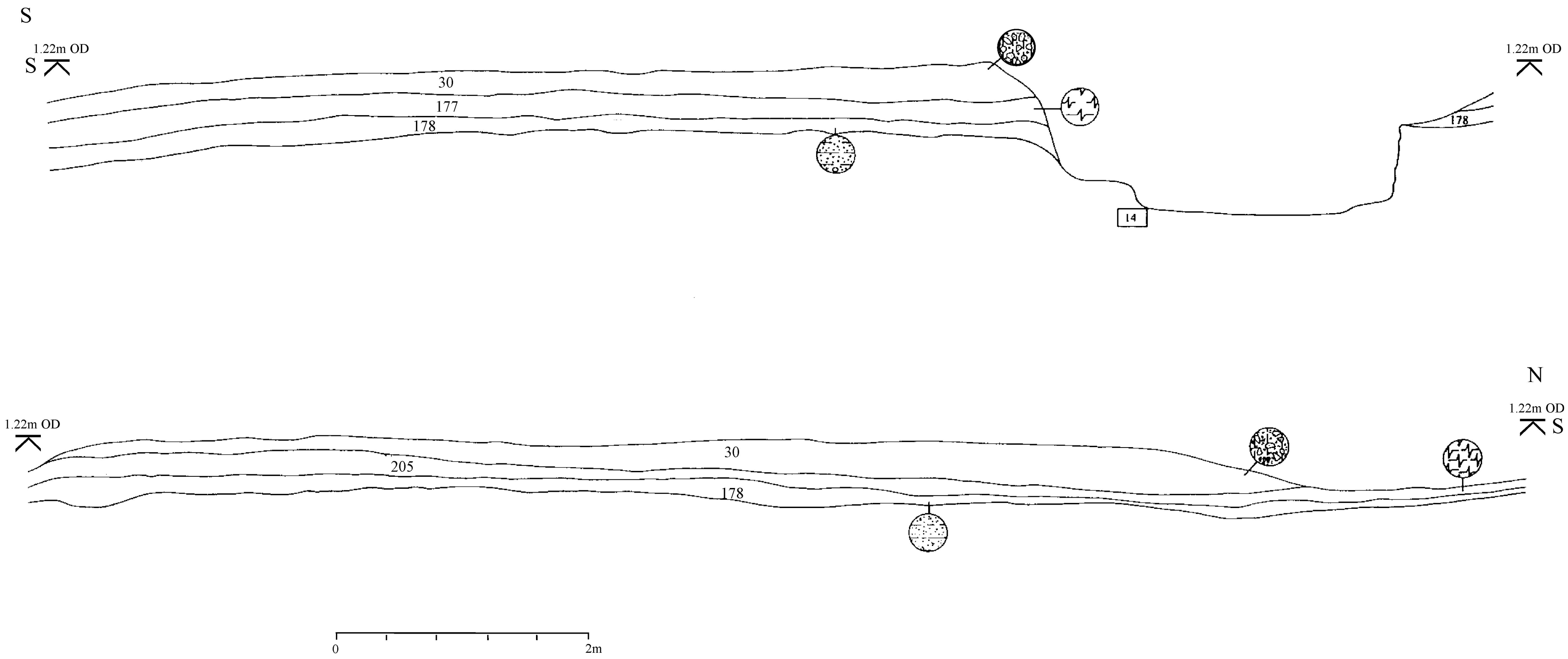


Figure 10 Section through the burnt mound and subjacent deposits: peat *177*, *205* and buried soil *178*. Scale 1:50

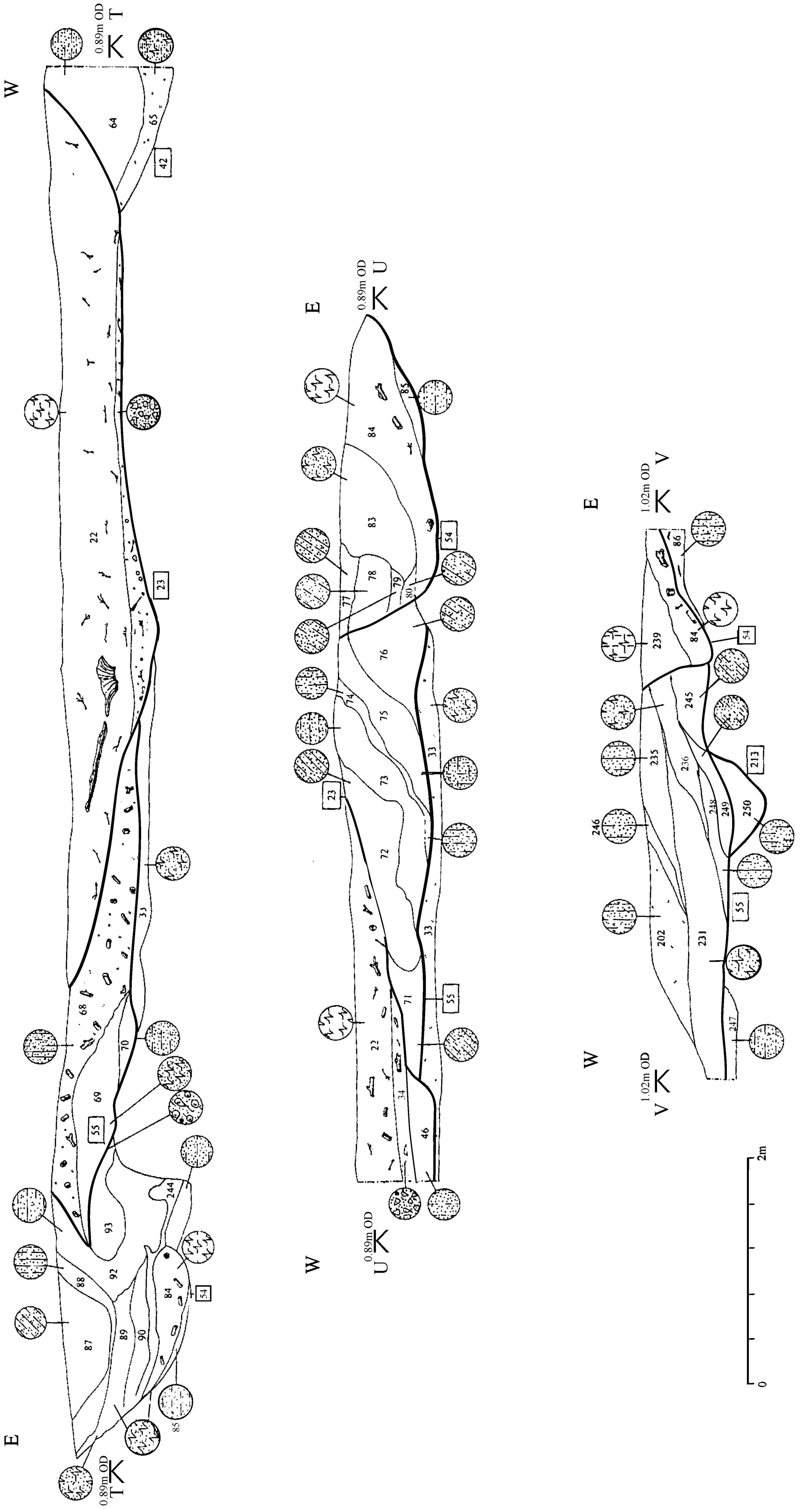


Figure 11 Sections through pits *23*, *42* and *213* and bank *55* and ditch *54*. Scale 1:50

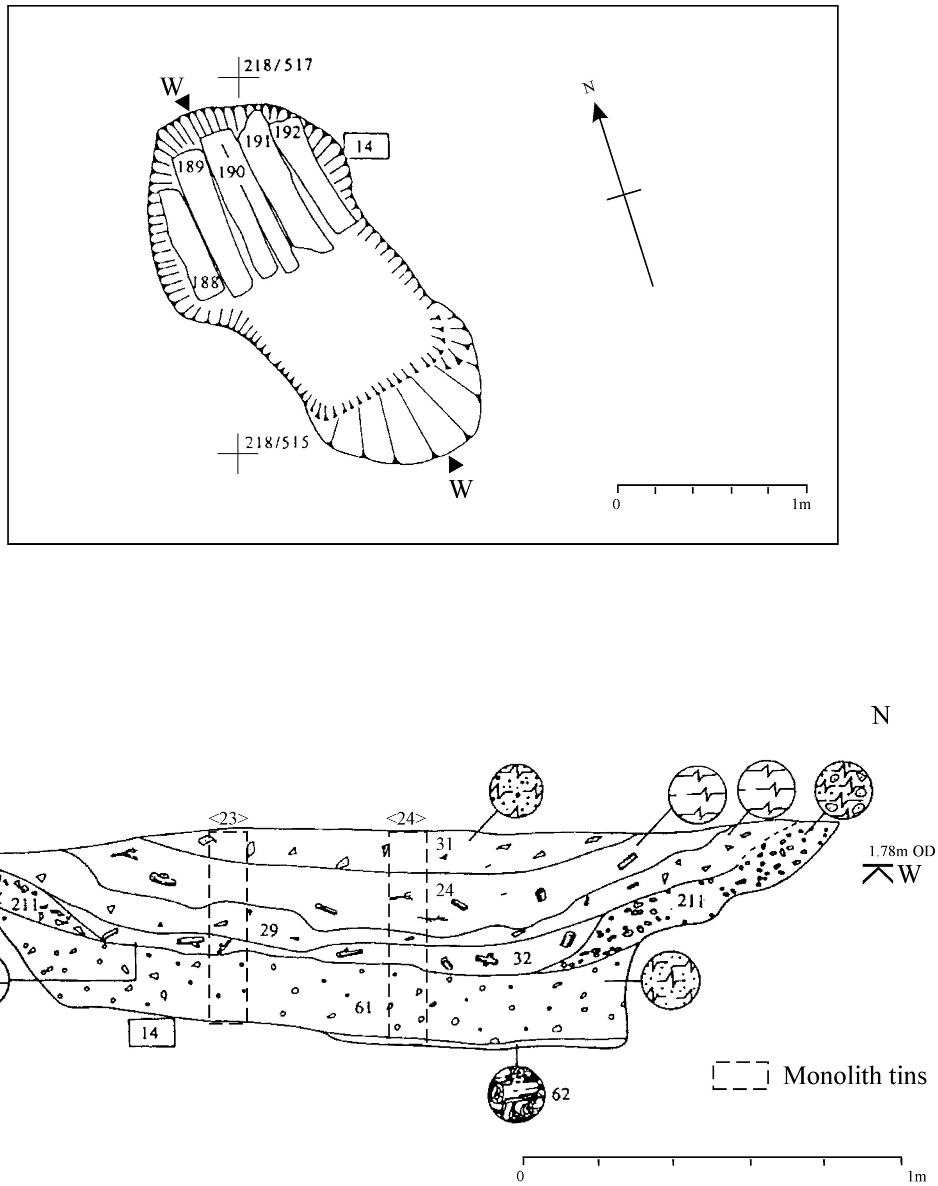


Figure 12 Plan and section of pit *14*. Scales 1:40 and 1:20

Peat (*89*/*90*, *239*) began to accumulate in the ditch and deformation visible in the sections suggests that at some point the stake line collapsed inwards under the weight of the bank (*e.g.* deposit *92*). Previously, the bank had been stable enough for a peaty soil (*69*, *74*, *231*) to develop on its surface. The upper part of ditch *54* was re-excavated and other material introduced to re-establish and heighten the bank up to 0.47m.

Pit *14*

(Fig. 12; Pl.IV)

Stratigraphically the latest of the pits associated with the burnt mound, *14* was located in, and cut through, its approximate centre. Although originally dug after the mound had begun to form, pit *14* was open and used as the mound developed and burnt material accumulated around it. Sub-rectangular in plan with an enlarged northern end, it was aligned north-west to south-east measuring 2.30 x (maximum) 1.10m. Its sides were almost vertical to a maximum depth of 0.57m, but with some stepping towards the top at both ends.

At its base thin primary deposits (not recorded in section) of calcareous sandy silt contained small numbers of burnt flints that had entered the feature during its construction. Overlying this in the northern half of the feature were five thin alder boards (*188–192*, collectively *62*). They were positioned tightly against each other and cut to length to match the curve of the pit sides. The survival of the planks indicated that the feature had held water both during and after its useful life. It is assumed that all infilling above the planks represents disuse or abandonment of the pit. The pit filled initially with in-washed grit and sandy peat growth, *61*, which produced a sherd of Beaker pottery. Subsequently burnt flint deposits *211* (including another pot sherd) eroded in from the mound; these were never cleared out, remaining *in situ*.

On top of the burnt material *211* several lengths of wood (*121–126*, collectively *32*) were retrieved in a very

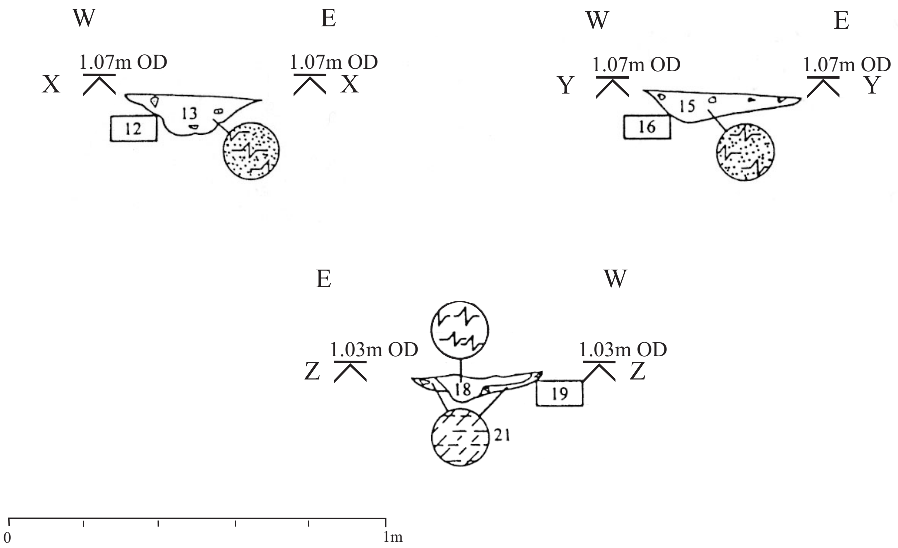


Figure 13 Sections of miscellaneous post-holes. Scales 1:20


Plate IV Alder planks in the base of pit *14*

desiccated and fragile condition. It was impossible to establish whether these pieces had ever been worked, whether they were related to *62* below or whether they formed any sort of structure within the pit that had been progressively filled in from the sides. Above the timbers, several layers of structured (*32*, *24*) and amorphous (*29*, *31*) peat were identified, reflecting the slow final filling of *14*.

Miscellaneous post-holes
(Figs 7, 13)
To the west of the mound three small post-holes, *12*, *16*, *19*, were identified. The features were stratigraphically below plough disturbed sandy peat deposits and the peaty layer *33*, *205*, could not be distinguished in this area. The features were recorded as cutting the buried soil, *178*, although it was not possible to determine from what level they had *actually* been cut. None survived beyond 0.11m deep. They have been grouped with the later phase of activity by their physical character.

Located 1m to the west of the mound, post-hole *16* was an ovoid feature 0.43m long x 0.33m wide. Its profile was somewhat stepped and rounded and it contained dark grey peaty sand and occasional burnt flints. One metre to the north, post-hole *12* was very similar. It was also oval, but had more pronounced stepped edges producing a pipe-like appearance in the centre. It contained identical peaty sand with a few burnt flints. A more circular feature, 0.36m across, post-hole *19* was located 5m to the north-west and also appeared to contain the ghost of a post. Black peat in the centre of the cut was surrounded with backfilled ‘natural’ and the odd burnt flint.

Chapter 3. The Artefacts

I. Worked flint

by Peter Robins and Sarah Bates
(Fig. 14, Table 1)

Introduction

Twenty-nine struck flints were collected from eight contexts. Of these five were from the ploughsoil *5*, a further nine from hand-cleaning the remnant/lower ploughsoil *20*, and eight from sieving the burnt mound *30*. The remainder of the flint came from excavated deposits, although feature sieving failed to produce any further examples. A summary of the assemblage is shown in Table 1.

Context	*Type*	*No.*
5	Secondary flake	2
	Tertiary flake	1
	Retouched flake	1
	Utilised flake	1
20	Core	2
	Secondary flake	4
	Tertiary flake	2
	Scraper	1
22	Primary flake	1
	Shatter	1
30	Primary flake	2
	Secondary flake	3
	Tertiary flake fragment	1
	Utilised flake	2
45	Leaf arrowhead	1
129	Tertiary flake	1
	Utilised blade	1
178	Blade	1
203	Secondary flake	1
	Total	*29*

Table 1 Summary of the worked flint assemblage

Description

Two small stubby, single platform cores are present, both from context *20*. One is on a very small cortical fragment whilst the platform of the other core was already patinated prior to its use. The rest of the assemblage comprises irregular small, struck flakes that in many cases are noticeably fresh and sharp. Two have been retouched: a thick flake has a few flakes removed steeply from its distal end and a small scraper from context *20* has steep retouch along its right side. Four pieces show signs of use/wear on part of their perimeter edges. One of these, a small blade *129*, has been utilised at its distal end/point. One flake from the burnt mound *30*, refits onto one of the cores from *20*, indicating that knapping was carried out at the site. One tiny flake fragment is burnt and another flake is also probably burnt.

Both thinly corticated pebbles and thinly corticated nodules, together with flint of a variety of colours are present, suggesting the use of locally-collected flints as raw material. Most of this raw material was probably small when gathered. While no firm indication of period can be made, the fresh nature of many pieces and the irregularity of many of the flakes suggests a late prehistoric origin.

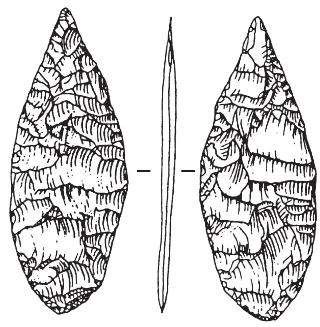


Figure 14 Leaf-shaped flint arrowhead. Scale 1:1

The only exception to this, and the only diagnostic piece in the assemblage, is a leaf-shaped arrowhead (Fig. 14) from context *45*. Its highly finished condition contrasts with the poor quality of the knapping and casual usage of flakes characteristic of the rest of the flint work. This piece is likely to be earlier Neolithic.

II. Pottery

by Sarah Percival
(Fig. 15, Table 2)

Introduction

The recovery of sherds of Beaker and other Bronze Age pottery from within the burnt mound and associated features at Northwold is highly significant. Examples of pottery found within such contexts are rare, with closely datable collections being scarcer still. Only a handful of examples of burnt mounds in lowland Britain that contain pottery have been published (Silvester 1991, 85–7, Healy 1996, 179, Bates and Wiltshire 2000). The paucity of ceramic material from burnt mounds is especially surprising in a Fenland context, given the abundant and well documented Beaker assemblages so far recovered (Healy 1996, 106) and the hundreds of burnt flint concentrations recorded by the Fenland Survey in Norfolk (Silvester 1991, 85; Healy 1996, 179).

Context	*Form*	*Quantity*	*Weight (g)*
8	unidentified	1	1
22	Beaker	12	41
28	Beaker	100	866
30	Beaker	25	221
34	Beaker	4	44
61	Beaker	1	50
112	Food Vessel	1	80
129	unidentified	1	1
205	Beaker	3	42
	Total	*148*	*1346*

Table 2 Quantity and weight of pottery by context

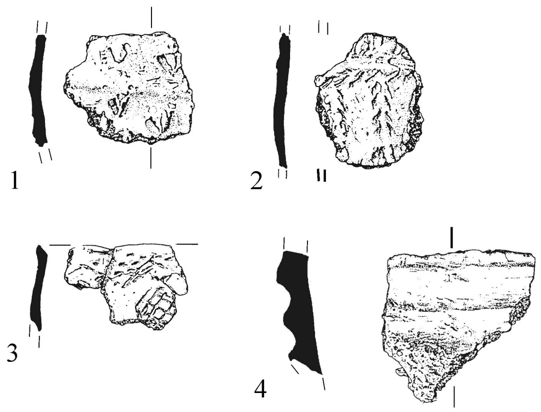


Figure 15 Pottery. Scale 1:4

Description

The Northwold assemblage comprises 148 sherds weighing 1,346g. The majority of the sherds are Beaker (145 sherds, 1,264g); one sherd is maybe of Food Vessel Urn (80g) and two small sherds are unidentifiable. No complete vessels are present.

A single, large rim sherd (Fig. 15, 4) was recovered from deposit *112*, an upper fill of pit *52*. The sherd is from a large, thick-walled vessel and comprises an externally thickened rim with internal rustication and deep horizontal grooves decorating the exterior of the body. The fabric is heavily tempered with grog and smaller quantities of calcined flint. Pit *52* was originally excavated just prior to construction of the mound and appears to have remained open throughout the mound's lifetime (A. Crowson pers. comm.). The sherd was incorporated towards the end of the use of the pit within material weathered from the surface of the mound. No other pottery was found in the pit. It is curious that no Beaker of the type found within the body of the mound was present, as a substantial amount of burnt flint had fallen into the pit from the mound. No other pottery of this type was found elsewhere on the site. Identification of the sherd is unclear. It may be a large Beaker, but alternatively it may represent a Food Vessel Urn dated to the Early to mid Bronze Age, perhaps around 2100–1500 cal BC (*c*. 3700–3200 BP) (Needham 1996, 124 fig. P2).

The Beaker sherds are manufactured from fabrics containing high proportions of quartz-sand with smaller quantities of grog and burnt, crushed flint. All but two of the sherds are decorated, most frequently with plastic rustication carried out using the fingertips or fingernails (123 sherds, 1,087g, Fig. 15, 1 and 2). Decoration appears to have been present all over the body of the vessel. Twenty sherds have incised decoration, either random or in a chevron motif. One vessel has incised chevrons combined with stabbed decoration to the rim (Fig. 15, 3). Comb-impressed decoration, frequently present within domestic Beaker assemblages from the fen-edge, is absent. The Beaker vessels are not finely made, but can be easily distinguished from the coarser Food Vessel, which is robust and thick walled. The fabric types and decorative forms fall easily within the range characteristic of later Neolithic/Bronze Age pottery from the region (Bamford 1982, Healy 1996).

The pottery dispersed within the body of the mound (context *30*, 25 sherds, 221g) and from the peaty deposits below, (contexts *28, 205*, 103 sherds, 908g) consisted exclusively of Beaker sherds. Peat layer *28* also incorporated a partial dog skeleton and a cache of water-rounded pebbles alongside the Beaker pottery. At least one sherd from the pre-mound peat joined one from the body of the mound. Further joins were obscured by the condition of the sherds, many of which were fragmentary and exhibited abrasion and concretion. The sherds from these deposits were of similar size, each having an average weight of 8.8g. Both assemblages strongly favoured fingertip-rusticated decoration and this, along with the conjoining sherds, suggests that they were closely contemporary or, indeed, were largely from a single vessel. Wear must have occurred either before or during the construction of the mound, perhaps indicating exposure of the sherds on the pre-mound surface or between episodes of deposition of burnt material. There was no evidence for *in situ* burning.

Sixteen sherds, weighing 85g, were found in two fills from within pit *23*. This pit seems to be contemporary with the mound and most likely contained standing water at the time of its use (A. Crowson pers. comm.). The pottery appears to represent one incomplete vessel, a Beaker with distinctive incised and stabbed decoration to the rim and body (Fig. 15, 3). The pottery was deposited throughout the lifetime of the pit, some within burnt flint and charcoal weathered from the burnt mound, some within the peat formed following the abandonment of the pit. No fingertip-rusticated sherds, like those from the pre-mound peat or the mound itself, were found.

Discussion

The Beaker from Northwold bears a strong resemblance to an assemblage excavated from a burnt mound at Feltwell Anchor (Boast 2000). Here fourteen Beaker sherds were found in pre-mound deposits. All the sherds are grog-and-flint tempered, all are decorated with fingernail impressions and comb-impressed sherds are also absent. Although the Feltwell site has been dated to 2140–1880 cal BC (3605±42 BP; weighted mean of GU-5571, 3540±60 BP, and GU-5572, 3670±60 BP) from skeletal remains in a grave cut through the mound, no radiocarbon dates were directly associated with the pottery (Bates and Wiltshire 2000).

Contemporaneity of Beaker and Food Vessel styles has been argued by Frances Healy in studies of assemblages retrieved from former fen-edge sandhills in Hockwold-cum-Wilton parish to the south of Northwold. Here 'from at least the 1930s Beaker and Food Vessel have been known to occur together on fen edge living sites' and the most common permutation is of Beaker *with* Food Vessel. Healy goes on to observe that 'the Food Vessels are exceptionally thick-walled and made in coarse friable grog tempered fabrics'; most of these are Food Vessel Urn. It has been suggested that within some domestic settlements there maybe some functional inter-changeability between Food Vessel Urns and rusticated Beaker, with both representing the more robust end of the Early Bronze Age vessel range (Healy 1995, 176).

Radiocarbon dating of the burnt mound demonstrates that it was constructed and went out of use within a fairly short space of time, between *cal BC 2195–2155 (at 95% probability; BS44)* or *cal BC 2200–2140 (at 95%*

probability; BS47). The mound and associated activity lasted for a relatively short period of time, estimated as between *35 and 165 years (at 95% probability)*. The ceramic evidence also suggests relatively brief occupation, with a very small number of vessels, perhaps as few as five, being represented. This concurs with evidence from contemporary sites where discrete assemblages collected from pits suggest a pattern of successive, discrete, short-lived episodes of deposition (Healy 1995, 176).

Within the context of a burnt mound the function of the pots remains obscure, but they probably represent domestic rubbish, similar to the scatters of Beaker domestic pottery that are ubiquitous on the fen-edge. Ceramics are also found commonly beneath round barrows (Petersen and Healy 1986) and were present beneath the burnt mounds at both Northwold and Feltwell. The pottery found within the Northwold mound is worn and fragmented, suggesting that it may represent material originally deposited on the surface, possibly on a midden. The short interval between the original deposition of the pottery and the generation of the burnt mound is confirmed by the presence of sherds from a single vessel both beneath and within the body of the mound.

Taking a different viewpoint, the deposition of the pottery within the mound and certain features close by may suggest a deliberate placing of carefully selected material within particular contexts. The most obvious example of deliberate deposition would be the semi-complete Beaker alongside the erratic beach or river pebbles (*28*). It is arguable that the presence of pottery, again possibly representing the remains of a single vessel, within the burnt mound itself is equally indicative of such practices. Examples of special deposits have been argued elsewhere (Cleal 1984, 148–51; Healy 1995, 175), and the practice is believed to have been current throughout the later Neolithic continuing well into the Bronze Age.

East Anglia is an area where the same style of Beaker pottery is ubiquitous, but where securely dated examples are sorely lacking (Kinnes *et al.* 1991, 39). The Northwold radiocarbon dates are especially important for domestic assemblages which occur in the Fenland in extraordinarily high numbers (Bradley 1993, 8), but are often more difficult to date than examples from funerary contexts (Kinnes *et al.* 1991, 36). The date range indicated for the Northwold assemblage of *cal BC 2265–2165 (at 95% probability)* and *cal BC 2140–2065 (at 95% probability)* falls towards the end of that suggested for Beaker currency, *c*. 2600–1800 cal BC (*c*. 4000–3500 BP), (Kinnes *et al.* 1991) and towards the beginning of that suggested for Food Vessels, *c.* 2100–1500 cal BC (*c*. 3700–3200 BP), (Healy 1996, 115). Stylistically the assemblage is characterised by two types of vessels, those exhibiting roughly incised decoration and those with plastic rustication. This combination suggests that the group falls within the Southern Beaker tradition, which is believed to have developed towards the end of the Beaker period. The radiocarbon dates confirm this interpretation.

Chapter 4. Zoological and Botanical Evidence

I. Faunal remains

by Simon Davis

Introduction

Two hundred and forty-eight pieces of animal bone and two pieces of antler weighing a total of 2.499kg were recovered from the site. Faunal remains were collected from fifteen contexts, many of which are from deposits overlying the burnt mound. The assemblage comprises largely hand-collected material, as the on-site sieving programme was generally non-productive. Preservation of the material is only mediocre, and this may be reflected in the predominance of larger bones, such as cattle, in the assemblage. Other species represented include sheep/goat, pig, dog and roe deer.

Interpretation

There is little that can be said about husbandry except that all of the bones (except roe deer) probably derive from domesticated animals. However, poor preservation makes the observation of cut marks difficult. Cattle humeri with distal trochlear widths (BT) of 71.6mm are within the limits of domestic cattle, and the pig teeth measurements are also within the limits of domestic pig rather than wild boar. Given the over-riding domesticated character of the assemblage it is suggested that the bones are probably food debris.

II. Plant macrofossils

by Peter Murphy

Uncharred macrofossils

Uncharred plant macrofossils, including fruits, seeds, leaves, thorns and buds were recovered from the lower fills of pits *52* and *14*. Methodologies for the retrieval and analysis of plant macrofossils and tabulated results are contained in the Appendix.

Pit 52

Sample 63 was taken from the lower fills (*128*, *179*, *180*, *181*) of this feature which accumulated at the beginning of activity relating to the burnt flint mound. The dominant taxon throughout was *Urtica dioica* (stinging nettle), associated with other weeds, notably *Rumex* sp. (docks). This indicates disturbed, locally nutrient-enriched soils. Other open habitat herbs comprised grassland species, particularly *Ranunculus acris/repens/bulbosus* (buttercups). Wetland and aquatic plants were present, but not abundant.

Woodland herbs included *Moehringia trinervia* (three-veined sandwort) and *Ajuga reptans* (bugle). Tree and shrub species were consistently present: *Alnus glutinosa* (alder), *Betula* sp. (birch), *Corylus avellana* (hazel), *Quercus* sp (oak), *Rubus* sect. *Glandulosus* (bramble), *Sambucus nigra* (elder) and *Solanum dulcamara* (woody nightshade). Whilst some of these remains of woody plants (*e.g.* birch fruits) are widely dispersed, others are not (*e.g.* oak cupules, alder female catkins), and their presence must imply very close proximity of trees, and probably woodland.

Although the assemblages throughout the lowest 50cm of this feature were composed of a consistent range of species, there was some variation in their relative abundance. Macrofossils of alder were more abundant above 20cm in the monolith, as were seeds of aquatics, notably *Lemna* sp. (duckweed). However, the counts involved are not large, and it would be unwise to interpret these variations in terms of environmental change.

One species is likely to represent plant material imported to the site: *Pteridium aquilinum* (bracken). *Pteridium* characteristically grows on well-drained soils (principally on acid sands, but also on more calcareous soils). It is not likely to have been growing at the site, for the other macrofossils from pit *52* point to poorly-drained conditions in the vicinity (although see pollen zones N52/1 and N52/4).

The upper fills of pit *52* (sample 51, contexts *37* and *111*) were not analysed. Assessment of *111* indicated that it included a very similar assemblage to context *181* below. Context *37* was of de-watered wood peat with abundant but poorly preserved alder seeds and female catkins and *Carex* nutlets.

Pit 14

Sample 76 was from the lowest fill (*209*) of this pit, a calcareous sandy mud under the wooden boards at its base. The macrofossil assemblage consisted largely of wetland herbs, particularly *Mentha* cf *aquatica* (mint), *Lycopus europaeus* (gipsywort), *Eupatorium cannabinum* (hemp agrimony) and *Juncus* spp (rushes). Other taxa included a few aquatics (Alismataceae, *Ranunculus* subg. *Batrachium*), nutlets of *Urtica dioica*, and some remains of woodland/scrub plants (*Ajuga reptans, Alnus, Rubus* and *Solanum dulcamara*). Locally open herbaceous vegetation growing on damp soils appeared to be indicated, but with some trees in the vicinity.

A similar sediment occurred above the boards (sample 24 (40–50cm): context *61*), but during assessment this was found to contain only poorly-preserved fruits of *Urtica dioica*, and was therefore not analysed. Deposits above this (sample 24 (32–37cm): context *31* and 20–30cm: context *24*) were basically wood peats, but included some charcoal and heat-shattered flint. Assessment showed that macrofossils (mainly degraded *Alnus* fruits, with some *Carex* and *Rubus*) were very poorly preserved, so no additional analysis was undertaken.

Conclusions

The two pits related to different phases of activity, though mathematical modelling of the radiocarbon results indicates that activity lasted for *35–165 years (at 95% probability)*. In spite of this short time, the pits produced rather different seed assemblages. Whilst both yielded remains of trees and shrubs, implying proximity of scrub or woodland, pit *14* included a higher proportion of wetland taxa and fewer weeds and dry land herbs. This may suggest that conditions at the site were becoming wetter through time. Indeed, rising groundwater levels ultimately resulted in the development of alder wood peat in the tops of the features and over the site as a whole.

Results from analyses of plant macrofossils and molluscs at some other 'burnt flint' sites near Mildenhall in Suffolk are thought to indicate location of sites in localised clearings within fen-edge woodland (Murphy 1988), and the results from Northwold are similarly interpretable.

The plant macrofossils contribute nothing to interpreting the function(s) of the site. Although some of the seeds and nutshells (of elder, bramble and hazel) could perhaps represent food wastes, the site produced no waterlogged remains of crop plants. Plant food processing and/or consumption does not seem to have been significant. It was suggested above that bracken was being imported to the site, but there are no indications of the purpose of this.

Charred macrofossils

As described in the Appendix, sub-samples of the flots from the bulk samples were scanned during assessment, but the only charred plant macrofossil noted other than wood charcoal was a single indeterminate cereal grain from BS35 (context *30*, *216*/*512*). Comparably sparse results came from the burnt mound at Feltwell Anchor, Norfolk, which produced only a few charred grain fragments, including *Triticum* (wheat), a scrap of *Corylus* (hazel) nutshell, and individual charred fruits of *Cladium mariscus* (saw-sedge) and *Polygonum* sp (Crowson 2000b, Bates and Wiltshire 2000). At neither site are there grounds for thinking that plant food processing or consumption were significant activities. Animal bone was similarly sparse at Northwold, consisting only of abraded small fragments and a dog skeleton (A. Crowson pers. comm.). Consequently, the only macroscopic biological material with any potential for indicating the spatial distribution and type(s) of activity at the site is the wood charcoal.

Charcoal distributions and densities

Charcoal from the two samples from the mound deposit submitted for radiocarbon dating (context *30*, BS44, 47) was identified by Rowena Gale. It comprised *Corylus/ Alnus* (hazel/alder), *Fraxinus* (ash), *Prunus* (sloe?), Pomoideae (hawthorn group) and Salicaceae (willow/poplar). The radiocarbon results from sample BS44 are statistically consistent (T'=7.9; ν=4; T'(5%)=9.5; Ward and Wilson 1978) and the calibrated range of the weighted mean is 2195–2049 cal BC (3723±16 BP; OxA-6626-6726-6823-6846+UB-4100) as are those from BS47 (T'=1.1; ν=4; T'(5%)=9.5; Ward and Wilson 1978) with a calibrated range of the weighted mean of 2275–2045 cal BC (3743±16 BP; OxA-6847-6850+UB-4101).

However, examination of the distribution of charcoal densities (grams of charcoal >6mm/ litre of soil) shows that there were, in fact, two areas of high charcoal density (>10 grams/litre): one in the south-east of the mound (from which BS44 and 47 were taken), and one in the north-west. No samples were dated from the north-west concentration (BS11, 12, 14), so it cannot be determined whether two contemporaneous 'activity areas' were represented, or whether these concentrations were deposited during different phases of activity. One possibility is that the north-west concentration related to pit *52*, and the south-east one to pit *23*. This contrasts with Feltwell Anchor, where only one charcoal concentration and one water-filled feature were found.

These two sites showed very marked differences in the densities of charcoal within their burnt mound deposits. Most samples from Northwold included 1–10 grams of charcoal >6mm per litre of soil, whereas at Feltwell the modal density was less than 1 gram /litre: the burnt mound at Northwold included around ten times as much charcoal as that at Feltwell. Plainly, this observation cannot be explained with any confidence, but possible explanations in terms of the scale and/or efficiency of fuel use could be proposed. For example, one alternative is that combustion at Feltwell occurred in better-oxygenated conditions, so that a higher proportion of the fuel was reduced completely to ash, and less survived as charcoal. Unfortunately, this is not a testable hypothesis.

III. Molluscs

by Peter Murphy

Sparse shell assemblages were recovered from the lower 50cm of fill in pit *52*, and from the base of pit *14*. The methods and tabulated results are presented in the Appendix. Shade-requiring taxa typical of woodland habitats were present in most samples, and it is notable that molluscs characteristic of damp woodlands were reasonably frequent (*e.g. Carychium minimum, Cochlodina laminata, Vitrea crystallina, Euconulus alderi*: Kerney and Cameron 1979). Other land snails occurred sporadically. Freshwater species were absent from the base of pit *52*, but were moderately abundant in sub-samples from fill *181*, 40cm above its base. They included species such as *Anisus leucostoma* and *Aplexa hypnorum*, which can tolerate intermittent desiccation in small water bodies, and also some obligate freshwater species such as *Planorbis planorbis* and *Valvata cristata*. This suggests increasingly wet conditions through time.

Shell densities were low throughout, particularly at the bases of the pits, implying initial rapid infilling, probably in part by collapse of the pit sides. The rather higher shell densities at the top of monolith 63 (pit *52*) suggest lower deposit accumulation later.

IV. Insects

by Mark Robinson

Introduction

Methods of retrieval were the same as for plant macrofossils and molluscs and are contained in the Appendix. Sub-samples of 200g from the organic sediments in pits *14* and *52* were sieved down to 0.5mm. Coleoptera fragments were found in six of the samples. Whilst preservation of the Coleopteran remains was acceptable the concentrations were very low, being of the order of five identifiable items per kg. The results are listed in the Appendix.

Interpretation

Both pits contained a few small beetles which can live in stagnant water (*e.g. Anacaena* sp. and *Ochthebius* cf. *minimus*). Pit *52* yielded scarabaeoid dung beetles (*Geotrupes* sp. and *Onthophagus* sp.) which feed on the dung of domestic animals. *Phyllopertha horticola*, from pit *14*, has larvae that feed on roots in grassland. The beetles, therefore, hint that the pits held water and that there was pasture in the vicinity.

V. Palynology

by Patricia Wiltshire

Introduction

The excavation revealed a burnt mound with heat-shattered flint, and a series of pits and shallow linear features. Three main phases of activity associated with the burnt mound were identified. This activity lasted over a fairly short period *(35–165 years at 95% probability)* between *cal BC 2265–2165 years (at 95% probability)* and *cal BC 2140–2065 years (at 95% probability)* (Crowson and Bayliss 1999). The fills of two pits (*52*, *14*) (Figs 9, 12) and a palaeosol (*66*, sampled from context *45*) (Fig. 8) were subjected to palynological analysis with the aim of providing a picture of the vegetation at and around the site, both during its functional life and after abandonment.

A large circular pit, *52*, penetrated the water table and its basal deposits were waterlogged. Previous palynological assessment had shown them to be polleniferous (Wiltshire 1995). This feature represented an early phase of activity at the site while another pit, *14*, post-dated the original formation of the burnt mound and was dug into the burned deposits near its centre. An old ground surface (*45*, represented by palaeosol *66)*, had been buried by a bank (*55*) formed from the upcast of ditch-digging, and was assumed to be contemporaneous with the burnt mound.

Methods

Detailed methods are given in the Appendix.

Results

Detailed descriptions of local pollen assemblage zones and results (Figures 22–27 and Table 8) are presented in the Appendix. Taxa are generally arranged according to their abundance, and/or the order in which they first appear in the sequence. Results for pit *52* are shown in Figs 24 and 25, and Table 8. Figure 24 shows total pollen and plant spores, microscopic charcoal, fungal and algal palynomorphs, and the various plant groups. An hiatus in the record is shown by a gap in the diagram. Figure 25 is a diagram of major taxa only while Table 8 shows all other taxa. All results for palaeosol *66* are shown in Figs 22 and 23, and all results for pit *14* are shown in Figs 26 and 27.

Interpretation of local pollen assemblage zones

Palaeosol 66

Assessment of a 20cm monolith of the buried soil had shown previously that only the superficial deposits were polleniferous enough to warrant further analysis (Wiltshire 1995). Accordingly, only the upper 6cm, commencing at the putative surface of the palaeosol, were examined (see Figs 22 and 23). Pollen and plant spore concentrations were low throughout the profile, although preservation was marginally better in the upper 3cm. Both charred and uncharred wood fragments were present throughout.

Zone N66/1: the relative homogeneity in the pollen curves in this zone suggests that either (1) infilling of the feature had been very rapid so that the zone represents a short (though undetermined) length of time, or (2) that there had been a thorough mixing of the soil from 3–6cm. Percentages of arboreal pollen were high, with *Tilia*, whose canopy casts deep shade, being the dominant tree. *Corylus* and *Alnus* were also important components of the woodland locally while *Quercus*, *Pinus*, and *Ulmus* were less well represented. Ferns seem to have formed the understorey although there must have been open areas to support some herbs and possible cereal-growing in the catchment. There were probably moist soils present supporting Cyperaceae, although there is no direct evidence that the soil was waterlogged or even periodically wet.

It might be argued that the high representation of *Tilia* and fern spores, and relative abundance of Lactuceae and unidentifiable pollen, indicates differential decomposition of palynomorphs and a biased assemblage. However, more vulnerable taxa were well represented and, although it is likely that some palynomorphs had been lost, it is probable that this zone adequately reflects the vegetation at Northwold prior to human activity in the area.

Zone N66/2: the upper 3cm of the soil profile indicate marked changes in the local vegetation. Much lower percentages of *Tilia* were recorded while the representation of *Corylus, Quercus, Pinus*, and *Ulmus* increased. This suggests that *Tilia* had been managed in some way, resulting in a thinner canopy and allowing pollen of other shade-tolerant trees, as well as light-requiring taxa such as *Betula, Salix, Sambucus nigra*, and *Rubus*, to be deposited on the soil surface. Opening up of the tree canopy is also indicated by the presence of *Calluna* and herbaceous plants such as Poaceae, Chenopodiaceae (goosefoot), and *Plantago lanceolata* which are characteristic of open, disturbed soils. Ferns also seem to have benefited from higher light intensities with a marked increase in spores, except for *Polypodium*, a species usually found outside woodland only if it has suitable supports such as banks or walls. Cereal-type pollen was consistently present and this might support the suggestion that opening up of the site allowed extra-local pollen to be deposited. The lack of cereal macrofossils suggests that cereal processing waste might have been unimportant as a fuel supplement at the site (Murphy 1998).

Microscopic charcoal concentrations rose very markedly and this may be related to more intensive activity at the burnt mound. The ground also seems to have become wetter with Cyperaceae increasing, other wetland taxa being recorded, and algae growing on the soil surface. The presence of *Sparganium*-type and *Ranunculus* (*Batrachium*-type) probably reflects the proximity of a body of sluggishly-moving or stagnant water such as might be found in a ditch. The soil was wet enough to become anaerobic and iron pyrite framboids were able to form (Wiltshire *et al.* 1994). However, this wetness might have been periodic or seasonal since the high values for fungal remains, and particularly *Glomus*-type, suggests that plants (other than just Cyperaceae [see Smith and Douglas 1987]) were growing in the bioactive soil.

Pit 52

This feature appears to have been contemporary with activity associated with the burnt mound, and the lower fills seem to have accumulated early in the history of the site. A large hiatus is shown between zones N52/2 and N52/3 (see Figs 24 and 25, and Table 8), and this was due to the presence of woody debris in the profile making analysis impossible. Samples were taken from contexts *37*, *40*, *111*, *128*, *179*, *180*, and *181* (Fig. 9).

Zone N52/1: the erratic pollen curves, low palynomorph concentrations, and numbers of unidentifiable grains are symptoms of rapid sedimentation rates (Dimbleby 1985). It would be unwise, therefore, to ascribe significance to any apparent patterning in the pollen spectra. However, the large amounts of microscopic charcoal within the sediment support the contention that the feature was functional during the period of activity associated with the burnt mound. The abundance of iron pyrite framboids and presence of algae also suggest that the pit contained stagnant water with decaying plant material in the bottom (Wiltshire *et al.* 1994). The abundant fungal hyphae may have been derived from plant litter falling into the pit. Wetland plants also suggest that standing water, or very wet soils, were also available locally. It is impossible to say whether the burnt mound was set within a clearing, or simply within thinned, mixed woodland, but *Alnus*, *Corylus*, and *Quercus* were certainly dominant components of the vegetation. In any event, enough light was able to penetrate to allow light-requiring shrubs and herbs to flower, and *Pteridium*, which was probably well established in the woodland, was able to sporulate more freely as the woodland edge increased (Conway 1949; Dring 1965).

Zone N52/2: for the same reasons indicated above, it appears that sedimentation was rapid in zone N52/2. The very high levels of microscopic charcoal suggest that a great deal of burning was occurring locally, while the iron pyrite framboids indicate the continued presence of stagnant water, polluted with decaying organic material (Wiltshire *et al.* 1994). The only significant difference between the local environment represented by this zone and that in N52/1 is that the site seems to have become opened up even more, with weedy grassland and ruderal herbs being better represented. The presence of *Glomus*-type indicates that bioactive soil was eroding into the feature and this might be a function of increased disturbance. Overall higher values for cereal-type pollen and fern spores could also be indicative of an increasingly open woodland canopy. Crops might have been grown within clearings (Coles 1976; Edwards 1993; Wiltshire and Edwards 1993), and processing waste used to supplement other fuel. However, no cereal macrofossils were found in the feature (Murphy 1998) which suggests that the cereal pollen was being derived from a primary source.

Zone N52/3: quantities of plant debris in the sediment profile means that this zone is separated from the basal zones by a large hiatus in the record. The relatively high pollen and plant spore concentrations, the smaller number of degraded grains and a greater coherence in the palynomorph curves in N52/3 suggest that sedimentation rate was lower in this zone than in the bottom of the pit. The pollen diagram also shows that there had been considerable changes in the local environment by the time the sediments of N52/3 had accumulated. The very small amounts of microscopic charcoal suggest that activity at the burnt mound had ceased, although people were probably still occupying areas nearby since cereal-type pollen was frequent throughout the zone.

Iron pyrite framboids were not found and *Spirogyra* was more abundant than other green algae. *Spirogyra* is stimulated to produce spores during periods of desiccation (Round 1981) and its relative abundance, with the absence of iron pyrite, suggests that although the pit became wet enough to support algae, the sediments were frequently dry and aerated. This would lead to higher redox potential so that the reducing conditions necessary for framboid formation were not available. Areas of standing water must have been present in the vicinity, however, because *Sparganium*-type and *Alisma*-type (*e.g.* water plantain) were growing in the catchment.

This zone seems to represent a period after the burnt mound was abandoned. The marked increase in *Alnus* percentages suggests that the tree was recovering from some form of intensive management such as pollarding, coppicing, or even felling. However, the site must have been sufficiently open to allow the pollen of a wide range of other trees, shrubs, and herbs to find their way into the sediment.

Zone N52/4: a great deal of comminuted wood debris meant that another hiatus in the record occurred at the end of the previous zone, and the persistence of the wood at 10cm and 12cm means that the results from these two sub-samples are probably biased and should not be considered.

When compared with the previous zone, *Alnus* percentages are very much lower while those of other trees and shrubs are higher. This might suggest that during the period represented by the hiatus, *Alnus* had been preferentially selected and other trees and shrubs, ferns and herbaceous plants were able to increase. However, although percentage values for palynomorph spectra are preferred over absolute ones (see Calcote 1998) they can present problems of interpretation. Fluctuations, in the representation of plant taxa, might be more apparent than real since reciprocity can be a statistical artefact. However, removal of *Alnus* (even by coppicing) would allow enhanced dispersal of pollen and spores of other taxa. The rest of this zone shows that considerable changes had occurred at the site and these may have been due to renewed exploitation of the locality. The marked drop in *Alnus* percentages and the reciprocal increase of *Corylus, Quercus*, and other trees suggests that *Alnus* was being exploited preferentially.

The pit seems to have contained stagnant water, being damp enough to support green algae. The site appears to have become wetter, however, allowing Cyperaceae and other wetland plants to flourish, possibly in ditches or wet hollows. The marked increase in Poaceae and some herbs, and the massive increase in fern spores, also suggests that the clearing had become colonised by ferns, grasses and weeds which were able to flower and sporulate more freely as the influence of *Alnus* was reduced. It is interesting, though, that sporulating *Pteridium* fronds must have been present in small numbers. *Pteridium* does not do well in wet conditions and it is possible that the ferns represented so abundantly in this zone were species which tolerate or favour waterlogged soils, such as *Dryopteris carthusiana* (narrow buckler fern), or

Thelypteris palustris (marsh fern). *Dryopteris* and *Thelypteris* were certainly identified at the site (see Table 8), but when their spores lose their outer covering (perine), it is impossible to differentiate them from those of many other ferns (Pteropsida monolete indet).

People were still present in the area since microscopic charcoal was present at a low level throughout the zone, and cereal-type pollen was found in the uppermost sub-sample. In spite of evidence of continued use of the area, the centre of activity seems to have moved away from the immediate site, and the burnt mound was abandoned.

Pit 14

This feature was cut into the burnt mound and post-dated both the digging of pit *52* and the burial of the old ground surface. Some mixing of sediments might, therefore, be expected.

Zone N14/1: there is little doubt that the base of the pit accumulated sediment very quickly after it was dug. It also seems that the base of the pit penetrated the original soil surface underneath the mound. Up to 20% *Tilia* pollen was found in this zone and yet there is evidence that this tree (or least its flowering branches) had been drastically reduced before pit *52* had been constructed, and by the time the old land surface was covered by the bank *55* material. To be represented in the basal sediment of the pit, the pollen would have to have been brought up from below. It seems likely that the pollen assemblages in this zone result from the mixing of the palaeosol and sediments that were similar to those in the two basal zones of pit *52*. There are similarities with microscopic charcoal concentrations as well as with other palynomorph spectra such as *Pteridium*, Poaceae and fungal remains. One major difference, however, is the lack of iron pyrite framboids in the base of pit *14*. This feature did not appear to have reached the water table, nor to have functioned as a water reservoir.

Zone N14/2: the palynomorph spectra are similar to those in zone N52/3 in pit *52*, a layer of sediments that accumulated after abandonment of the mound. It seems likely, therefore, that the layers of deposits, representing the two zones in the two separate features, accumulated during the same period. There are differences in the actual percentages of the various spectra, as would be expected, but the overall relative abundances and patterns are very similar.

Zone N14/3: the palynomorph spectra in this zone are very similar indeed to those in zone N52/4 in pit *52* and there is little doubt that the two sets of sediments are contemporaneous. They record very similar environments.

Discussion

Soils with moderate to high levels of bioactivity are subjected to dynamic pedogenic processes and, therefore, differ from sediments in several important aspects. In soils, apart from penetrating roots, organic debris accumulates at the surface, gradually decomposes, and becomes mixed into the underlying, weathering mineral fraction at various rates. The speed of decomposition of organic material and its incorporation and mixing into the soil profile depends on many factors. The main influences are pH (reaction), pF (water potential), and Eh (redox potential) since these affect the soil biota and its interaction with the abiotic fractions of the soil matrix (Brady 1974; Wood 1995).

Circumneutral, aerated, base-rich soils will tend to support large populations of soil animals and micro-organisms and this usually results in rapid decomposition of organic material and thorough mixing throughout the soil profile over considerable depths. In these cases, it is unlikely that there will be a correlation between depth and age of soil components, and little patterning of palynomorph spectra. However, acidified soils which are prone to waterlogging are often stratified, and preservation and stratification of palynomorphs can be good. Even aerated soils exhibit these characteristics if microbial activity is inhibited by, for example, low pH (Wiltshire 1999a; Crabtree forthcoming). In these cases, changes in vegetation are often recognisable even though it is impossible to assign a chronology to events. At present, it is not possible to obtain reliable radiocarbon estimates from soils since the residence times of the organic fraction cannot be determined. Also, except in certain cases, palynomorphs in deeper horizons of soil profiles tend to have been subjected to decomposer activity for longer periods and can yield pollen spectra biased in favour of recalcitrant taxa (Dimbleby 1985). Although palynological analysis of palaeosols produces less refined results than those from undisturbed sediments, the problems associated with soil studies are often over-stated; there are many instances where there is convincing evidence of vegetation change being recorded in soil profiles (see Dimbleby 1985; Wiltshire 1997; Wiltshire 1999a; Wiltshire 1999b).

Analysis of palaeosol *66* has shown that some time before the site was exploited, dense *Tilia*-dominated woodland probably covered the area. By the time activity at the burnt mound was under way, the site had been opened up and *Tilia* seems to have been selectively targeted. A thinning of the canopy enabled the pollen of trees growing some distance away to become incorporated into the soil, and consequent enhanced light levels allowed shrubs and herbs to flower. Some time later, when the site was open, the soil surface appears to have become wet before being buried by a soil bank formed from the upcast from ditch digging.

Little is known about the nature of sediment accumulation in archaeological features, particularly in pits. It is often assumed that they fill very rapidly; but actual chronologies for sedimentation rates are difficult to obtain (Pitt-Rivers 1898; Cornwall 1958). Nevertheless, it has been shown that sediments within pits and water-holes can yield useful information on environmental change, both within features themselves and in the wider catchment (Manning *et al.* 1997; Wiltshire and Murphy 1998; Wiltshire forthcoming a), especially if sediments accumulated slowly. Even data obtained from rapidly-accumulating deposits can contain useful information. While there will be little meaningful patterning in individual pollen spectra in such cases, an idea of the range of plants in surrounding vegetation, and a broad picture of the relative importance of various plants in the habitat, may be gained. Conditions within the sediments themselves may also be revealed (Wiltshire forthcoming b).

It would appear that pit *52* contained stagnant water during its functional life and it might have acted as a water reservoir for the activity associated with the burnt mound. After it was dug, sediment accumulated very rapidly in the bottom of the feature. The high concentrations of iron pyrite framboids suggest that plant litter (probably leafy debris already infected with fungal hyphae) was allowed to ferment in the bottom (see Wiltshire *et al.* 1994), and the surrounding, bioactive soil contributed to the fill. It is possible that iron pyrite could form at any time in the history of the feature but it is difficult to see why this should happen differentially. It is more likely that its formation is indicative of conditions within the sediment as it was being deposited. As long as the matrix surrounding the iron pyrite retains a low redox potential, the framboids will remain stable even though upper layers may become aerated and not conducive to subsequent framboid formation.

The site was set in a woodland clearing, with *Alnus*, *Corylus*, and *Quercus* being the most abundant trees, and *Pteridium* being an important understorey plant. Later, more intensive management of the local trees accompanied the activity which was responsible for producing larger amounts of microscopic charcoal, and the pollen of other trees and shrubs growing extra-locally could be dispersed into the feature. Greater light intensities also allowed grasses and ruderals to flower more prolifically on the open and disturbed soils. Cereals were being produced and the lack of crop macrofossil evidence suggests that pollen was being dispersed from cereal plots growing in adjacent clearings and/or from processing near the site, rather than from crop waste used as fuel.

A great deal of woody debris seems to have been dumped into the pit, possibly when the site was abandoned. However, people continued to be active in the area since cereals were still being grown and charcoal continued to find its way into the feature. After abandonment, there was a marked recovery of *Alnus*, and *Salix* was frequent. The higher representation for these trees might represent the plants' response to cutting: regeneration would have been accompanied by multiple branching and great flowering capacity. Both plants can flower within four years of severe coppicing and pollarding (personal observation) so their recovery would be registered quite rapidly in a pollen diagram. The surroundings also seem to have become wetter, but pit *52* probably dried out seasonally. Later still, the site seems to have become even wetter and *Alnus* was managed such that its flowering capacity was much reduced. Other trees appear to have been unaffected and were better represented in the record, while the open areas seem to have become colonised by weeds and grasses with sedges and ferns. It is interesting that *Tilia* percentages increased slightly in this latter phase. It is disappointing that it was not possible to analyse the deposits that later accumulated over the whole site. It would have been interesting to see whether this valuable resource tree recovered from the previous intense management when the clearing was abandoned. This was the case at Feltwell Anchor, about 6km to the south-west on the Norfolk Fen-edge (Bates and Wiltshire 2000).

Pit *14* cut into the pre-mound surface, and sediments which had accumulated over that slumped into the bottom of the pit quite rapidly. The function of the pit cannot be ascertained from the palynological record, but it would appear that deposits which accumulated in the top half of the sequence were contemporaneous with the upper sediments of pit *52*. This might mean that pit *14* had a very short functional life.

Differences shown in the pollen diagrams can be explained in terms of spatial heterogeneity since any surface accumulating pollen will be influenced more by *in situ* and closely adjacent plants than those even small distances away. However, both features show that after the mound was abandoned, people continued to be active in the area and cereals were being grown. *Alnus* appears to have become the most abundant tree but this may have been a response to coppicing or pollarding, which resulted in enhanced flowering during recovery. Later still, *Alnus* declined and there was a reciprocal increase in the representation of other trees, shrubs, and open habitat herbs. *Salix* increased considerably as well as grasses and weeds. However, the site also seems to have become invaded with ferns and sedges. Judging by the increase in Cyperaceae, and the low representation of *Pteridium* (which cannot tolerate waterlogging), it is likely that the ferns were species tolerant of high water table. *Pteridium* is able to spread very aggressively into clearings and it is probable that wetness was responsible for limiting its expansion (Grime *et al.* 1988). The decline in *Alnus* might have been due to active exploitation of the tree and its removal coincides with other marked changes at the site. Although mixed woodland prevailed locally, the immediate site remained open, although it seems to have been wetter and dominated by grasses, sedges and ferns.

VI. Soil micromorphology

by Charly French

Introduction

Excavation of this Beaker period burnt flint site provided truncated exposures through the mound itself, the surviving palaeosol and linear features beneath the mound. The site is situated at the base of the northern slope of a sand ridge, with the lower levels of the site still covered by a thin horizon of desiccated wood peat.

Two sets of soil blocks were taken in order to investigate the pre-site soil type and land-use, the possible function and infilling sequence of one of the pre-mound ditches as well as the nature of the composition of the mound itself. Profile 1 was taken from the re-exposed FEP trench of Leah and Matthews (feature *9*, Fig. 7) at the very western edge of the mound through the *in situ* palaeosol. Profile 2 was taken through a southern exposure of the mound where it overlay a linear feature *41* (Fig. 4).

The methodology of Murphy (1986) and Bullock *et al.* (1985) were used to process and describe the thin sections, respectively. The detailed micromorphological descriptions are contained in the Appendix.

Descriptions

Profile 1

A depth of *c.* 40–50cm of peaty sand ploughsoil overlies a *c.* 10cm surviving thickness of buried soil. This truncated soil was composed of an apedal, porous and homogeneous loamy sand. It has suffered severe loss of the organic and fines (silt and clay) components through leaching and oxidation/disturbance, processes probably associated with recent intensive arable use. Unfortunately, this remnant of the *in situ* soil is devoid of most features relating to past pedogenic processes, and very little else may be gleaned.

Profile 2
This profile was taken through the burnt mound and a variety of underlying sediments/feature fills. The profile is described from thin sections as follows:

0–3cm	wood charcoal (see P. Murphy, this chapter) of burnt mound
3–8cm	peaty sand with wood charcoal and burnt flint fragments (1–15mm) of burnt mound
8–13cm	dense calcitic sand with two intermittent lens of peaty sand
13–14cm	lens of peaty sand and wood charcoal
14–17cm	mixture of peat and calcitic sand
17–20cm	porous loamy sand

The dense horizon of wood charcoal must be the remains of the fuel used in the process associated with the burnt flint mound. The underlying peaty sand with wood charcoal and burnt flint (3–8cm), and the dense calcitic sand (fabric 1; 8–13cm) may represent mound material comprised of soil, subsoil and general debris associated with the manufacturing process on site and the creation of the mound. There are two lenses of peaty sand within the mound make-up, which may indicate natural hiatuses occurring in the use of this part of the mound.

This mound material is situated on the fill of an earlier ditch, *41*, of which the upper part was analysed in thin section. It comprises an upper lens of peaty sand (13–14cm) developed as a standstill horizon on a peaty calcitic quartz sand (fabric 2; 14–17cm) and leached loamy quartz sand (fabric 3; 17–20cm). The upper fill type appears to be a mixture of soil material (as in Profile 1 above) and mound material (as at 8–13cm above). It may therefore represent a mixture of partially oxidised former soil and/or subsoil material. The abundant presence of calcium carbonate throughout the void space suggests proximity to the ambient water table in the past. The latter fill type (= fabric 3) bears remarkable similarity to the base of the surviving palaeosol in Profile 1, and may be eroded soil material.

Interpretation
The palaeosol preserved beneath the mound is a poorly surviving relict of the presumed original soil profile. There are few signs of pedogenesis other than to say it has been subject to the incorporation of minor amounts of illuvial silty clay and an organic component which has largely degraded through subsequent oxidation and micro-biological decay. Unfortunately, there is insufficient information on which to base any discussion of past land-use at this site, but it would appear that this old land surface and soil had suffered some degree of truncation in the past.

The surviving mound material is composed of a mixture of wood charcoal, peaty sand and redeposited loamy and calcitic sand similar to that observed in the surviving buried soil profile. The upper fills of the underlying ditch indicate the erosion of sediments similar to the buried soil and subsoil as well as peat formation, all of which have been subject to the alternating rise and fall of the groundwater table, oxidation and the desiccation of peat and the organic component.

Examination of near contemporary sites at Feltwell Anchor, Norfolk (French 1992) and Coveney, Cambridgeshire (French 1993), revealed some similarities. At Coveney, the burnt flint mound profile survived as a truncated, thin, but extensive spread of burnt flint associated with *in situ* B horizon soil material and possibly redeposited subsoil material. At Feltwell, the burnt mound was comprised of charcoal and burnt flint, and was situated on the weathered surface of the subsoil. Thus, all of these sites are associated with some degree of truncation of the associated palaeosols.

VII. Wood
by Peter Murphy

Introduction
Wood was collected by hand during the excavation. Notes on the form and state of preservation of the wood were made, and the material was identified, where possible, using criteria defined by Schweingruber (1978). A catalogue of the wood is included in the Appendix.

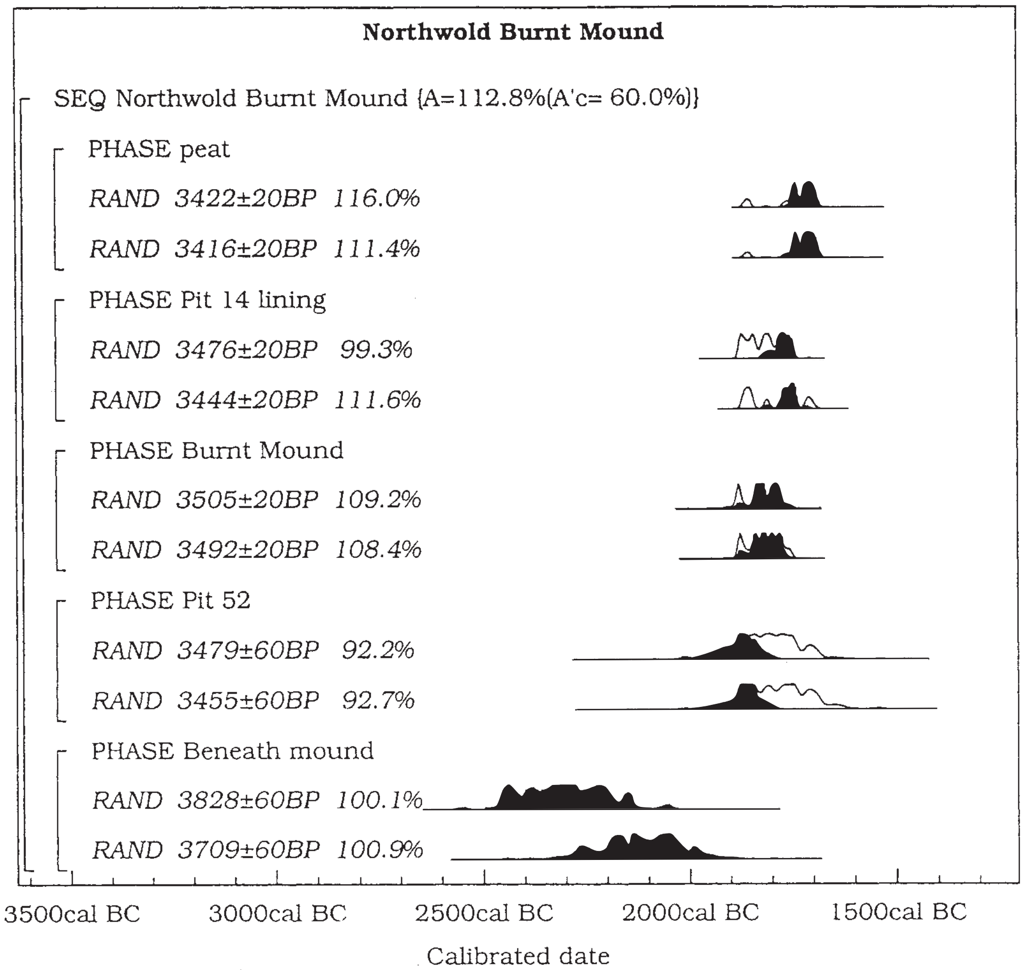
Description
Much of the wood from the site was in a very poor state of preservation, due to de-watering, microbial degradation and compression by the weight of overlying deposits. The peat covering the archaeological deposits was a wood peat, and from the presence of badly degraded seeds and female catkins of alder (*Alnus glutinosa*) was clearly an alder wood peat, but the wood in it was too degraded to be identified. It showed the radial fissuring and contorted rays characteristic of de-watered wood undergoing physical deformation and microbial degradation.

Some wood from the upper fills of archaeological features (principally pits *14* and *52*) was similarly poorly preserved, fragile and crumbling, with no bark or cut surfaces surviving. Brief descriptions of these pieces were made and samples removed for sectioning and microscopic examination. Most of the wood was then discarded, retaining only sub-samples for potential radiocarbon dating. The cell structure of most pieces (*60*, *121–6*) was far too disrupted for identification.

However, a stake (*176*c) from pit *52*, and horizontally-laid thin boards from the base of pit *14* (*189*, *190*), were in somewhat better condition. It was noticeable that the two boards from the middle of pit *14* were quite well-preserved, in terms of gross structure, whereas those from the periphery of the feature were more decayed. Perhaps the wood itself, by retaining water, created its own micro-environment in the middle of the pit (for cross-sections of *188–192*, see Figure 28).

The cell structure of the boards was, in general, in a poor state. In transverse section there was gross deformation (contorted rays, radial fissures and collapse of cells), and fungal hyphae were observed in vessels. In radial longitudinal section most specimens showed at least a few scalariform perforation plates with more than ten bars, and the rays were homogeneous. From these characters, these boards were thought to be of alder (*Alnus* sp).

The cell structure of the hazel (*Corylus* sp) stakes from pit *52* (*176* a–c), was much better, mainly because they were not subject to lateral compression.



The radiocarbon results were simulated using the RAND function of OxCal, with error terms estimated from the type of material available from each context. The distributions plotted in outline are the result of simple radiocarbon calibration. The distributions plotted in black are based on the chronological model used. The large square brackets down the left hand side along with the OxCal keywords define the overall model exactly.

Figure 16 Probability distributions of dates from a simulation of the sequence at Northwold: each distribution represents the relative probability that an event occurred at a particular time

VII. Interpreting chronology

by Alex Bayliss, Christopher Bronk Ramsey, Andy Crowson and F. Gerry McCormac
(Figs 16–19, Table 3)

Introduction

Eighteen radiocarbon measurements were made on ten samples of waterlogged wood, plant macrofossils and charcoal from the sequence of deposits at Northwold. Ten determinations were made by the Oxford Radiocarbon Accelerator Unit and eight by the Radiocarbon Dating Laboratory of the Queen's University, Belfast in 1996–7.

Aims of the dating programme

The radiocarbon dating programme had two major objectives. Firstly to provide precise dates for the period of use of the mound and the associated Beaker pottery. This would allow inter-site comparisons to be made with some knowledge of the relative dating of the sites and assemblages under consideration. Secondly to investigate the chronological make-up of the mound, particularly with reference to possible spatial differences. For this reason bulk samples of charcoal were retrieved on a 1m grid (see above Chapter 2, I. Methodology). The aim was to distinguish reliably between two hypotheses — that the mound represents a very short period of activity, or that it represents a long period of use. If either of these objectives could be successfully achieved, it was hoped that the site could contribute to wider archaeological research into the dating of Beaker pottery (Kinnes *et al.* 1991) and into the morphology of burnt mounds (Hodder and Barfield 1991).

Analytical approach

Although the simple calibrated date ranges of radiocarbon measurements are accurate estimates of the dates of the samples, this is usually not what we really wish to know as archaeologists. It is the dates of the archaeological events that are represented by those samples that are of interest. For this reason an interpretative, contextual, approach has been taken to answer the archaeological objectives for the dating of the site.

Explicit methodology is now available which allows the combination of the results of the radiocarbon analyses with other information, such as stratigraphy, to produce realistic estimates of these dates of archaeological interest. It should be emphasised that these distributions and ranges are not absolute, they are interpretative *estimates*, which can and will change as further dates

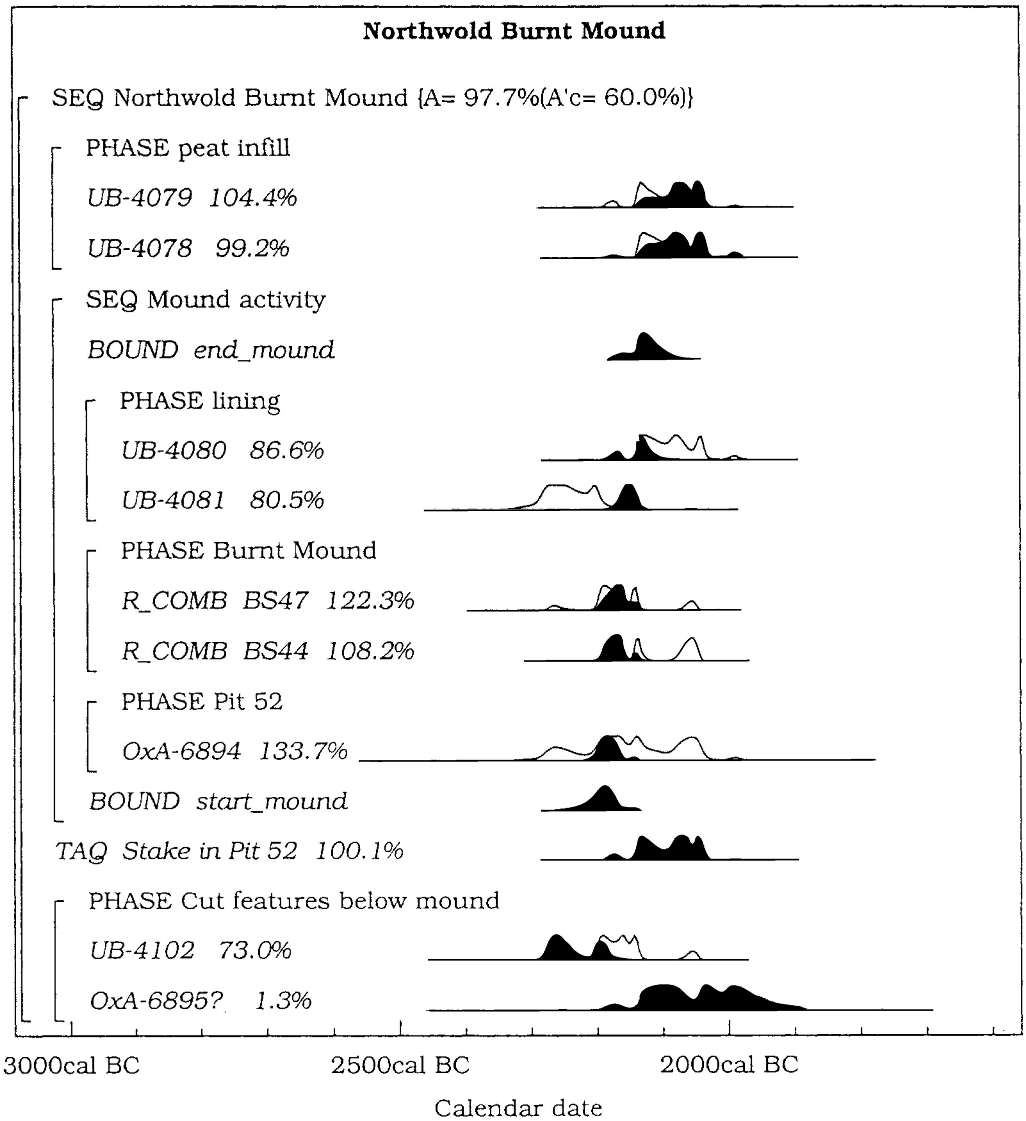


Figure 17 Probability distribution of dates from the sequence at Northwold: each distribution represents the relative probability that an event occurred at a particular time. The format is identical to that of Figure 16

become available and as other researchers choose to model the existing data from different perspectives.

The technique used is known as 'Gibbs' sampling' (Gelfand and Smith 1990) and has been applied using the program OxCal v2.18 <http://www.ox.ac.uk>. Full details of the algorithms employed by this program are available from the on-line manual or in Bronk Ramsey (1995), and fully worked examples of this approach are given in the series of papers by Buck *et al.* (1991; 1992; 1994). The algorithms used in the models described below can be derived from the structure shown in Figs 16–19.

Here we concentrate on the archaeology — particularly on the reasoning behind the interpretative choices that we have made in producing the models. These archaeological decisions fundamentally underpin our choice of statistical model.

Sampling

Fortunately a relatively complete stratigraphic sequence was preserved and recovered from Northwold (see above Chapter 2, IV. The burnt mound and associated features). By taking this sequence and examining the type of material that was available for dating from each context, a series of samples of known relative age was identified. Utilising an archaeological estimate (based on stylistic attributes and provided by prehistoric ceramic analyst Sarah Percival) of 1800 BC for the date of the rusticated Beaker that was recovered from part of the sequence, the simulation shown in Fig. 16 was constructed. This suggested that it might be possible to date the mound to within a century if high-precision measurements could be obtained.

The desirability of high-precision dates was also shown by estimating how many measurements would be required to distinguish between a short phase of use for the

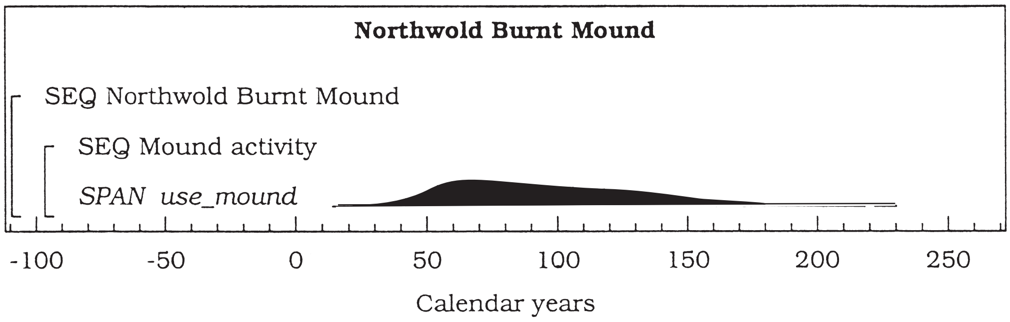


Figure 18 Probability distribution of the number of years during which the mound was in use, derived from the model defined in Figure 17

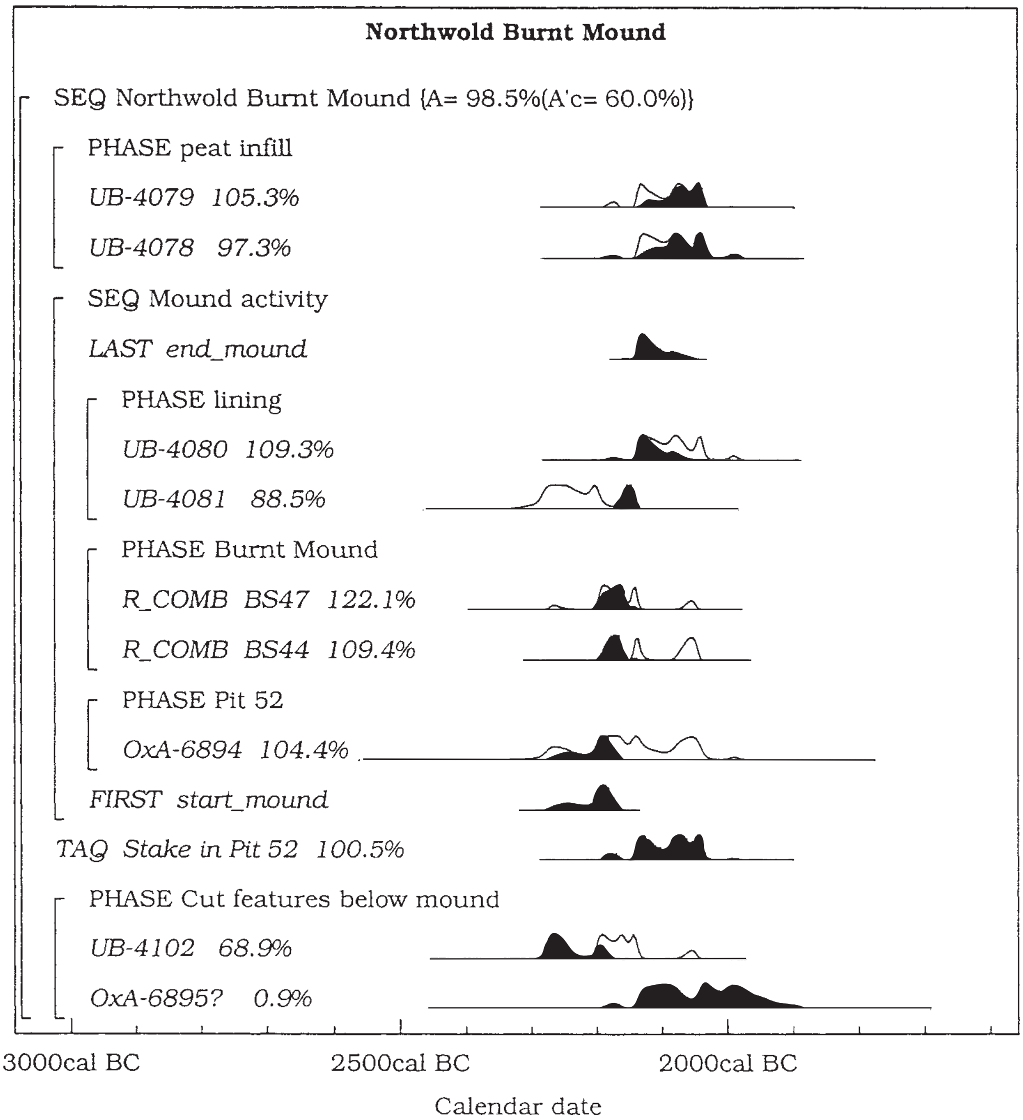


Figure 19 Alternative model for the dating of the sequence at Northwold: each distribution represents the relative probability that an event occurred at a particular time. The format is identical to that of Figure 16

Laboratory Number	*Sample/Context Reference*	*Radiocarbon Age (BP)*	*$\delta^{13}C$ (‰)*	*Weighted mean (BP)*	*Calibrated date range (95% probability)*
UB-4078	*123*	3682±20	26.8±0.2	-	cal. BC 2140–1985
UB-4079	*125*	3692±20	28.7±0.2	-	cal. BC 2185–2030
UB-4080	*188*	3682±20	28.9±0.2	-	cal. BC 2140–1985
UB-4081	*192*	3783±24	28.9±0.2	-	cal. BC 2315–2140
UB-4099	*176*	3692±20	30.2±0.2	-	cal. BC 2185–2030
UB-4102	BS94, *251*	3751±22	27.5±0.2	-	cal. BC 2280–2045
OxA-6894	BS62, *128*	3730±45	25.2	-	cal. BC 2290–2030
OxA-6895	BS74, *200*	3650±45	28.6	-	cal. BC 2190–1890
UB-4100	BS44, *30*	3706±21	27.9±0.2		
OxA-6626	BS44(i), *30*	3750±55	26.4		
OxA-6726	BS44(ii), *30*	3770±55	26.4	3724±16 (T'=7.9; T'(5%)=9.5; ν=4)	cal. BC 2195–2040
OxA-6823	BS44(iii), *30*	3840±55	26.1		
OxA-6846	BS44(iv), *30*	3650±55	26.5		
UB-4101	BS47, *30*	3746±22	27.7±0.2		
OxA-6847	BS47(i), *30*	3730±60	28.0		
OxA-6848	BS47(ii), *30*	3700±50	25.8	3743±16 (T'=1.1; T'(5%)=9.5; ν=4)	cal. BC 2275–2045
OxA-6849	BS47(iii), *30*	3765±45	26.3		
OxA-6850	BS47(iv), *30*	3755±45	26.3		

Table 3 Radiocarbon determinations

mound and a long one of 200 years or more. For the fairly short phases which were expected in this case, high-precision measurements are extremely cost-effective (Bayliss and Orton 1994).

Of course, the mathematical approach taken here depends fundamentally on the relationship between the actual date of the formation of the archaeological context and the date of the material sampled. Because of this the taphonomy of the samples selected for dating has been discussed explicitly as part of the description of the structural sequence given in Crowson and Bayliss 1999.

All the samples from the site submitted for radiocarbon dating were plant remains. Since the centre of a large tree will have the radiocarbon content of the year in which the tree-ring grew, it is essential that all the material should be identified to age and species before dating (van Strydonk *et al.* 1999). Otherwise there will be a significant offset between the actual date of the material which has been sampled and the date of the archaeological context, irrespective of how the sample reached the context. For this reason, samples of short-lived species or of roundwood or sapwood were submitted in order to minimise the age-at-death offset present in samples from tree-rings (Crowson and Bayliss 1999, table 1).

Radiocarbon analysis

Samples processed in Oxford were prepared using methods outlined in Hedges *et al.* (1989) and Bronk Ramsey and Hedges (1997), and measured using Accelerator Mass Spectrometry (Hedges *et al.* 1989). In Belfast they were processed according to methods outlined in Tans *et al.* (1978), Pearson (1984) and McCormac *et al.* (1992), and measured using Liquid Scintillation Counting (Noakes *et al.* 1965).

Both laboratories maintain continual programmes of quality assurance procedures, in addition to participation in international inter-comparisons (Rozanski *et al.* 1992; Gulliksen and Scott 1995). These tests indicate no laboratory offsets and demonstrate the validity of the precision quoted.

Radiocarbon results

The results are given in Table 3, and are quoted in accordance with the international standard known as the Trondheim convention (Stuiver and Kra 1986). They are conventional radiocarbon ages (Stuiver and Polach 1977).

Calibration

The calibrations of these results, which relate the radiocarbon measurements directly to the calendrical time scale, are given in Table 3 and Figure 17. All have been calculated using the dataset published by Pearson and Stuiver (1986) and the computer program OxCal (v2.18) (Bronk Ramsey 1995). The calibrated date ranges cited in the text are those for 95% probability. They are quoted in the form recommended by Mook (1986), with the end points rounded outwards to 10 years if the error term on the measurement is greater than ±25 or to 5 years if it is less than this. The ranges in italics are ranges derived from mathematical modelling of archaeological problems (see below). The calibrated ranges in Table 3 have been calculated according to the maximum intercept method (Stuiver and Reimer 1986), all other ranges are derived from the probability method (Stuiver and Reimer 1993; van der Plicht 1993; Dehling and van der Plicht 1993).

The interpretative model

The model of the chronology of the site is shown in Figure 17. This integrates the radiocarbon evidence with the relative dating that is provided by the stratigraphic sequence. It should be said that two results were not in good agreement with the original stratigraphic position suggested by the archaeological interpretation. It seems likely that BS74 did not really come from a pre-mound feature (A=12.9%; Bronk Ramsey 1995), but was intrusive. It has therefore been excluded from the model. UB-4099 has been included in the model as a *terminus ante quem* for the material below it. This is because it is possible that this stake was driven into the pit at a later date than originally envisaged.

All the results from the burnt mound are statistically indistinguishable (T'=9.9; T'(5%)=16.9; ν=9; Ward and

Wilson 1978). This suggests that there is no chronological variation in the make-up of the mound in different grid squares. Nevertheless, we have decided not to take a weighted mean of all the measurements, since we do not know that all the fragments of wood are of exactly the same date. Instead we have taken a weighted mean for each sampling unit (BS44:T'=7.9; T'(5%)=9.5; ν=4; BS47: T'=1.1; T'(5%)=9.5; ν=4). This approach makes the same assumption as if we had simply taken bulk samples for radiometric dating from the mound (Ashmore 1999). The statistical consistency of the results suggests that this is reasonable.

Using this approach and the model shown in Figure 17, we can see that the actual burnt mound activity is dated to *cal BC 2195–2155 (at 95% probability; BS44)* or *cal BC 2200–2140 (at 95% probability; BS47).* The mound and associated activity, such as the construction of pits *52* and *14*, started in *cal BC 2265–2165 (at 95% probability)* and ended in *cal BC 2140–2065 (at 95% probability)*. This activity lasted for a relatively short period of time, estimated as between *35 and 165 years (at 95% probability*; Figure 18).

Sensitivity analysis

In order to investigate the potential problem of statistical scatter on the radiocarbon measurements (Steier and Rom 2000), an alternative model for the dating of the site has also been constructed (Figure 19). The results of this analysis are very similar to those from the model shown in Figure 16. For example, this model estimates that the burnt mound and associated activity started in *cal. BC 2245–2160 (at 92% probability)* and ended in *cal. BC 2175–2075 (at 95% probability)*.

Chapter 5. Discussion

I. Early events

If modern agricultural practices in southern Fenland continue along the path of ever increasing intensification, progressively earlier sites will continue to be exposed to the plough as the remaining peat shrinks and blows away. Sites of Mesolithic and Neolithic date, discovered through survey, are already represented in the Norfolk peat fens, primarily along former courses of the rivers Wissey and Little Ouse and on the desiccated fen-edge (Healy 1991). The distribution of these finds coupled with records and observations of soil exposures show that at least a similar range of environments was available to these earlier communities as to Bronze Age populations. Our knowledge of the earlier periods will expand as sites presently buried under post-Neolithic peat are revealed.

Dating the earliest silt-filled features at Northwold is problematic. Unfortunately, none produced macrofossils suitable for radiocarbon analysis. The find of a single leaf-shaped arrowhead on the surface of the buried soil provides a very approximate *terminus post quem* for its formation, but is scarcely sufficient to attribute a date to the early features. Whilst the arrowhead tells us that earlier Neolithic people were active in the area, micromorphological and palynological analysis of the buried soil reveals something of the environment they inhabited and perhaps helped shape.

Generally, the palaeosol appeared in a somewhat truncated state. However, the severe micro-biological decay that it was subjected to was not the cause, and the reasons for truncation are not clear. In spite of its differential survival, however, part of the soil profile sealed beneath the upcast bank retained adequately preserved palynomorphs to determine aspects of the local environment. Before extensive human activity began in the area, woodland, dominated by lime with some hazel and alder, covered the site. Soils were moist, but some cereals were being grown in more open areas in the district. It is difficult to interpret accurately from the pollen record the point at which the early features were actually dug. However, there may be an association with an opening up of the tree canopy and the marked depletion (and suggested preferential selection) of lime trees prior to the formation of the burnt mound.

The fills of the early features contrast starkly with those related to mound activity. Different processes of sedimentation were occurring and the early features filled quite rapidly, principally with water-borne silts. None, therefore, could have remained open for any length of time. Nevertheless, given the paucity of excavated pre-Bronze Age occupation evidence in Norfolk, the silt-filled features are of some importance. Hall and Coles (1994, 45) state that Fenland's combination of good trees, woodland soils, water and grazing potential encouraged small-scale farming from the early fourth millennium BC. This, notwithstanding Healy's observations that Neolithic occupation sites in Norfolk show a preference for elevated positions (Healy 1984, 98–9), may well be borne out by the Northwold evidence.

If the attribution of a Neolithic date is correct, the sinuous ditch and its supposed western parallel may represent very early efforts to enclose, partition or drain for farming in a woodland clearing. Pit digging is in keeping with evidence from Neolithic occupation sites, although the contents of the Northwold pits offer few clues as to their original function. It is difficult to argue a structural function for most of the 'post-hole' features, which may well be the truncated remains of shallow pits.

The two exceptions to this are the large features cut by the sinuous ditch in the east and cutting the other ditch in the west. These almost certainly held timber uprights, but their apparent isolation leaves their function open to speculation. Their purpose was evidently lost at some point and it seems likely that the superimposed features reflect repeated, short-term occupation consistent with a mobile (and perhaps seasonal) economy.

The accumulation of peat over the tops of the infilled features marks a lengthy hiatus in occupation of the site before the arrival of the Early Bronze Age hot rock technicians.

II. The mound, its features and functions

Given the volume of burnt flint in the ploughsoil and the surviving depth around its edges, a conservative estimate of the original height of the mound would be a minimum of 0.50m. Between discovery (1987) and excavation, seven and a half years of intensive cultivation and soil erosion had undoubtedly further reduced the mound and dispersed flints throughout the ploughzone. By contrast, on the north bank of the river Waveney at Scole, a burnt mound sealed beneath peat that had never been subjected to agricultural denudation stood up to 0.65m high. A second probable mound to its north had been heavily disturbed from the Roman period onwards, and was consequently spread and reduced to no more than 0.20m (Ashwin and Tester forthcoming). The Northwold mound fell somewhere between these situations, having remained undisturbed beneath its protective blanket of Bronze Age and later peat until relatively recent drainage schemes allowed the land to be taken into cultivation.

Whilst weathering of the exposed mound surface undoubtedly contributed to fracturing the flint, the small size of the fragments clearly reflects repeated use of the raw material to a point beyond which it was no longer useful. Although good quality flint is relatively abundant on the upland to the east, it is possible that rough or flawed surface-gathered flint — that is to say material that was not entirely suitable for working — would have been chosen. Thereafter, bigger nodules were probably deliberately broken down and re-use of already small material was carried out.

It is difficult to see flint in this region as a precious resource, so it could be that either the effort in transporting it fenward (either overland or by river) mitigated against frequent re-stocking, or that small pieces — being quicker to heat up — were actually preferred. Sizes of no more than 10–30mm have been recorded on all the burnt flint sites excavated in Norfolk over the last ten years. Gathering this reduced material to re-heat must have involved the use of shovels or containers. Perhaps the inevitable inclusion of tiny shards of flint in the heated water was not a problem to its use.

Many hundreds of separate heating sessions must have taken place to reduce the raw material to such small fractions. Usage calculations of burnt mounds have been attempted in Ireland by measuring a number of variables in mound composition to determine an approximate number of uses (results available at <http://www.discoveryprogramme.ie>), a technique that could usefully be applied to mound excavation in Britain.

Identification of fuel charcoal from the Northwold mound by Rowena Gale revealed a dominance, in what was an admittedly mixed assemblage, of *Corylus/Alnus* sp. Similar results were obtained from Feltwell Anchor (Crowson 2000b, Bates and Wiltshire 2000) and this pattern is not thought to be an artefact of different burning temperatures (R. Gale pers. comm.). Although alder is a poor choice of fuel in comparison to other wood, such as oak, its pre-eminence may indicate intentional selection as the charcoal assemblage points to lesser use of several other tree species growing in the area. Moreover, this apparent choice could be a signal that quality timber was reserved for more important ventures than bonfires by the side of a bog. Alternatively, and perhaps most appealingly, alder and the range of other wood including ash, hawthorn and willow, may simply illustrate the tree-types that were cleared from the immediate locality — and needed to be cleared continually with seasonal regeneration — to accommodate the heating centre.

The shape of the mound is of some interest, inasmuch as it tends to the classic 'horned' outline. This contrasts with other local examples which are tear-drop-shaped (Feltwell) or linear (Scole). In Dyfed differentiation into oval, crescentic, kidney and horseshoe forms has been made (J. Hall pers. comm.), expanding on the classic characterisation of the New Forest 'boiling mounds' (Pasmore and Pallister 1967). Based on previous interpretations of the 'horned' ground-plan, the palpable explanation is that the shaft-like pit provided the focus of the burning activities and burnt debris was discarded and fanned out from that point.

Charcoal densities at Northwold, on the other hand, imply two distinct foci of burning in the north-west and south-east of the mound. Fires were not detected off the mound, and thus it appears that burning/heating took place surrounded by the wet features, but not immediately next to them. Heat loss in the flint during transfer from fire to water must have been a prime consideration. Fire debris was consequently spread from (at least) two different centres and the 'horned' plan developed as refuse crept out and was 'swallowed' by the pit.

That the scattering of burnt material was not a constant event was noted in a soil micromorphological profile. Two hiatuses in debris deposition in the south-east of the mound were noted through the development of peaty sand lenses.

Although waste accumulation may have reached a point at which it was no longer effective to continue heating and clearing, it is also possible that constriction of the mound limits was intentional rather than being governed by other considerations or agencies. Deliberate heaping may have occurred in order to advertise the presence of the mound. Large exposures of white stones in the Fenland landscape would certainly make a statement of occupation, if not possession. The insertion of an inhumation through the centre of the mound at Feltwell Anchor (Leah and Crowson 1994, Crowson 2000b, Bates and Wiltshire 2000) must at least identify the larger mounds as visible monuments in the field. This concept can also be demonstrated in South Wales, where a standing stone is sited atop a mound (Crane and Manning 1998). In another Welsh example a mound has grown around a standing stone. A Late Bronze Age man was found apparently decapitated at a Leicestershire burnt mound (Beamish and Ripper 2000).

Instances such as these may suggest an occasional ritual or ceremonial aspect to burnt mound formation. A degree of such behaviour may also be evident at the Northwold mound. The micromorphological analysis demonstrated episodic build up of burnt material, which implies repeated visitation rather than sustained occupation and the spreading of small amounts of burnt stone and fire debris on each visit. The deposition of pottery on the mound and in associated features during these visits might contain an element of ritual re-use of semi-complete 'domestic' vessels, of deliberate deposition rather than accident. Likewise, it is felt that the cache of water-rounded pebbles represents the placing of selected objects in a particular place. All of these items were left on or next to the mound and were subsequently sealed under fresh deposits of burnt stone or engulfed by encroaching peat-forming vegetation.

The precise mechanics of the mound and its associated features cannot truly be identified: we can only go so far. Stratigraphy, palynological analysis and radiocarbon dating have identified the shaft-like pit as the first feature cut during this phase of activity. If its interpretation as a water source or well is correct, it was also the most fundamental element of the site. Although material from the mound found its way into the pit, most likely through collapsing of its upper edges, the pit was never used for waste disposal or burial of any sort. On the contrary, as shell densities show, there was little accumulation in the pit after collapsing sides had part-filled its base: it was cleaned out, kept open and re-modelled over time. What other purpose are we to imagine for a large, deep, maintained, open pit with water in it when found in conjunction with a process with a large water requirement?

The preserved macrofossil and pollen records reveal much about the pit itself and the local environment during the lifetime of the mound. Dug through the groundwater table the pit provided a source, if questionably fresh, of water for the heating operations. Freshwater species of beetle and the presence of some freshwater plants support this theory. Furthermore, palynological analysis identified fermenting plant litter and many perfectly preserved oak leaves retrieved from the bottom of the pit would simply not have survived had they not been waterlogged since the day they fell into the open feature. Towards its base the pit sides were unstable, perhaps through containing groundwater, and contributed to a fairly rapid initial infilling. The fact that freshwater snails were absent from the base of the pit is explained by this quick collapse of natural soils from the pit sides. Significantly, freshwater snails are described as abundant above this point. Even at an early stage burnt flint and microscopic charcoal were entering the pit, showing that burning activities commenced more or less immediately after its excavation. It had been dug in a mixed environment that was part open, part wooded and part wet. Grassland and woodland herbs and weeds were present alongside wetland plants. Oak, which had increased with the depletion of lime, is regarded as the most populous tree at this time, an observation corroborated by the abundant intact leaves recovered from the lowest pit sediments.

The pit was almost certainly never covered and became polluted, not only with charcoal from the mound, but also with a build up of decaying vegetative matter. The most common interpretation of burnt mound sites is that they were for cooking, but if water quality was this poor, would cooking with it be desirable? Was it this pollution that eventually caused the other pits to be dug?

In spite of its stagnation the pit continued in use, later being cleaned out after progressive encroachment of burnt deposits. Prior to that episode, the very act of taking water out of the well must have disturbed the ground and introduced contaminants into the pit. It is suggested that the position of the tree trunk on the north-east side of the pit is not coincidence, but provided a small platform or firm foothold from which to safely reach the pit waters. Water may have simply been drawn manually with a wooden or ceramic vessel, but we should not discount the possibility of a rudimentary derrick, rope and bucket to plumb below the surface scum and increase efficiency.

The pit's environmental record certainly shows that people were exerting a tangible impact on the surrounding landscape: woodland was receding whilst grassland, and even limited cereal growing, were increasing. Escalating demand for timber as a fuel source for the mound cannot be proven, with clearance and farming of adjacent land the most likely cause of tree depopulation.

Questions over the purpose of burnt mounds have long been disputed and will not readily be resolved. All the recent Norfolk excavations have, rather sadly, failed to reveal any new technologies or substantial clues as to their exact use. Irish archaeologists adhere to the earliest interpretations: that they represent cooking sites, with an abundance of supporting evidence (O'Drisceoil 1988) and some experimentation/reconstruction (O'Kelly 1954, Lawless 1990). Evidence for plant food processing or consumption at Northwold, however, was entirely absent. Bone remains from the site did include food items, but perhaps because of indifferent preservation, these are insufficient to support the cooking argument.

Absence of bone and seed evidence on mounds has been used in support of Barfield and Hodder's sweat lodge theory (Shennan 1999), but it is difficult to see how this might work at Northwold when no evidence of structures that might constitute such an arrangement was encountered. In any case, the Norfolk mounds are somewhat different from their counterparts in the Midlands, in Ireland, Orkney or mainland Europe, in terms of composition and structure, and to accept only a single function or end product for these sites would be extremely unwise. As many contemporary uses as can be imagined for steam, hot water or even the cracked stone itself, must be considered plausible. Individual mounds may have served a variety of needs and their social role may have extended to providing a venue for celebrations or marriages or the place where payments were made.

The arguments of function are outlined in II. Background (above) and were most thoroughly rehearsed at the international burnt mound conferences in 1988 (Buckley 1990) and 1990 (Hodder and Barfield 1991). Ethnographic evidence is seemingly available in abundance to support any particular interpretation and most hot rock experimentation has tended to be anthropological in its research. The results and conclusions of one notable exception to this however, detailing experimentation from an archaeological perspective in laundering, dyeing and fulling, are described at the Irish web site <http://www.angelfire.com> (burnt mounds). Sheep's fleece was successfully processed into coloured fabric through successive hot rock water trough treatments and use of natural ammonia (urine) and fruit berries. Other interesting observations were that the granite stones used in the experiment did not generally shatter on first immersion — and were therefore repeatedly usable — and that high water temperatures were rapidly achievable and sustainable for a relatively long period of time. The web site likens *fulachta fiadh* to kitchen sinks *contra* the typically Irish notion of a cooking pot.

Faced with presently insoluble problems of function, some imagination is required to interpret the features associated with the mound. For instance, the large shallow pit appears to have acted as a reservoir and may have fulfilled any or all of a number of uses. It *could* have been used for keeping wood green prior to being shaped with the aid of steam. It *could* have been a cold water plunge pool for refreshing steam-cleansed bodies. The shape and depth of the pit *may* have been suited to soaking and preparing skins. Burnt flint along the base of the feature may not solely represent erosion from the mound, but may indicate that attempts were made to heat a comparatively large body of water. The structural evidence cannot be used to support any of these premises satisfactorily, but nevertheless the pit must have played a significant role in the operations if only for the effort taken in the erection and maintenance of the damming bank on its eastern flank.

Equally, the central plank-lined pit was pivotal to operations and our interpretations. It is the obvious candidate for the trough, tank or cistern found in conjunction with so many burnt mounds and used to heat water in. These appear variously lined with stone slabs (*e.g.* Sheehan 1991) or timber planks (*e.g.* Martin 1988). Other alternatives are hollowed-out logs, such as that used at Feltwell (Leah and Crowson 1994, Crowson 2000b, Bates and Wiltshire 2000), or perhaps semi-permanent arrangements utilising hides as linings. One of the more interesting variants is the dugout canoe re-used as a trough at Curraghstarsna near Cashel in Co. Tipperary, Ireland (Hammond 1986). It is puzzling, however, that the Northwold example was instated only after the mound had begun to accumulate, as an augmentation to the process rather than as an original feature. No evidence was retrieved to suggest an earlier tank existed, but it is feasible that a smaller version in the same location had been replaced or even that the principal function of the mound changed. Given the neighbouring Feltwell example there is also the possibility that a portable trough had previously been employed. The author's view is that some sort of trough or tank would always have been an integral element of the whole process — we simply didn't find evidence for it.

Considering the vertical sides towards the base of the central pit, it is taken that timber planks were originally installed around its edges, as well as along its base, to create a container. Whilst this alone may not have been watertight, additional material such as clay, which does not survive in the archaeological record may have been incorporated in the design. Contemporary groundwater levels may also have supported a higher level in the tank as we know the area became wetter over time. A very similar example of a shallow pit lined with thin timber boards has been recorded at Raheen in County Limerick (Gowen 1988, 129–32). Here side planks were also absent, but a number of stake-holes are believed to have provided supports for a now-vanished lining. Its disuse was also marked by accumulations of mound material. At Willington in south Derbyshire a much larger trough was lined on sides and bottom with alder or birch and retained with four corner posts. It too was still filled with shattered stones from its final use (University of Leicester Archaeological Services n.d.). In Leicestershire, on a palaeochannel of the river Soar at Birstall, a roughly circular pit was lined with tangentially split oak planks whilst its sides were retained by woven wattles (Beamish and Ripper 2000).

Although the pollen evidence from the deposits within the lined pit at Northwold suggests that the feature did not hold standing water, the deposits in question, principally peat and peat based soils, accumulated after the tank had fallen out of use. On the other hand, sandy mud from beneath the planks on the base of the pit produced a macrofossil assemblage consisting largely of wetland herbs and aquatic plants. The likelihood is that at least some of these plant taxa were supported at some time within the pit during its working lifetime. Water tables must have been sufficiently and consistently high from the time of abandonment onwards in order to support peat-generating vegetation inside the tank and for the thin timber lining to have survived for 4,000 years.

For the pit to function it must have been substantially cleaned out after every heating event and its abandonment is marked at the point it was no longer cleaned by accumulations of sandy peat over its base and subsequent infilling by burnt stones weathering off the mound. A large part of the shattered flint on the site was probably generated through immersion in this feature.

The upper tank pit fills are indistinguishable from those in the upper part of the well pit, and relate to environmental events following the site's abandonment. Palynomorphs indicate that people were still active in the area engendering local environmental changes. Alder initially revived (possibly after woodland management for the mound had ended), and then decreased due to perceived preferential selection. The site remained in a clearing, becoming damp without being truly wet. Ultimately, rising groundwater brought about the generation of peat from encroaching alder wood which filled the tops of the open features and buried the site altogether.

III. Distribution

Field walking records for the Norfolk peat fens suggest a degree of separation or zoning of prehistoric activities, inasmuch as numerous spreads of burnt flint are found singly or in small clusters in apparently isolated positions (Silvester 1991). Such observations during the last century were occasionally interpreted as representing seasonal or temporary hunting or feasting sites (*e.g.* O'Kelly 1954). The site at Northwold is not quite alone: other, smaller spreads of burnt flint can be seen in fields all around. Furthermore, evidence that can only be gained through excavation shows that other activities were carried out nearby: microscopic pollen reveals that cereals were being cultivated close to the site whilst the burnt mound was in use. It is suggested that the location may have been sought because of proximity to better supplies of timber than could be obtained on the busier fen-edge where domestic occupation was denser. There is also the possibility that burnt stone concentrations associated with nearby settlement sites — the centres of domestic and agricultural life — were generated in a different way or for a different purpose than the intensive activities witnessed at High Fen Drove. Zoning of such activities cannot be discounted: industrial or production units and other non-domestic activities may well be sited away from the main settlement nuclei.

East Anglia was not widely renowned as an area with many burnt mounds before the work of the Fenland Survey, but they are now known to be extremely common and their representation across Britain may reflect the thoroughness of survey. Reports (below) of the last twenty years from Norfolk, Suffolk and Essex and forthcoming publications provide evidence of this. Aside from the 300+ sites in Norfolk's Fenland, the Sites and Monuments Record lists examples from across the county. Six, including one flanked by ditches, were recorded at Witton (Lawson 1983, 94). The author has seen and probed several more pronounced mounds in woodland at neighbouring Bacton. These are located by streams on slopes, measure over 0.50m deep and appear to seal buried soils.

Elsewhere in the county there are the two discussed above from Scole (Ashwin and Tester forthcoming) and another (with associated Beakers) from Brundall (Bates forthcoming). Examples in Suffolk include one with a withy- and plank-lined pit from Swales Fen (Martin 1988). Another, with a rectangular pit, was found at Henham (Newman 1992) and three more are known from West Row Fen (Murphy 1988). A low mound has also been published from the Blackwater estuary in Essex (Wilkinson and Murphy 1995, 80–1). Where studied, palaeoecological data from these sites demonstrate a set of common locational denominators: clearings in wet alder woodlands (P. Murphy pers. comm.). It is not so easy, however, to determine archaeologically whether these site locations were chosen preferentially or whether it is simply the case that all Bronze Age fen- and channel-edge environments were characterised by wet alder woods.

Where extensive field survey and assessment has taken place, identification of burnt mounds and spreads has increased hugely alongside maturing awareness of their significance. Although not abundant throughout the study area, as in the Norfolk Fenland Survey burnt stone spreads were the most prolific site-type discovered during the North-West Wetlands Survey (M. Leah pers. comm.). In Shropshire the Survey located dozens of extant mounds and dense concentrations of burnt stone in peat measuring anywhere between 5–30m in diameter (Leah *et al.* 1998, 137–51). Again, as in Norfolk, these sites showed a preference for gravel and sandy ridges overlooking and protruding into wetlands. Streams and flood-plain mires appeared to be preferred locations over bogs and meres.

The early work of Cantrill and Jones in South Wales (1906; 1911), has been brought up-to-date through rescue-led excavations since the later 1970s (Williams 1990) and most recently by the Dyfed Archaeological Trust's 1997–8 assessment of 365 known burnt stone sites (Crane and Manning 1998). Work here has attempted to recognise trends in terms of related settlement or ritual activities, regional and geological differences, formation processes and resultant mound shape and size. Streams and springs appear to have been the most favoured situations with far fewer in marshy areas. This phenomenon indicates a preference for flowing water over still water and it is reasonable to believe that this reflects the requirements of the process. These mounds may be associated with adjacent settlement sites: such desirable locations might otherwise be given over entirely to occupation of a more 'domestic' nature. One might conclude that activity zoning underpinned the acquisition of such sites.

IV. Dating

In 1990 M. Baillie commented: 'It has long been clear that these sites represented an excellent opportunity for radiocarbon analysis' (Baillie 1990, 165). Although an ambitious programme of burnt mound analysis in tandem with a tight sequence of radiocarbon determinations has not been attempted before in Britain, the Northwold excavation has justified Baillie's claim, providing an abundance of material suitable for dating. Relatively short estimates have been established for occupation, usage and abandonment as well as contributing to an ongoing Ancient Monuments Laboratory research project into the taphonomy of charcoal for radiocarbon analysis. The chronological homogeneity of the charcoal from the mound (see above) and the relatively brief period of use (*35–165 years (at 95% probability))*, suggests that the Northwold burnt mound represents short-lived activity with a specific function, which did not lead to constant or repeated use of the site for many centuries. The succession of cut and re-cut features and the hiatuses observed in mound formation demonstrate that the site was probably revisited a number of times, although this should perhaps be seen as a seasonal activity and renewal rather than sporadic use over an extended period.

Radiocarbon dates from the current excavation and the neighbouring mound at Feltwell Anchor (2400–1880 cal BC; GU-5573; 3720±80 BP and 2400–2030 cal BC; GU-5574; 3770±50 BP) (Bates and Wiltshire 2000) are comparatively earlier than most other examples. Radiocarbon determinations from sites in the West Midlands and Scotland tend to cluster in the range *c*. 1000–1700 cal. BC (*c*. 2800–3400 BP), (Barfield and Hodder 1981; Ehrenberg 1991, 55), whilst those from the Irish sites provide a date range of between *c*. 2100–1250 cal BC (*c*. 3700–1000 BP) for the majority of mounds (Brindley and Lanting 1990). A few of the Welsh sites are early, but the majority of those so far dated fall later in the Bronze Age (Williams 1990, fig. 61). Sweden's *skärvstenshögar* were deposited principally in the later second millennium cal BC and the first half of the first millennium cal BC (Larsson 1990, 145–6). Thermo-luminescence dating of burnt mounds has yet to be fully exploited.

It is self-evident that even small sets of reliable dates are of great value to archaeologists and challenge and add greater precision to traditionally-accepted methods of artefactual, constructional or technological dating. A collection of radiocarbon dates from burnt mounds in the Norfolk and Suffolk Fens is to be published by P. Murphy in *East Anglian Archaeology* (Ashwin and Tester forthcoming), which places all the examples in the earlier Bronze Age. Although a 'Late Neolithic' mound has been reported from Willington, Derbyshire, this would benefit from the clarification afforded by radiocarbon dating (Beamish and Ripper 2000). Further research remains to be undertaken and more dated examples sought, but it seems that Bronze Age communities of eastern England were among the front-runners of hot stone technology.

V. Pottery

When Harry Apling discovered 'nearly a pailful of (Beaker) pottery fragments' in a Norfolk burnt mound some seventy years ago (Apling 1931, 365), he could not have realised how scarce diagnostic finds from such contexts would prove to be down the years. Today, where pottery exists in association with stratified deposits, burnt mounds have tremendous potential for solving problems of ceramic chronologies. British prehistoric pottery mostly demonstrates a gradual process of development — Mildenhall wares of the Early Neolithic become Peterborough ware of the later Neolithic become the Food Vessels of the Late Neolithic/Early Bronze Age. Beakers, however, appear as a fully-developed 'type' and do not relate to any of the early indigenous British styles. Beaker is found in abundance in fen-edge contexts, the classic site at Hockwold-cum-Wilton (Bamford 1982, 8–30) being only 9km south of Northwold. Fen Beaker is usually said to be 'domestic', in that it is not generally found as a burial accompaniment, but was in everyday use. At Northwold there is the additional possibility of selective, specialised deposition of vessels in certain contexts. Analysis of the vertical and horizontal deposition of the ceramic assemblage also indicates a small number of successive visits to the site rather than a single episode of activity (S. Percival pers. comm.).

Local knowledge aside, the national chronology of Beakers is problematic and has been under review. Chronology based solely on stylistic succession (Clarke 1970) cannot be applied to the country as a whole, since different styles were current in different areas at the same time. Radiocarbon dating has been used to tackle these problems, and a British Museum dating programme has established their currency in Britain between *c*. 2600–1800 cal BC (*c*. 4000–3500 BP) (Kinnes *et al.* 1991). Although this is a very wide range, it suggests that some broad aspects of stylistic change through time do in fact hold good for some places. There is a marked lack of comparative data available for sites in eastern England, however, and new distinctive assemblages associated with radiocarbon dates are extremely important to the future study of Beakers in this region. The association of the present assemblage with a length of activity estimated as between *35 and 165 years (at 95% probability)* provides a much-needed reliable basis for cross-comparison with

East Anglian Bronze Age collections, whilst also being of some international import.

Although greatly varied, Bell Beakers of continental western Europe share the same principal features of British Beakers. Attempts to determine a chronology of development and relationship with Single Grave Beaker groups in Europe have been founded on available radiocarbon determinations from charcoal (Case 1993). As with the British debate, however, discussion over the origins and typological succession of pan-European Beakers looks set to continue.

VI. Final word

In-depth study of burnt stone mounds is still in relative infancy when compared to other prehistoric monuments and activities. Evidence of prehistoric death and ceremony survives better — or is both more easily recognised and more 'exciting'— than that of domestic or industrial life. The structured approach of the Fenland Project, in surveying the Fenland landscape as an entity through time, has embraced burnt mounds within its detailed exploration of various themes and aspects of human activity. Rarely have so many resources as those provided by the Fenland Project been targeted to attain a better appreciation of the burnt mound phenomena and successfully accomplish its stated aims. We have learned more of the processes of formation and site activity even if precise function remains elusive. We have established the environmental setting and observed human impact upon it over time. Date, duration and seasonality of occupation were realised through scientific analyses, although the mound's significance to local populations and the role it might have played in their community is a little harder to assess.

The true success of the Northwold project will be judged by its input to the study of prehistoric ceramic chronologies, its valuable palaeoenvironmental and landscape reconstructions and its selective and innovative approach to achieving a close sequence of radiocarbon dates. Moreover, and perhaps the greatest achievement, is the part played by the Fenland Project as a whole in exploring the past, present and uncertain future of England's wetland archaeology. The themed approach to site selection has proved particularly rewarding, providing directly comparable data sets on various site-types suffering similar processes of disruption. Aside from revealing the lives of past societies, their economies and the landscape they inhabited, the Project's publications and archives now offer research data that can be used to inform and help shape all future wetland archaeology management policies.

Recognising the unique value of the archaeological and environmental preservation stored in wetlands, English Heritage has long been committed to their research and conservation. Following the completion of the final regional survey in Lincolnshire and the Humber Levels, a national assessment of the condition of the country's archaeological wetland resource was commissioned from the University of Exeter as part of English Heritage's on-going wetlands initiative. The results of this research, titled *Monuments at risk in England's wetlands* (MAREW, Van de Noort *et al.* 2002) produced a predictably depressing verdict, estimating a loss of nearly 3,000 wetland monuments during the last half century with damage likely at a further 10,000. Acutely aware of the fragility of many of our wetland areas and armed with the modern assessment on top of the data gathered over a longer period, English Heritage has now published a forward conservation management strategy document aimed at safeguarding the long term future of wetlands: *English Heritage strategy for wetlands* (English Heritage 2002, available at <http://www.eng-h.gov.uk>). This will be achieved through cross-agency collaboration, increasing public awareness and access, and support and co-operation with local authorities and other land owning interests.

Time is pressing though, and in the Fenland context, if we have learned anything, it is that excavation is the most appropriate 'management' response to the threat posed to the archaeological and environmental record by the region's intensive arable farming and its demands on soils and hydrology. It is difficult to see how the costs of checking current land management and maintaining appropriate hydrological conditions over a large area would be met, and change in rural west Norfolk is not always well received. The Norfolk Fens still hold a small number of potentially well-preserved burnt mounds, but if many more years are allowed to elapse before they are investigated through excavation then the organic and stratigraphic survival witnessed at Northwold may not even be a possibility for these sites. Presently, worthy collaborations and the implementation of new management initiatives seem a long way off. Farmers will keep on ploughing and draining and, until such wide ranging consensual agreements on the future direction of land management in the southern and eastern Fens are achieved, there remains little realistic alternative to record by excavation. Even if cultivation could be restrained tomorrow, the environmental evidence — which at the very least is as valuable as the archaeology — would continue to decay in its present drying state. For the management response of preservation *in situ* read progressive deterioration *in situ*.

Whilst it may be objected that the degree of preservation of any one site should not be taken as a definitive guide to the survival of others, the destruction recorded at the majority of sites examined during the Evaluation and Management Projects bears a stark warning. Deposit truncation, deflation and decay are the direct results of demanding agricultural régimes and attendant changes in the condition and preservation of the archaeological record.

Although the question of recent deterioration in the burial environment in Fenland has not been fully addressed (P. Murphy pers. comm.), its preserving quality has deteriorated most rapidly since the second world war 'Dig For Victory' campaigns and subsequent arable enlargement and systematic de-watering. The MAREW research showed that an estimated 50% of the original extent of England's lowland peat has been lost to agriculture, drainage, extraction and industry during the course of the past fifty years alone (Van de Noort *et al.* 2002). In the face of land reclamation, re-use and agricultural destruction the study of burnt mounds '…takes on a renewed importance…when increased work of this kind may wipe out these important pointers to our prehistoric settlement in north-west Europe' (Buckley 1990, 9).

Appendix: Environmental sampling methodologies, detailed descriptions and tabulated results

Plant macrofossils, molluscs and insects
by Peter Murphy
(Figs 20–21, Tables 4–7)
The burnt mound deposit, *30*, composed mainly of charcoal and heat-shattered flint, was sampled in a grid pattern, as was the underlying buried soil *178*. Bulk samples were also collected from associated cut features. Charred plant material was collected from 5 litre sub-samples by manual flotation, using a 0.5mm collecting mesh. The samples were almost all very charcoal-rich. The flots also included intrusive material from the overlying wood peat: peat aggregates and degraded wood fragments. During assessment, sub-samples (two 9cm petri dishes per sample) of the flots were scanned under a binocular microscope at low power. Apart from charcoal, the only charred plant macrofossil noted was a poorly preserved indeterminate cereal grain from Bulk Sample (BS) 35. Although it is likely that some other charred macrofossils were overlooked during rapid scanning, the assessment results plainly demonstrated that there were no concentrations of charred macrofossils other than charcoal. Mollusc shells including *Carychium* spp and *Cepaea* sp occurred sporadically in contexts *30* and *178*, but these could be intrusive from the overlying layers.

The main aim of the analysis of these bulk samples was to produce a charcoal density plan for the site, which could relate to spatial or temporal variations in charcoal deposition. Separating *all* charcoal from later contaminants would have been prohibitively time-consuming, so the flots were dry-sieved on 6mm mesh, and charcoal fragments >6mm were separated from peat and wood fragments. The charcoal was then weighed, and the results expressed as grams of charcoal >6mm per litre of soil. Samples were also submitted to Rowena Gale for charcoal identification, prior to submission for radiocarbon dating.

Samples were collected from the large pits, *14* and *52*, for assessment and analysis of macrofossils. Pit *52* was excavated in two stages. The upper fills were first sectioned, sampled (column sample 51) and removed. The lower deposits were then sectioned. They were highly unstable (consisting of waterlogged muds with a high proportion of heat-shattered flints), and collapsed just before sampling. It was, however, possible to collect sample 63 (a 10 x 10 x 50cm monolith tin) from the lowest 50cm of the pit fill before further collapse. The difficult circumstances of excavation meant that the deposits between samples 51 and 63 were not sampled. Samples were obtained from the lowest 50cm of fill in pit *14* (sample 24: contexts *61*, *32*, *24*) and from immediately below the wooden boards at its base (sample 76: context *209*).

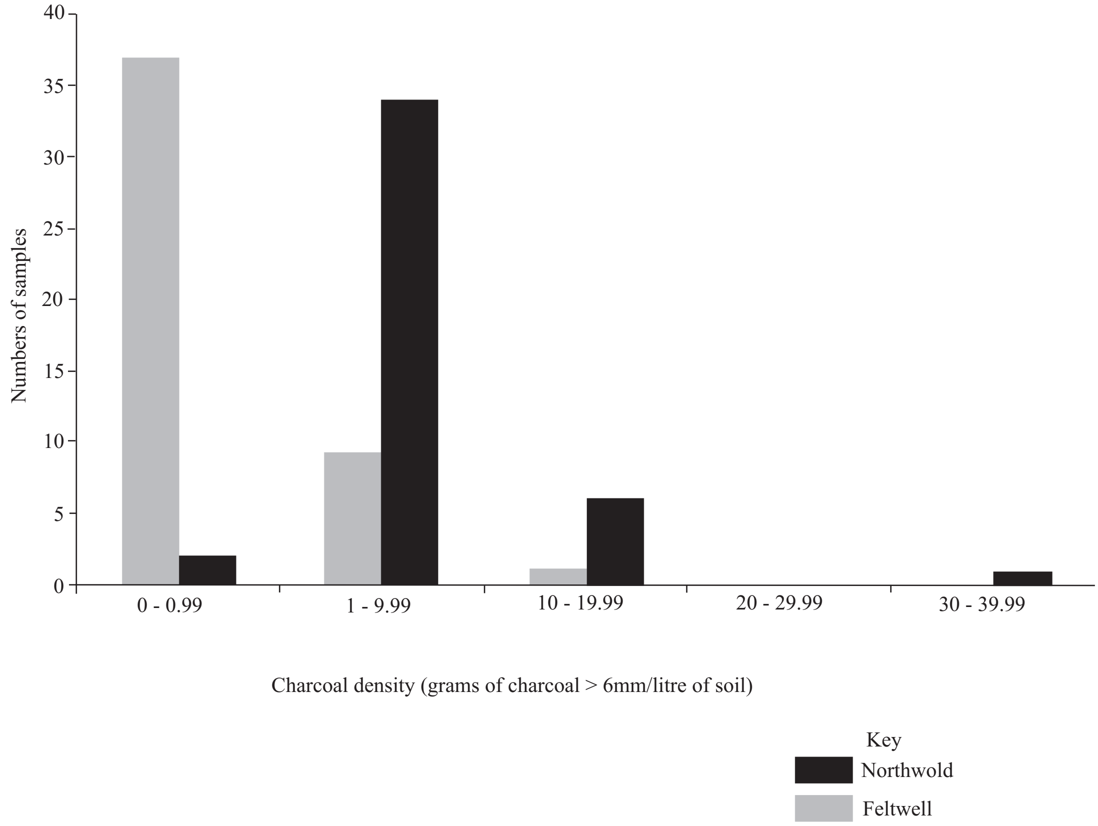


Figure 20 Charcoal densities in the burnt mounds at Feltwell Anchor and Northwold

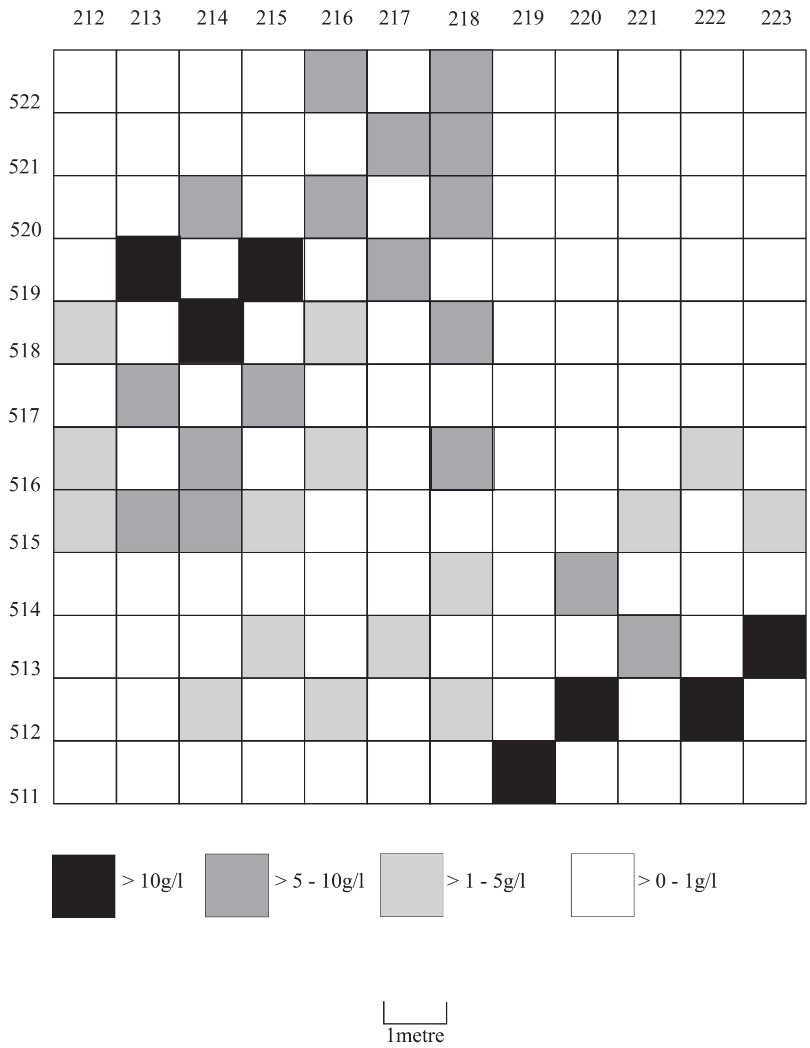


Figure 21 Distribution of charcoal fragments >6mm

During assessment, 200g sub-samples were disaggregated manually in hot water, then washed out over 2mm and 0.5mm mesh sieves. The retents were scanned under a binocular microscope at low power, noting the presence, abundance and state of preservation of plant and animal macrofossils. On the basis of this assessment (Murphy 1998) all samples from the monolith sample 63 (base of pit *52*) and sample 76 (context *209*, base of pit *14*) were selected for analysis of plant macrofossils and molluscs. Concentrations of insect remains were very low, however, and no analysis beyond assessment (Robinson 1995) was carried out. Macrofossils were extracted using standard methods (Kenward *et al.* 1980). Nomenclature follows Kerney and Cameron (1979), Kerney (1975) and Stace (1991).

Sample number	63	63	63	63	63	63	63	76
Cut number	52	52	52	52	52	52	52	14
Context number	*181*	*181/179*	*179*	*128*	*128*	*128*	*128*	*209*
Depth (cm)	0–10	10–20	20–30	30–40	40–44	44–48	48–50	
Trees and shrubs								
Alnus glutinosa (catkin bracts)		×	×	×	×	××		×
Alnus glutinosa (L) Gaertner (female catkins)	3	2		1				
Alnus glutinosa (seeds)	30	24	4	2	3	6	1	3
Betula sp					1			
Corylus avellana L (nutshell fragments)				×				
Quercus sp (immature cupule)		1						
Quercus sp (leaf fragments)					××	×		
Rubus section *Glandulosus*	2	1	11	2	3	7	1	1
Sambucus nigra L				1				
Solanum dulcama L	2	2			1	1		6
Herbs (weeds/grassland species)								
Ajuga reptans L			2					1
Aphanes arvensis/macrocarpa	1							
Apiaceae indet						1		
Asteraceae indet						1		
Caryophyllaceae indet		1						
Lapsana communis L	1	1						
Moehringia trinervia (L) Clairv.	1							
Plantago major L			1					
Poaceae indet	1	2	4	2		6	1	
Polygonum aviculare L				1				
Prunella vulgaris L			1					
Ranunculus acris/repens/bulbosus	4	1	6	2	2	2		
Rumex sp	2	2	23	9	2		1	
Torilis japonica (Houtt) DC		1			2			
Urtica dioica L	66	56	111	75	49	99	28	6
Wetland herbs and aquatics								
Alisma plantago-aquatica L		1			2			
Alismataceae indet								1
Carex spp	5	2	1	4	1	2	1	2
cf *Pulicaria* sp								14
Epilobium sp		1	3				1	4
Eupatorium cannibinum L								9
Juncus spp	14	7	6					17
Lemna sp	7	4						
Lycopus europaeus L		2						39
Mentha cf *aquatica* L	1		7					74
Oenanthe aquatica (L) Poiret		1			1			
Ranunculus subg *Batrachium*		1			1			2
Heathland taxa								
Pteridium aquilinum (L) Kuhn			3	63	32			
Other plant macrofossils								
Buds/budscales	×	×	×	×	×	×	×	
Charcoal	×××	×××	×××	××	×	××	××	×××
Leaf fragments	×	×	×	×	××	×		
Mosses	×	×	×	×	×	×	×	
Rubus-type (thorn)	1				1		1	
Twig fragments	×	×	×	×	×	×	×	×
Indeterminate seeds etc	5	23	50	16	14	12	2	20
Invertebrates								
Cladocerans	×	×	×					
Insects	×	×	×	×	×	×	×	×
Molluscs	×	×	×	×	×	×	×	×
Ostracods	×							
Sample weight (kg)	0.4	0.75	0.75	0.9	0.43	0.23	0.21	1.08
% sample sorted	100	50	50	50	50	100	100	100

Table 4 Plant macrofossils and other remains from pits *14* and *52*

Bulk sample	*Context number*	*Grid co-ordinates*	*Charcoal weight (g)*	*Charcoal density (g/litre of soil)*	*Identifications*	*Radiocarbon age (BP)*	*Weighted mean (BP)*	*Calibrated date range (95% confirdence)*
Burnt flint mound								
6	*30*	217/521	43.4	8.7				
7	*30*	216/522	27.8	5.6				
9	*30*	216/520	30.1	6				
10	*30*	214/520	47	9.4				
11	*30*	215/519	60.8	12.2				
12	*30*	213/519	51.6	10.3				
13	*30*	217/519	46	9.2				
14	*30*	214/518	58.9	11.8				
15	*30*	212/518	22.5	4.5				
16	*30*	216/518	16.3	3.3				
17	*30*	213/517	36.4	7.3				
18	*30*	215/517	30.2	6				
19	*30*	216/516.5	15.6	3.1				
20	*30*	214/516.5	37.2	7.4				
21	*30*	212/516.5	23.6	4.7				
22	*30*	212/515	16.3	3.3				
25	*30*	213/515	45.6	9.1				
26	*30*	215/515	17.8	3.6				
27	*30*	?	5	1				
28	*30*	214/515	27	5.4				
29	*30*	216/514	2	0.4				
30	*30*	217/515	Sample lost					
31	*30*	217/513	11.5	2.3				
32	*30*	214/512	12.7	2.5				
33	*30*	215/513	10	2				
34	*30*	214/512	8.2	1.6				
35	*30*	216/512	6.8	1.4				
36	*30*	220/514	27.7	5.5				
37	*30*	218/514	18	3.6				
38	*30*	221/515	11	2.2				
39	*30*	222/516	17.8	3.6				
40	*30*	223/515	6.9	1.4				
41	*30*	222/514	52.5	10.5				
43	*30*	218/512	17.7	3.5				
44	*30*	223/513	59.6	11.9	*Corylus/Alnus*, *Fraxinus*, *Prunus*, Pomoideae, Salicaceae	3706±21, 3750±55, 3770±55, 3840±55, 3650±55	3742±16	cal BC 2195–2040
45	*30*	222/512	81.7	16.3				
46	*30*	221/513	40.6	8.1				
47	*30*	220/512	153	30.6	*Corylus/Alnus*, *Fraxinus*, *Prunus*, *Quercus*	3746±22, 3730±60, 3700±50, 3765±45, 3755±45	3743±16	cal BC 2275–2045
48	*30*	218/518	27.4	5.5				
49	*30*	219/511	57.7	11.5				

Bulk sample	*Context number*	*Grid co-ordinates*	*Charcoal weight (g)*	*Charcoal density (g/litre of soil)*	*Identifications*	*Radiocarbon age (BP)*	*Weighted mean (BP)*	*Calibrated date range (95% confirdence)*
52	*30*	?	45.4	9.1				
53	*30*	218.5/520	30.8	6.2				
54	*30*	218.5/521	24.4	4.9				
56	*30*	218.5/522	28.3	5.7				
Buried soil								
82	*178*	217/517	0	0				
83	*178*	213/518	0	0				
84	*178*	216/521	0.1	<0.1				
85	*178*	217/515	0	0				
86	*178*	213/515	0.9	0.2				
87	*178*	215/512	0	0				
88	*178*	220/515	0.1	<0.1				
89	*178*	223/515	0.1	<0.1				
90	*178*	?	0	0				
91	*178*	219/517	0	0				
92	*178*	220/521	0.2	<0.1				
93	*178*	222/519	0	0				
Other contexts								
3	*35*		0	0				
8	*8*	215/521	52.3	10.5				
57	*32*		27.1	5.4				
58	*112*		9.6	1.9				
59	*40*		20.8	4.2				
61	*127*		50.8	10.2				
62	*128*		16.4	3.3	*Corylus*	3730±45		cal BC 2290–2030
69	*128*		51.4	10.3				
70	*179*		244.9	49				
71	*180*		130.5	26.1				
72	*181*		76.2	15.2				
73	*202*		1	0.2				
74	*200*		0.5	0.1	*Corylus*	3650±45		cal BC 2190–1895
77	*212*		26.6	5.3				
78	*212*		35.7	7.1				
79	*110*	224/519	1.1	0.2				
80	*110*	219/518	0.2	<0.1				
94	*251*		131	26.2	*Corylus/Alnus, Fraxinus, Prunus, Quercus*, Salicaceae	3751±22		cal BC 2280–2045
96	*231*		0.1	<0.1				
97	*84*		0.5	0.1				

with data from Crowson and Bayliss 1999, (weighted mean BP); and Gale forthcoming (identifications)

Table 5 Charcoal weights and densities

Sample number	63	63	63	63	63	63	63	76
Cut number	52	52	52	52	52	52	52	14
Context number	*181*	*181/179*	*179*	*128*	*128*	*128*	*128*	*209*
Depth (cm)	0–10	10–20	20–30	30–40	40–44	44–48	48–50	
Terrestrial (shade requiring)								
Aegopinella cf *nitidula* (Draparnaud)		4	1			1		
Carychium sp	4	1		3		4		3
Carychium minimum Mueller	1							
Carychium tridentatum (Risso)				2				
Cochlodina laminata (Montagu)			1					
Discus rotundatus (Mueller)		1				1		1
Euconulus alderi (Gray)		1				1		
Oxychilus sp								1
Punctum pygmaeum (Draparnaud)			1					
Vitrea crystallina (Mueller)		1						
Vitrea sp		2						
Terrestrial (catholic)								
Cepaea/Arianta	1						2	
Cochlicopa sp		1						1
Trichia hispida group	1			1				
Terrestrial (open country)								
Vallonia costata (Mueller)								1
Vallonia sp				1				
Other terrestrial								
Vertigo sp	1							
Freshwater/freshwater slum								
Anisus leucostoma (Millet)	5							1
Aplexa hypnorum	2	1	1					
Planorbidae indet	2							
Planorbis planorbis (Linnaeus)	4	1		1*				
Sphaeriidae indet (juveniles)		1						2
Valvata cristata (Mueller)	2	1						
Others								
Derived chalk foraminifers						1		
Ostracods		2	1		2			1
Indet apical mollusc fragments	3	2	1					1
Shells/kg	65	23	7	9	0	30	10	10
Sample weight (kg)	0.4	0.75	0.75	0.9	0.43	0.23	0.21	1.08
% sample sorted	100	50	50	50	50	100	100	100

* badly deformed specimen

Table 6 Molluscs from pits *14* and *52*

Pit	*14*	*14*	*52*	*52*	*52*	*52*
Context	*32*	*24*	*128*	*181*	*111*	*37*
Sample	24	24	63	63	51	51
Depth (cm)	32–37	20–30	30–40	0–10	60–70	20–30
Coleoptera						
Pterostichus sp.						×
Agonum sp.						×
? *Hydroporus* sp.				×		
Anacaena sp.	×					
Ochthebius cf. *minimus*			×			
Geotrupes sp.				×	×	
Onthophagus sp.					×	
Phyllopertha horticola		×				
cf. *Cyphon* sp.		×				

Table 7 Coleoptera from pits *14* and *52*

Palynology
by Patricia Wiltshire
(Figs 22–27, Table 8)

Sampling
Sub-samples consisting of approximately 2g were taken laterally within each core over 1cm depth of sediment. *Pit 52*: Sub-samples were taken from 0–30 cm at 2cm intervals, and from 90–139cm at 4cm and 2cm intervals, depending on lithology. *Pit 14*: Sub-samples were taken from 2–10cm at 2cm intervals, and from 14–48cm at 4cm intervals. *Soil 66*: Sub-samples were taken contiguously from 0–5cm.

Processing
Standard preparation procedures were used (Dimbleby 1985). Wet sediment was measured for 2.0cm^3 volume displacement (Bonny 1972). Tablets of *Lycopodium* spores (Stockmarr 1972) were added to allow estimates of palynomorph concentration (Benninghof 1962). Samples were lightly stained with 0.5% safranine and mounted in glycerol jelly.

Identification and nomenclature
Identification was aided by examination of modern reference material wherever necessary. Nomenclature follows that of Bennett *et al.* (1994), Moore *et al.* (1991), and Stace (1991). Cereal-type pollen refers to all grains of >40.0μm (Edwards 1989). No attempt was made to differentiate *Corylus avellana* (hazel) from *Myrica gale* (sweet gale), and both are included in *Corylus*-type. Considering the nature of the site, it was considered that this pollen taxon represented hazel and this taxon will be referred to as '*Corylus*' rather than '*Corylus*-type' throughout.

Counting
Counting was carried out with a Zeiss phase contrast microscope at ×400 and ×1000 magnification as appropriate.

Pollen and plant spores: palynomorph concentrations were very variable throughout all three sequences of sediments and it is likely that this was a function of sediment accretion rate and other taphonomic factors. Where palynomorphs were so sparse that counts of less than 100 were achieved, percentage data are shown on the pollen diagrams as open bars rather than blocks. Where counts are very low, pollen diagrams need to be interpreted with great care but they are justified here simply to demonstrate the relative importance of the most common taxa.

In pit *52*, concentrations were very low throughout much of the basal sediment, and in the deepest sub-samples of the upper sediments (from 28–30cm, 102–122cm, and 130–138cm). Counts in other sub-samples for pit *52* ranged from between 390 and over 1700, with most having counts of more than 400 grains. Pollen and plant spore counts in pit *14* were also low except for the upper sediments where counts of up to nearly 900 were achieved. Counts in palaeosol *66* ranged from 112 to 500, with most being over 300 grains.

In each sample, grains which were too badly corroded for identification were also counted, being classified as 'unidentified'. This category included a small number of grains which eluded identification and remained as unknowns.

Microscopic charcoal: errors are inherent in all quantitative methods of estimating the abundance of microscopic charcoal in pollen preparations. Chemical and physical processing of polleniferous sediments inevitably result in comminution of large fragments of charcoal into variable numbers of smaller particles. Another possible source of error is variation in the volume of sub-samples. Here, sub-sample volume was the same throughout, and processing error was treated as a constant. All particles >5 µm diameter were counted in relation to Lycopodium spores over fifteen traverses.

Iron pyrite framboids, and fungal and algal palynomorphs: these were counted in the same way as microscopic charcoal particles. Counts of fungal hyphae were achieved by tallying, irrespective of size, all individual pieces within the field of vision. If a hypha extended both margins of the field, it was scored as 1.

Expression and presentation of data
Pollen diagrams are simply aids to interpretation and the form of data expression must be appropriate for the specific data set. Diagrams were drawn with the computer programme Tilia and Tiliagraph (Grimm 1991). Total pollen and plant spores were expressed as numbers x 10^5 cm^{-3}, microscopic charcoal as numbers x 10^6 cm^{-3}, and fungal and algal palynomorphs as numbers x 10^3 cm^{-3}. The various plant groups were expressed as a percentage of total pollen and plant spores. An hiatus in the record is shown by a gap in the diagram. Figure 24 is a diagram of major taxa only while Table 8 shows all other, relatively well-represented taxa. All taxa achieving less than 1% of their appropriate sum are shown as '+' in the Figures and Table.

Concentrations of pollen and plant spores, microscopic charcoal, fungal and algal palynomorphs, and iron pyrite framboids were all expressed as numbers cm^{-3}. No attempt was made to calculate concentration values for plant taxa (Calcote 1998). For the summary diagram, taxa within plant groups were expressed as a percentage of total pollen and plant spores. Individual plant taxa were expressed in terms of total dry land pollen. However, spore-producers, 'Ferns & allies, & *Sphagnum*' and wetland taxa, 'Aquatics, emergents, & plants of wet soil' were taken out of the sum to avoid bias. Thus, spore-producers were expressed as a percentage of total dry land pollen plus spore-producers, and wetland taxa as a percentage of total dry land pollen plus wetland taxa.

Two pollen diagrams are presented for each feature (Figs 22–7). The diagrams were divided into 'zones' for convenience of description, and were designated N66/1–2, N52/1–4, and N14/1–3 accordingly. Zone boundaries were drawn subjectively based on changes in the palynomorph spectra. It must be stressed that in some cases, particularly in the lower two zones of pit *52*, the divisions are not zones in the true sense of the word but merely aid description of the profile.

Taxa are generally arranged according to their abundance, and/or the order in which they first appear in the sequence. Results for pit *52* are shown in Table 8 and Figs 24 and 25. Fig. 24 shows total pollen and plant spores, microscopic charcoal, fungal and algal palynomorphs, and the various plant groups. An hiatus in the record is shown by a gap in the diagram. Fig. 25 is a diagram of major taxa only while Table 8 shows all other taxa. All results for palaeosol *66* are shown in Figs 22 and 23, and all results for pit *14* are shown in Figs 26 and 27.

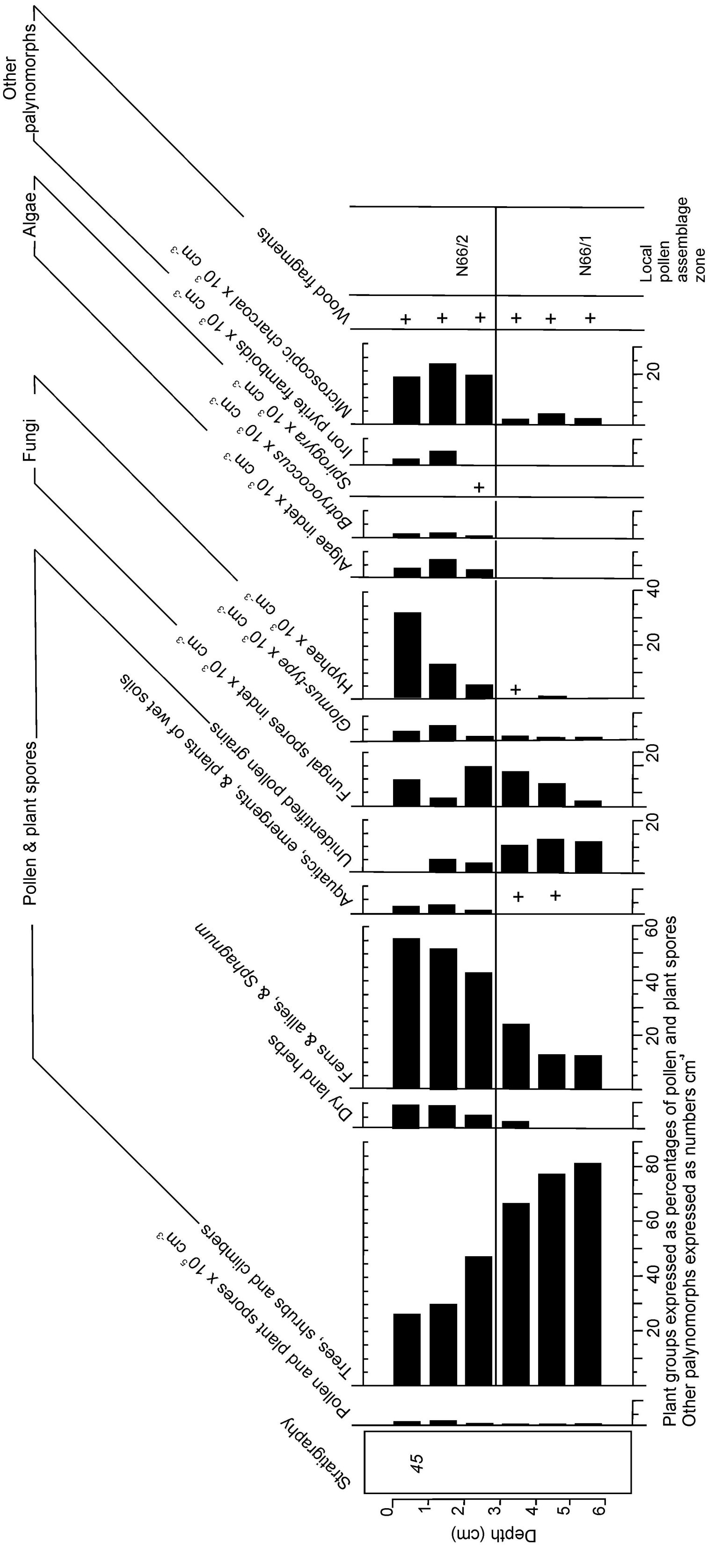


Figure 22 Plant groups from palaeosol *66*

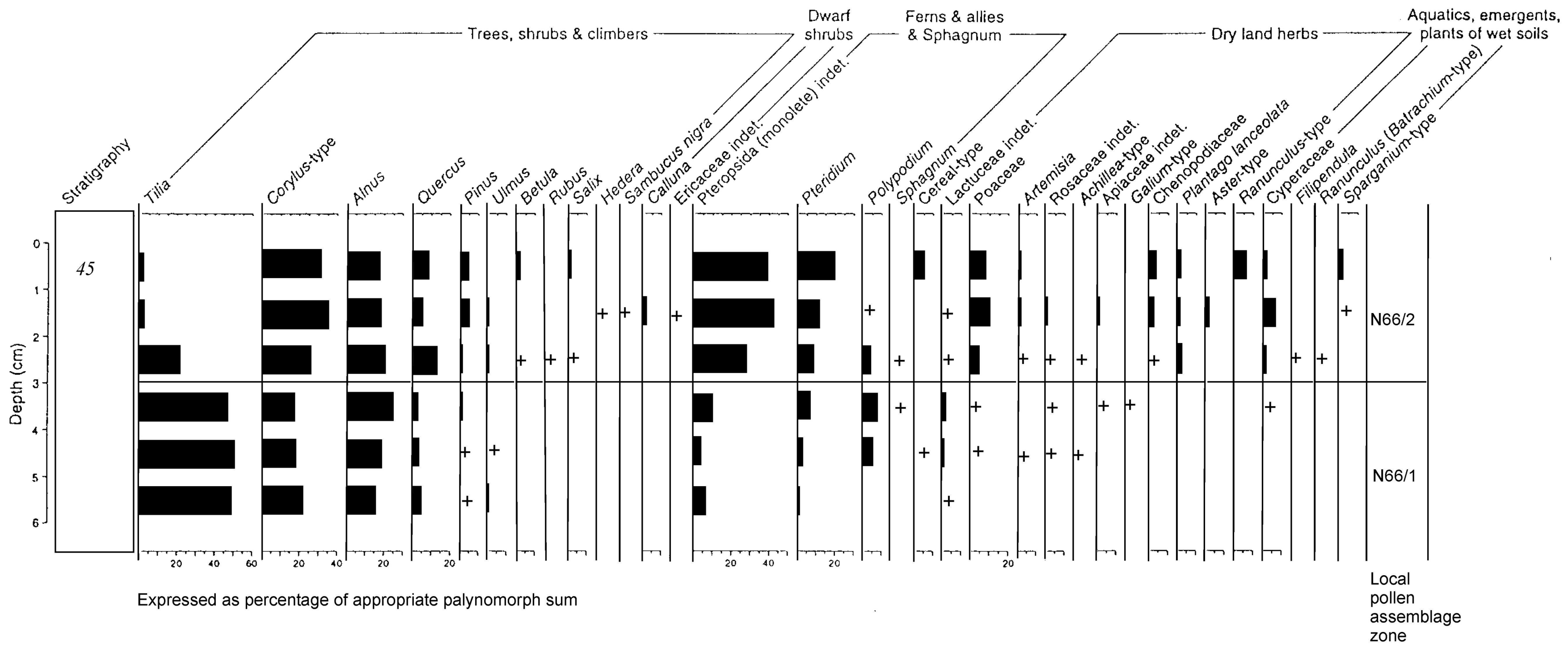


Figure 23 Plant species from palaeosol *66*

Local pollen assemblage zones	N52/4							N52/3									N52/2												N52/1						
depth cm	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	90	94	98	102	106	108	110	112	114	116	118	122	126	128	130	132	134	136	138
Wood remains																																			
vessel fragments						★★★	★★★	★★★	★★★	★★★			★	★			★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★
Nematode eggs																																			
Tricuris	★																																		
Algae																																			
Botryococcus x1000 per cu. cm			★													★			★															★	
Mougeotia x 1000 per cu. cm	★	★	★	★	★											★																			
Pediastrum x 1000 per cu. cm			★																																
Trees shrubs and climbers																																			
Betula			★		1.8		3.8			★	★	★	★	★		★	★		★											1	1.2				
Fraxinus				1	★						★	★	★	★	★				23											★					
Hedera										★	★	★	★	★	★														★	★					
Ulmus	1		★	1						★	★	★	★	★	★														★	★					
Prunus-type																													★						
Ilex														★																					
Rhamnus				★								★	★																						
Rubus					3.5																														
Dwarf shrubs																																			
Caluna																			★																
Ericacea indet.													★																						
Dry land herbs																																			
Ranunculus-type													★	★					★										56	★	1.2				2.3
Plantago indet.											★																		★			3.6	2.5		
Rosaceae indet.	1		1.1	1	3.5						★		★		★	★			★				2							★					
Cirsium		8.8	★																				2												
Rhinanthus-type																					5														
Urtica indet.																				5.9															
Campanula																			★																
Caryophyllaceae (Cerastium-type)					★										★				★																
Rumex (*cf* R.Crispus)																			★																
Rumex indet.																			1.1																
Caryophyllaceae (*cf* Stellaria holostea)																			★																
Solanum dulcamara																			★																
Urtica dioica																			★																
Galium-type				1									★		★			★																	
Lactuceae (Taraxacum-type)				★											★	★		★																	
Helianthemum							3.8				★	★			★	★																			
Caryophyllaceae indet.													★																						
Brassicaceae (Sinapis-type)											★																								
Succisa										★	★																								
Lysimachia										★																									
Epilobium-type			★																																
Lactuceae indet.			★																																
Brassicaceae (Capsella-type)		1.1																																	
Achillea-type	1																																		
Ferns and aliens and sphagnum																																			
Thelypteris				★													1.6	1	1.1				6						★		1.2				
Athyrium																			1.1				6	6.1					★	★					
Dryopteris																			★																
Sphagnum															★																				
Equisetum		★	1.3	★																															
Aquatics and plants of wet soils																																			
Mentha-type																		★																	4.3
Filipendula					★							★							1.1				2						★		1.2		2.4		
Sparganium-type	★		★	2		11	6.9			★	1.1		★	★		★													★						
Caltha																												1.5							
Alisma-type				4.5								★							★																
Lemna															★	★																			
Thalictrum												★																							
Apiaceae (Apium-type)					★																														
Typha latifolia	2.7		★																																

Plant taxa expressed as percentage of appropriate sum, other palynomorphs expressed as numbers per cu. cm of subjective abundance

Table 8 Plant taxa and other palynomorphs from pit *52*

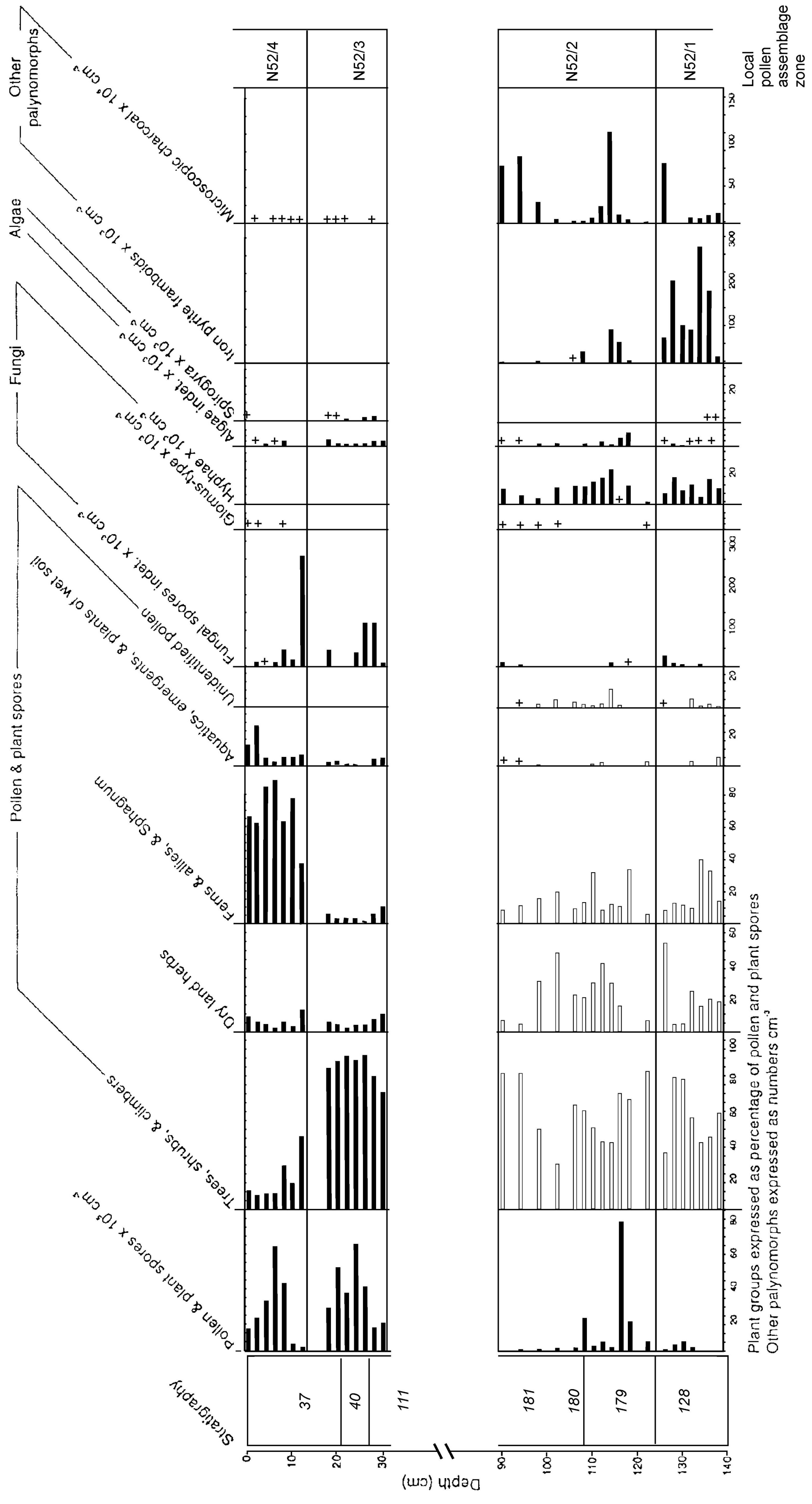


Figure 24 Plant groups from pit 52

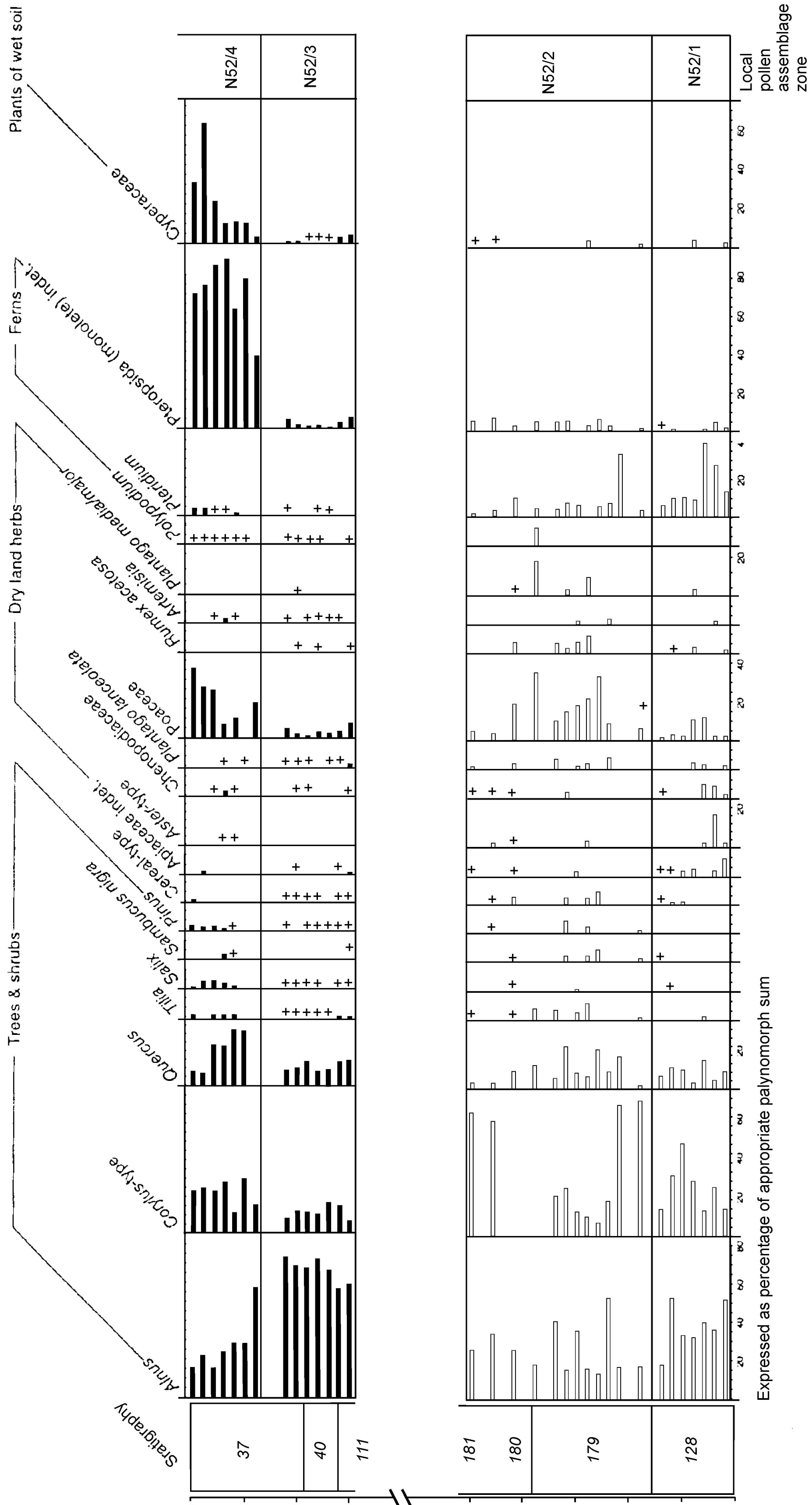


Figure 25 Plant species from pit 52

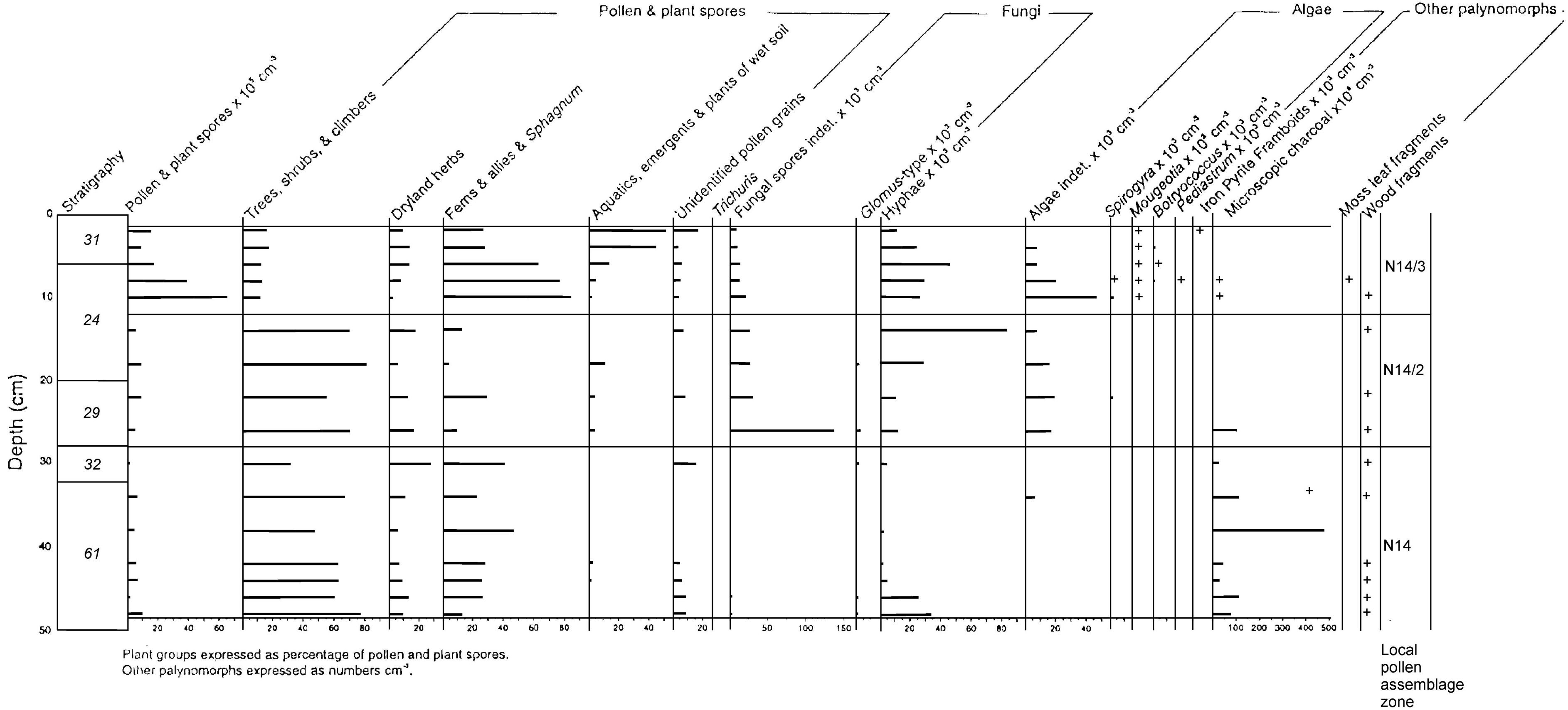


Figure 26 Plant groups from pit *14*

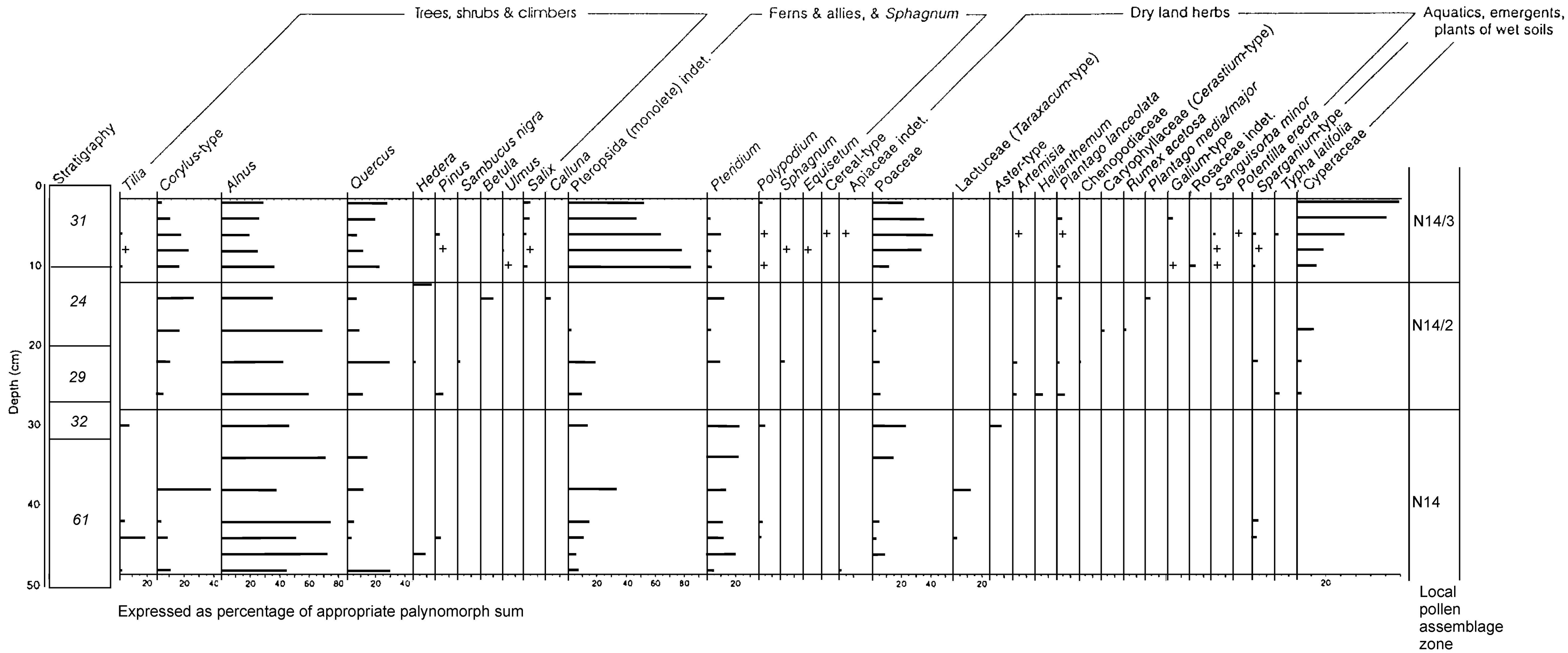


Figure 27 Plant species from pit *14*

Description of local pollen assemblage zones

Palaeosol *66*
(Figs 22 and 23)
Zone N66/1: arboreal pollen ranged from 70–82% of the sum, although most of the high values were because of high *Tilia* (lime) representation. *Corylus*-type (hazel) and *Alnus* (alder) were also well represented while *Quercus* had lower values ranging from 3.8–5.5%. *Pinus* (pine) and *Ulmus* (elm) were also recorded. Fern spores relatively abundant and *Sphagnum* was present, and single cereal-type grain was found at 4cm. The most abundant dry land herbaceous taxon was Lactuceae (dandelion-like plants) while Poaceae (grasses) and other ruderals reached values of <1% of the sum. Plants which favour wet conditions were represented only by Cyperaceae (sedges). No iron pyrite framboids or algal remains were recorded, and fungal hyphae and *Glomus*-type (arbuscular mycorrhizal sporangia) were very sparse. However, fungal spores increased progressively up the profile. Microscopic charcoal was only moderately abundant. Pollen grains which were too degraded for identification reached high values of between 10.9–12.5 %.

Zone N66/2: *Tilia* values continued to decline and reached a value of only 2.3% in the uppermost sample. *Alnus* values remained about the same as in the previous zone but there were relative increased percentages for all other tree and shrub taxa, and *Betula* (birch), *Rubus* (*e.g.* bramble), *Salix* (willow), *Hedera* (ivy), *Sambucus nigra* (elder), *Calluna* (common heather) and some other, unidentified, heather were also recorded. There was a marked increase in spores of monolete Pteropsida (undifferentiated ferns) and *Pteridium* (bracken), although *Polypodium* (polypody fern) declined. *Sphagnum* was also recorded.

Dry land herbs increased in number of taxa and in abundance, particularly Poaceae and *Plantago lanceolata* (ribwort plantain) although Lactuceae declined. Cereal-type pollen also increased towards the top of the profile as did pollen of wetland plants, with *Filipendula* (meadowsweet), *Batrachium*-type (*e.g.* water crowfoot), and *Sparganium*-type (*e.g.* bur-reed). Iron pyrite framboids were relatively abundant towards the top of the profile and algal remains were also well represented. Free fungal spores achieved similar values to those in zone N66/1 although *Glomus*-type and hyphae were much increased. There was a very marked rise in the concentrations of microscopic charcoal.

Pit *52*
(Figs 24 and 25, Table 8)
Zone N52/1: the very low concentrations of pollen and plant spores, the somewhat erratic nature of the palynomorph curves, and the relatively high percentage of unidentifiable pollen grains (see Figures 3 and 4), suggests that sedimentation was very rapid early in the life of the feature. Arboreal pollen had the highest percentages with *Alnus* and *Corylus* being the dominant taxa in the assemblage. *Quercus* was the only other tree with continuous representation although *Tilia, Betula, Ulmus,* and *Fraxinus* (ash) were also present. Towards the top of the zone, light-demanding shrubs such as *Sambucus nigra*, *Salix*, *Prunus*-type (*e.g.* sloe), and the climber *Hedera* (ivy) were recorded.

Ferns, particularly *Pteridium*, were well represented as were dry land herbs such as Poaceae, *Plantago lanceolata*, Chenopodiaceae, and *Rumex acetosa*. Plants of wet places such as Cyperaceae, *Mentha*-type (*e.g.* water mint), *Sparganium*-type, and *Filipendula* were present, and cereal-type pollen was consistently found in the upper levels of the zone. Algal and fungal remains were present but it is interesting that no *Glomus*-type was recorded. Iron pyrites framboids were very abundant as was microscopic charcoal. Wood fragments were present in every sub-sample.

Zone N52/2: sedimentation in this zone appears to have been very similar to that in zone N52/1, with low pollen and plant spore concentrations and erratic patterning in virtually all the curves on the diagrams. However, there was an increase in the abundance of arboreal taxa and many more herbaceous taxa were recorded, both dry land and wetland herbs. Ferns were also represented at about the same level as in the previous zone and a single tetrad of *Calluna* was found. Cereal-type pollen reached higher percentages than before but was not represented in every level. Algal and fungal remains reached higher values than in zone N52/1 and *Glomus*-type was frequent. However, free fungal spores were less abundant than before. The curves for iron pyrite framboids and microscopic charcoal were highly erratic with framboids being less abundant and charcoal fragments more abundant than in the previous zone. Wood fragments were present in every sub-sample.

Zone N52/3: pollen and plant spore concentrations had a higher average value in this zone than in the previous ones and pollen curves were much less variable. There were relatively fewer degraded grains so percentages for unidentified taxa were lower. Trees and shrubs reached between 71–93% of the pollen sum, and most of this increase was due to *Alnus*; *Corylus* and *Quercus* scored between 7.8–10% and 8.8–14% of the sum respectively. *Tilia* was present in every sub-sample but mostly as one or two grains. A wide range of other trees and shrubs were represented but all achieved values of <1%. *Betula, Salix, Sambucus nigra, Pinus, Fraxinus, Hedera, Ulmus, Ilex,* and *Rhamnus* and a single grain of Ericaceae were recorded. A relatively wide range of dry land herbs were present but all, including Poaceae, were at low levels.

Ferns were also recorded at lower levels than in the previous two zones although wetland plants were more abundant. Algae, particularly *Spirogyra*, and free fungal spores achieved higher values although no fungal hyphae were found. *Glomus*-type was present only at 30cm. Iron pyrite framboids were not found. There was an hiatus at the end of the zone where large amounts of wood debris obscured any palynomorphs that may have been present.

Zone N52/4: the results for the sub-samples at 10cm and 12cm must be viewed with caution since the high levels of wood remains obscured many of the palynomorphs. Pollen and plant spore concentrations were recorded as being low but this is related to the poor field of view. It also means that easily-recognised pollen and spores were probably over-represented in these sub-samples. In the rest of the zone, pollen and plant spore concentrations ranged between 13–63 $x10^5$ cm^{-3} and there was no problem in their identification. The decline in arboreal pollen in this zone was related to the marked drop in *Alnus* percentages while other trees and shrubs showed a reciprocal rise. Dry land herbs were less frequent than in the previous zone but there was a marked increase in Poaceae. There were also increased percentages for Cyperaceae while other wetland plants such as *Sparganium*-type, *Typha latifolia*, and *Equisetum* (horsetail) were also well represented. Although *Spirogyra* declined to extinction except for a single spore found in the uppermost sub-sample, other green algae were present at low level.

Small amounts of microscopic charcoal were present in every sub-sample. Free fungal spores and *Glomus*-type were recorded but no fungal hyphae and no iron pyrite framboids were found. Cereal-type pollen was present in the uppermost sub-sample and also a single egg of the intestinal parasitic nematode worm, *Trichuris* (see Table 8).

Pit *14*
(Figs 26 and 27)
Zone N14/1: pollen and plant spore concentrations were low throughout the zone, palynomorph curves were erratic, and unidentified grains were relatively abundant. No iron pyrite was found, and wet-plant plants and algae were poorly represented. Microscopic charcoal concentrations fluctuated but were generally high. Arboreal pollen percentages were high, fluctuating between 32%–77% of the total sum, but most of these values were due to the abundance of *Alnus* pollen. Other relatively well-represented trees were *Tilia, Corylus* and *Quercus*, while *Hedera* and *Pinus* were also recorded. The only dry land herbs to be recorded were Poaceae, Apiaceae indet. (*e.g.* hogweed), Lactuceae, and *Aster*-type (*e.g.* daisy). Free fungal spores, and hyphae were recorded in most levels, and *Glomus*-type was found at the base and top of the zone.

Zone N14/2: pollen and plant spore concentrations were low also throughout this zone and again, the palynomorph curves were somewhat erratic. No iron pyrite was found and wetland plants were poorly represented, although better than in the previous zone. Algae were also more frequent and more abundant than before. Tree and shrub pollen achieved the highest percentages ranging from 55%–80% of the total sum. *Alnus* ranged between 36%–60% and *Corylus* achieved higher frequency and *Quercus* had high percentages than in the previous zone. *Hedera, Sambucus nigra, Betula*, and *Calluna* were all being recorded. Poaceae and *Pteridium* had lower percentages than in the previous zone but other dry land herbs such as *Plantago lanceolata* and other ruderals were better represented. Overall, microscopic charcoal was present in much lower concentrations than previously. Free fungal spores and fungal hyphae reached high values throughout the zone, and *Glomus*-type was recorded.

Zone N14/3: the concentrations of pollen and plant spores reached relatively high levels between 8–64 x 10^5 cm^{-3} and the palynomorph curves were coherent. The zone was marked by an overall drop in arboreal pollen percentages with *Alnus* being responsible for most of the decline. *Tilia* was recorded in several levels while *Pinus* was present and *Ulmus* reached values up to 1.2%. *Salix* entered the record for the first time and achieved percentages of between 1%–4% which are high for this shrub.

Poaceae increased to between 11%–40% throughout the zone, and *Plantago lanceolata* and other dry land herbs were represented. *Pteridium* was less well represented than before but other ferns increased very greatly, as did Cyperaceae. *Sparganium*-type, *Typha latifolia* (greater reedmace), *Equisetum* and *Sphagnum* were also recorded. Small numbers of iron pyrite framboids were found in the uppermost sub-sample and microscopic charcoal was present in very small amounts throughout the zone. A single cereal-type pollen grain and single *Trichuris* egg were found. Algae showed a marked increase in abundance and the number of taxa recorded. Fungal spores and hyphae were still abundant though *Glomus*-type was not recorded.

Soil micromorphological descriptions
by Charly French

Profile 1
Structure: apedal, homogeneous; *Porosity:* 25–45%; very open fabric; all vughs, irregular to sub-rounded, <500µm; *Organic component:* frequent (20–25%, but <2% of total groundmass) very fine fragments of organic matter in silt/clay fraction, <50µm; rare (<1%) large fragments of wood; replaced by amorphous sesquioxides; *Mineral Components:* limit 100µm; coarse/fine ratio: 85/15; coarse fraction 5% coarse, 60% medium and 20% fine quartz sand, sub-rounded to sub-angular, 100–750µm; fine fraction: 5% very fine quartz sand, 50–100µm, sub-rounded to sub-angular; 5% silt and 5% clay; moderately birefringent; grey/reddish brown (CPL), brown (PPL), opaque greyish white/brown (RL); *Groundmass:* fine and related: open porphyric; coarse: undifferentiated; *Pedofeatures: Textural:* 5–10% non-laminated dusty clay of grains and groundmass, moderate to strong birefringence, yellow to gold to amber (CPL); *Amorphous:* all fine fraction weakly impregnated with amorphous sesquioxides; micro-sparite calcium carbonate as near continuous infills of void space in lower 2cm of slide, comprising up to 30% of the groundmass.

Profile 2/upper sample 1: 0–8cm
Structure: two distinct, upper and lower horizons; upper 1–3cm: all carbonised wood fragments with cell structure preserved, 1–10mm; lower 3–8cm: *Porosity:* 30–40% very open fabric, all interconnected vughs, <500µm; *Mineral Components:* 10% flint gravel, 2–15mm, sub-angular, fire-cracked; 90% soil; limit 100µm; coarse/fine ratio: 35/65; coarse fraction: 10% coarse, 20% medium and 5% fine quartz sand, 100–750µm, sub-angular to sub-rounded; fine fraction: 5% very fine quartz sand, 50–100µm; 50% peat and plant tissue, severely oxidised; 3% silt and <2% clay; dark reddish brown (CPL), reddish brown (PPL); *Groundmass*:fine and related: open pophyric; coarse: undifferentiated; *Pedofeatures: Amorphous:* whole fabric exhibits a weak impregnation with amorphous sesquioxides.

Profile 2/lower sample 2: 8–20cm
Structure: series of lens and fabrics as follows, all apedal:

8–13cm: fabric 1): dense calcitic quartz sand; limit 100µm; c/f ratio: 30/70; coarse fraction: 10% medium and 20% fine quartz sand, 100–350µm; fine fraction: 10% very fine quartz sand, 50–100µm; 50% micro-sparite calcium carbonate; 5% amorphous sesquioxide impregnated peat/organic matter; 2% very fine fragments of organic matter in groundmass, <50µm; 3%

non-laminated silty (dusty) clay; contains two diffuse lenses of peaty sand; pale yellowish brown (CPL and RL), yellowish brown (PPL); *Porosity*: <10%; all vughs, <500µm;

13–14cm: lens of peaty sand and wood charcoal;

14–17cm: fabric 2): peaty calcitic sand; limit 100µm; c/f ratio: 45/55; coarse fraction: 5% coarse, 20% medium and 20% fine quartz sand, 100–750µm; fine fraction: 5% very fine quartz, 50–100µm; 5–15% peat/organic matter; 2% very fine fragments of organic matter in groundmass, <50µm; 30–40% micro-sparite calcium carbonate; 3% silty (dusty) clay; very dark golden black (CPL), reddish brown (PPL), dark reddish brown (RL); *Porosity*: 25–30% interconnected vughs;

17–20cm: fabric 3): loamy sand; limit 100µm; c/f ratio: 65/35; coarse fraction: 10% coarse, 25% medium and 30% fine quartz sand, 100–750µm; fine fraction: 10% very fine quartz, 50–100µm; <10% peat/organic matter; 5% very fine fragments of organic matter in groundmass, <50µm; 5–10% silty (dusty) clay; dark golden brown (CPL), reddish brown (PPL), brown (RL); *Porosity*: 30–40% interconnected vughs.

Wood
by Peter Murphy
(Fig. 28, Table 9)

Context	*Description*
32	Four wood chunks 200–300mm long. Badly decayed, with no original surfaces. One alder (*Alnus* sp), one probably alder, one indeterminate.
121	Halved large roundwood stem 500mm long, 100+ mm original diameter. Straight. No bark, deep radial fissures. Indeterminate.
122	Small heartwood chunk, 460x160x20mm. Badly decayed, no original surfaces. Indeterminate.
123	Roundwood stem, 570mm long, diameter *c*.50mm. Straight. Badly decayed, no bark. *Quercus* sp (oak).
124	Small heartwood chunk, 550x40x35mm. No original surfaces, badly decayed. Indeterminate.
125	Roundwood stem, 1770mm long, diameter *c*.85mm. Badly decayed, no bark. Probably alder.
126	Roundwood stem, 580mm long, diameter *c*.120mm. Rotted on one face, with radial fissures. Traces of bark. Probably alder.
176	Roundwood stakes retrieved after collapse of section face in pit *52*.
a	Unworked roundwood with bark, 55mm diameter. Hazel (*Corylus* sp).
b	Roundwood with bark, 70mm diameter. Abraded chisel point. Hazel.
c	Roundwood with bark, 105mm diameter. Chisel point made by numerous blows. Tool marks. Hazel.
188	Thin board, tangential conversion. 640x130x25mm. Wood structure poor with contorted rays. Surfaces decayed. Probably alder.
189	Thin board, tangential conversion. 870x190x25mm. Wood structure moderately good. Upper surface fairly smooth and flat, with pitting produced from adpressed stones. Lower surface with tool marks. Probably alder.
190	Thin board, tangential conversion. 900x181x14mm. Wood structure moderately good. Upper surface fairly smooth and flat, with pitting. Lower surface with tool marks and oblique cuts at one end. Possibly alder — no perforation plates visible.
191	Thin board, tangential conversion. 710x170x20mm. Surface preservation poor. Probably alder.
192	Thin board, tangential conversion. 730x140x15mm. Wood structure poorly preserved, with contorted rays. Probably alder.

Table 9 Wood catalogue

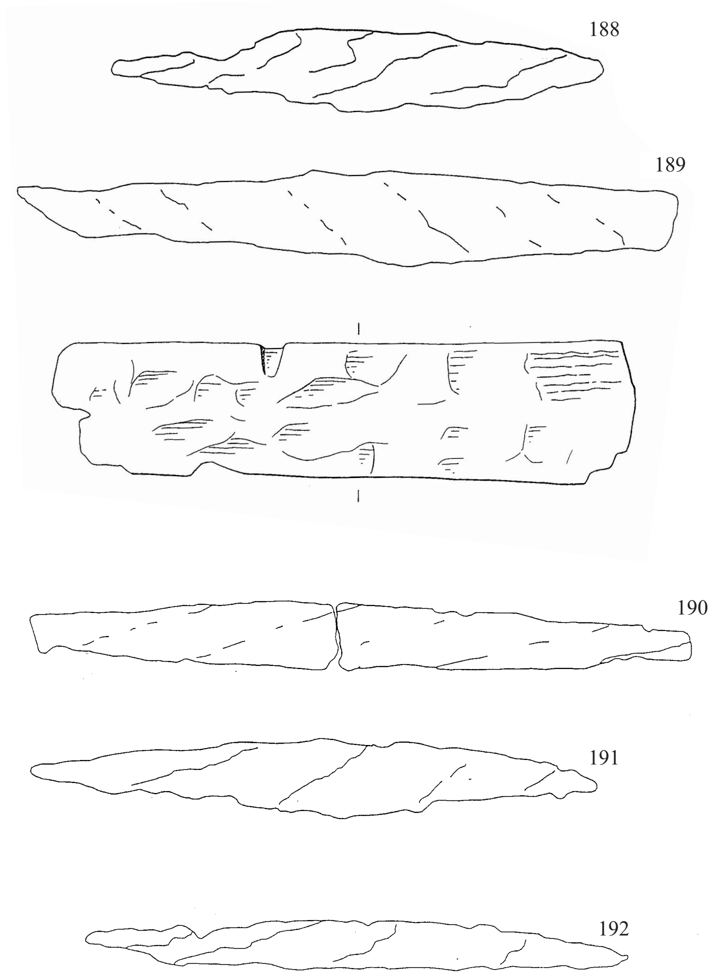


Figure 28 Cross sections of boards from pit *14*, scale 1:2
Plan view of *189*, scale 1:10

Bibliography

Anthony, I.M.C. and Sanderson, D.C.W., n.d. Available: http://www.gla.ac.uk/surrc/personnel/postgrad/burntstone.html Accessed: 26 February 2004

Apling, H., 1931 'Bronze Age settlements in Norfolk', *Proc. Prehist. Soc. E. Anglia* 6, 365–70

Ashbee, P., 1983 'Excavation of a pot-boiler site (6980/c4) in 1972', in Lawson, A.J., *The Archaeology of Witton near North Walsham*, E. Anglian Archaeol. 18, 95–6

Ashmore, P.J., 1999 'Radiocarbon dating: avoiding errors by avoiding mixed samples', *Antiquity* 73, 124–30

Ashwin, T.M. and Tester, A., forthcoming *Excavation of a Roman Small Town at Scole*, E. Anglian Archaeol.

Baillie, M.G.L., 1990 'Provision of dates for fulachta fiadh' in Buckley, V.M. (ed.), *Burnt Offerings: International Contributions to Burnt Mound Archaeology*, (Dublin), 165–9

Bamford, H., 1982 *Beaker Domestic Sites in the Fen-edge and East Anglia*, E. Anglian Archaeol. 16

Barfield, L.H. and Hodder, M.A., 1981 'Birmingham's Bronze Age', *Current Archaeology* vol. 7 (7), 198–200

Barfield, L.H. and Hodder, M.A., 1987 'Burnt mounds as saunas, and the prehistory of bathing', *Antiquity* 61, 370–9

Bates, S.J., forthcoming 'Excavation of a burnt flint mound at Brundall, Norfolk', *Norfolk Archaeol.*

Bates, S.J. and Wiltshire, P.E.J., 2000 'Excavation of a burnt mound at Feltwell Anchor, Norfolk, 1992', *Norfolk Archaeol*. 43 (3), 389–414

Bayliss, A., and Orton, C.R., 1994 'Strategic considerations in dating, or How many dates do I need?', *Univ. London Inst. Archaeol. Bull.* 31, 151–67

Beamish, M. and Ripper, S., 2000 'Burnt mounds in the East Midlands', *Antiquity* 74, 37–8

Bennett, K.D., Whittington, G. and Edwards, K.J., 1994 'Recent plant nomenclatural changes and pollen morphology in the British Isles', *Quaternary Newsletter* 73, 1–6, (Quaternary Research Association)

Benninghof, W.S., 1962 'Calculations of pollen and spore density in sediments by addition of exotic pollen in known quantities', *Pollen et Spores* 4, 332–3

Binford, L.R., 1972 *An Archaeological Perspective*, (New York)

Blomefield, F., 1807 *An Essay Towards a Topographical History of the County of Norfolk* II, 210–21

Boast, R., 2000 'Pottery', in Bates, S.J. and Wiltshire, P.E.J., 'Excavation of a burnt mound at Feltwell Anchor, Norfolk, 1992', *Norfolk Archaeol*. 43 (3), 408

Bonny, A.P., 1972 'A method for determining absolute pollen frequencies in lake sediments', *New Phytologist* 71, 393–405

Bradley, R., 1993 'Where is East Anglia? Themes in regional prehistory', in J. Gardiner (ed.) *Flatlands and Wetlands: Current Themes in East Anglian Archaeology*', E. Anglian Archaeol. 50, 5–13

Brady, N.C., 1974 *The Nature and Properties of Soils* (8th edition, New York)

Brindley, A.L. and Lanting, J.N., 1990 'The dating of fulachta fiadh', in Buckley, V. M. (ed.), *Burnt Offerings: International Contributions to Burnt Mound Archaeology*, (Dublin), 55–6

British Geological Survey, 1985 East Anglia Sheet 52N 00 Solid Geology

Bronk Ramsey, C., 1995 'Radiocarbon calibration and analysis of stratigraphy', *Radiocarbon* 36, 425–30

Bronk Ramsey, C. and Hedges, R.E.M., 1997 'Hybrid ion sources: radiocarbon measurements from microgram to milligram', *Nuclear Instruments and Methods in Physics Research* B 123, 539–45

Buck, C.E., Christen, J.A., Kenworthy, J.B. and Litton, C.D., 1994 'Estimating the duration of archaeological activity using ^{14}C determinations', *Oxford J. Archaeol*. 13, 229–40

Buck, C.E., Kenworthy, J.B., Litton, C.D. and Smith, A.F.M., 1991 'Combining archaeological and radiocarbon information: a Bayesian approach to calibration', *Antiquity* 65, 808–21

Buck, C.E., Litton, C.D. and Smith, A.F.M., 1992 'Calibration of radiocarbon results pertaining to related archaeological events', *J. Archaeol. Sci.* 19, 497–512

Buckley, V. M. (ed.), 1990 *Burnt Offerings: International Contributions to Burnt Mound Archaeology*, (Dublin)

Bullock, P., Fedoroff, N., Jongerius, A., Stoops, G. and Tursina, T., 1985 *Handbook for Soil Thin Section Description*, (Waine Research, Wolverhampton)

Calcote, R., 1998 'Identifying forest stand types using pollen from forest hollows', *The Holocene* 8 (4), 423–32

Cantrill, T.C. and Jones, O.T., 1906 'The discovery of prehistoric hearths in South Wales', *Archaeol. Cambrensis*, 6th ser., 6, 17–34

Cantrill, T.C. and Jones, O.T., 1911 'Prehistoric cooking places in South Wales', *Archaeol. Cambrensis*, 6th ser., 11, 253–86

Case, H., 1993 'Beakers: deconstruction and after', *Proc. Prehist. Soc*. 59, 241–68

Clarke, D.L., 1970 *Beaker Pottery of Britain and Ireland*

Cleal, R., 1984 'The Later Neolithic in eastern England', in Bradley, R. and Gardiner, J., (eds), *Neolithic Studies, a Review of Some Current Research*, Brit. Archaeol. Rep. 133 (Oxford), 135–58

Coles, J.M., 1976 'Forest farmers: some archaeological, historical and experimental evidence relating to the prehistory of Europe', in De Laet, S.J. (ed.), *Acculturation and Continuity in Atlantic Europe. Fourth Atlantic Colloquium, Ghent*, (Bruges), 59–66

Coles, J.M., 1990 *Fenland Evaluation Project 1989–90: summary of findings and recommendations*, (English Heritage)

Conway, E., 1949 'The autecology of bracken (*Pteridium aquilinum* Kuhn.). The germination of the spore, the development of the prothallus and the young sporophyte', *Proc. Royal Soc. Edinburgh* 163B, 325–343

Cornwall, I.W., 1958 *Soils for the archaeologist*, (Phoenix House, London)

Crabtree, K., forthcoming 'Palynology', in Carruthers, W., Crabtree, K., Straker, V. and Wiltshire, P.E.J., `Wareham Experimental Earthwork 1996: Past and present vegetation studies', *J. Archaeol. Sci.*

Crane, P. and Manning, A., 1998 *The Burnt Mounds of Dyfed: 1997–8 Archaeological Assessment Survey*, (unpublished Dyfed Archaeological Trust Report)

Crowson, A., 1995 'Excavation of a burnt mound at High Fen Drove, Northwold' *Fenland Research* 9, 20–23

Crowson, A., 2000a 'High Fen Drove, Northwold', in Crowson, A., Lane, T. and Reeve, J. (eds), *Fenland Management Project Excavations 1991–1995*, Lincolnshire Heritage and Archaeol. Rep. Ser. No. 3, 188–92

Crowson, A., 2000b 'Feltwell Anchor, Feltwell', in Crowson, A., Lane, T. and Reeve, J. (eds), *Fenland Management Project Excavations 1991–1995*, Lincolnshire Heritage and Archaeol. Rep. Ser. No. 3, 182–7

Crowson, A. and Bayliss, A., 1999 'Dating a burnt mound and its Beakers at Northwold, Norfolk', in Evin, J., Oberlin, C., Daugas, J.P. and Salles, J.F. (eds), 'Actes du 3ème congrès international «Archéologie et ^{14}C», Lyon, 6–10 Avril 1998', *Revue d'Archéométrie Suppl. 1999 et Soc. Préhist. Fr. Mémoire* 26, 243-8

Dehling, H. and van der Plicht, J., 1993 'Statistical problems in calibrating radiocarbon dates', *Radiocarbon* 35, 239–44

Dimbleby, G.W., 1985 *The Palynology of Archaeological Sites*, (London)

Dring, M.J., 1965 'The influence of shaded conditions on the fertility of bracken', *British Fern Gazette* 9, 222–7

Edwards, K.J., 1989 'The cereal pollen record and early agriculture', in Milles, A., Williams, D. and Gardner, N. (eds), *The Beginnings of Agriculture,* Symposia of the Association for Environmental Archaeology 8, Brit. Arch. Rep. International Series 496, 113–35

Edwards, K.J., 1993 'Models of mid-Holocene forest farming for north-west Europe', in Chambers, F.M. (ed.), *Climate Change and Human Impact on the Landscape*, (London, Chapman and Hall)

Ehrenberg, M.A., 1991 'Some aspects of the distribution of burnt mounds' in Hodder, M.A. and Barfield, L.H. (eds), *Burnt Mounds and Hot Stone Technology*, Papers from the Second International Burnt Mound Conference, 41–58

English Heritage, 1991 *Exploring our past: strategies for the archaeology of England*

English Heritage, 1992 *The Fenland Project: From Mapping to Management. Research Objectives of the Fenland Management Project*

English Heritage, 2002 *English Heritage Strategy for Wetlands*

Evans, C., 2000 'Testing the ground — sampling strategies', in Crowson, A., Lane, T. and Reeve, J. (eds), *Fenland Management Project Excavations 1991–1995*, Lincolnshire Heritage and Archaeol. Rep. Ser. No. 3, 15–21

French, C.A.I., 1992 'Feltwell 171, Norfolk: Soils Assessment', (internal report to Norfolk Archaeological Unit, Fenland Management Project, English Heritage)

French, C.A.I., 1993 'Coveney: Soil micromorphological analysis', (internal report to Cambridge Archaeological Unit, Fenland Management Project, English Heritage)

Gelfand, A.E. and Smith, A.F.M., 1990 'Sampling approaches to calculating marginal densities', *J. American Stat. Assoc.* 85, 398–409

Gowen, M., 1988 *Three Irish Gas Pipelines: New Archaeological evidence in Munster,* (Dublin)

Grime, J.P., Hodgson, J.G. and Hunt, R., 1988 *Comparative Plant Ecology: a functional approach to common British species*, (London)

Grimm, E.C., 1991 *TILIA and TILIA-GRAPH*, (Illinois State Museum, Springfield)

Gulliksen, S. and Scott, M., 1995 'Report of the TIRI workshop: Saturday 13th August 1994', *Radiocarbon* 37, 820–1

Hall, D. and Coles, J., 1994 *Fenland Survey: An essay in landscape and persistence*, English Heritage Archaeol. Rep. 1, (London)

Hall, D. and Coles, J., 2000 'From aspiration to reality', in Crowson, A., Lane, T. and Reeve, J. (eds), *Fenland Management Project Excavations 1991–1995*, Lincolnshire Heritage and Archaeol. Rep. Ser. No. 3, 231–42

Hammond, N., 1986 'Canoe cookery the hard way', *The Times*

Healy, F., 1984 'Farming and field monuments: the Neolithic in Norfolk', in Barringer, C. (ed.), *Aspects of East Anglian Prehistory (20 years after Rainbird Clarke)*, (Norwich)

Healy, F., 1991 'Lithics and Pre-Iron Age Pottery', in Silvester, R.J., *The Fenland Project Number 4: Norfolk Survey, The Wissey Embayment and Fen Causeway*, E. Anglian Archaeol. 52, 116–39

Healy, F., 1995 'Pots, pits and peat: ceramics and settlement in East Anglia' in Kinnes, I. and Varndell, G. (eds), *Unbaked Urns of Rudely Shape; Essays on British and Irish Pottery for Ian Longworth*, Oxbow Monograph 55, 173–84

Healy, F., 1996 *The Fenland Project Number 11: The Wissey Embayment: Evidence For Pre-Iron Age Occupation Accumulated Prior to the Fenland Project*, E. Anglian Archaeol. 78

Hedges, R.E.M., Bronk, C.R. and Housley, R.A., 1989 'The Oxford Accelerator Mass Spectrometry facility: technical developments in routine dating', *Archaeometry* 31, 99–113

Hodder, M.A. and Barfield, L.H., 1991 *Burnt Mounds and Hot Stone Technology*, Papers from the Second International Burnt Mound Conference, Sandwell, 12–14 October 1990

Jeffery, S., 1991 'Burnt mounds, fulling and early textiles', in Hodder, M.A. and Barfield, L.H. (eds), *Burnt Mounds and Hot Stone Technology*, Papers from the Second International Burnt Mound Conference, Sandwell, 12–14 October 1990, 97–107

Kenward, H.K., Hall, A. and Jones, A.K.J., 1980 ‘A tested set of techniques for the extraction of plant and animal macrofossils from waterlogged archaeological deposits’, *Science and Archaeology* 22, 3–15

Kerney, M.P., 1975 ‘A list of the fresh and brackish-water Mollusca of the British Isles’, *J. Conch*. 29, 26–8

Kerney, M.P. and Cameron, R.A.D., 1979 *A field guide to the land snails of Britain and North-west Europe*, (London)

Kinnes, I., Gibson, A., Ambers, J., Bowman, S., Leese, M. and Boast, R.B., 1991 ‘Radiocarbon dating and British Beakers: the British Museum programme’, *Scot. Archaeol. Rev.* 8, 35–78

Larsson, T.B., 1990 ‘Skärvstenhögar — the burnt mounds of Sweden’, in Buckley, V. M. (ed.), *Burnt Offerings: International Contributions to Burnt Mound Archaeology*, (Dublin), 142–53

Lawless, C., 1990 ‘A fulachta fiadh Bronze Age cooking experiment’, *Cathair Na Mart* 10

Lawson, A.J., 1983 *The Archaeology of Witton near North Walsham*, E. Anglian Archaeol. 18

Layard, N.F., 1922 ‘Prehistoric cooking places in Norfolk’, *Proc. Prehist. Soc. E. Anglia* 3, 483–98

Leah, M.D. and Crowson, A., 1994 ‘The excavation of a potboiler mound at Feltwell Anchor (Site 23650)’, *Fenland Research* 8, 46–50

Leah, M.D. and Matthews, M., 1990 *‘Northwold 36 Site Dossier’*, (unpublished Fenland Evaluation Project fieldwork records, Norfolk Archaeological Unit)

Leah, M.D., Wells, C.E., Stamper, P., Huckerby, E. and Welch, C., 1998 *The Wetlands of Shropshire and Staffordshire*, NWWS 7, Lancaster Imprints 5, (Lancaster)

Manning, A., Birley, R. and Tipping, R., 1997 ‘Roman impact on the environment at Hadrian’s Wall: precisely dated pollen analysis from Vindolanda, northern England’, *The Holocene* 7 (2), 175–86

Martin, E., 1988 ‘Swales Fen, Suffolk: a Bronze Age cooking pit?’, *Antiquity* 62, 358–9

McCormac, F.G., Kalin, R.M. and Long, A., 1992 ‘Radiocarbon dating beyond 50,000 years by liquid scintillation counting’ in Noakes, J.E., Shonhofer, F. and Polach, H.A. (eds), *Liquid Scintillation Spectrometry*, 125–33

Mook, W.G., 1986 ‘Business meeting: Recommendations/ Resolutions adopted by the Twelfth International Radiocarbon Conference’, *Radiocarbon* 28, 799

Murphy, C.P., 1986 *Thin section preparation of soils and sediments*, (AB Academic, Berkhamsted)

Murphy, P.L., 1988 ‘Palaeoecological studies of three Bronze Age ‘burnt flint’ sites near West Row, Mildenhall, Suffolk’, English Heritage Ancient Monuments Laboratory Report 165/88

Murphy, P.L., 1998 ‘High Fen Drove, Northwold, Norfolk (Site 23680 NWD TL 7141 9696); Plant macrofossils (including wood) and molluscs from a Bronze Age ‘burnt flint’, mound’, (unpublished report)

Needham, S., 1996 ‘Chronology and periodisation in the British Bronze Age’, *Acta Archaeologia* 67, 121–40

Newman, J., 1992 *Henham 013 — Excavation, June 1991*, (unpublished fieldwork record, Suffolk County Council Archaeological Service)

Noakes, J.E., Kim, S.M. and Stipp, J.J., 1965 ‘Chemical and counting advances in liquid scintillation age dating’ in Chatters, R.M. and Olsson, E.A. (eds), *Proceedings of the sixth international conference on radiocarbon and tritium dating*, 68–92

O’Drisceoil, D.A., 1988 ‘Burnt mounds: cooking or bathing?’, *Antiquity* 62, 671–80

O’Kelly, M.J., 1954 ‘Excavations and experiments in ancient Irish cooking places’, *J. Royal Soc. Antiquaries Ireland* 84, 105–55

Pasmore, A.H. and Pallister, J., 1967 ‘Boiling mounds in the New Forest’, *Proc. Hampshire Field Club* 24, 14–19

Pearson, G.W., 1984 *The development of high-precision ^{14}C measurements and its application to archaeological timescale problems*, (unpubl. PhD thesis, Queens Univ. Belfast)

Pearson, G.W. and Stuiver, M., 1986 ‘High-precision calibration of the radiocarbon timescale, 500–2500BC’, *Radiocarbon* 28, 839–62

Peterson, F.F. and Healy, F., 1986 ‘The excavation of two round barrows and a ditched enclosure on Weasenham Lyngs, 1972’, in Lawson, A.J., *Barrow Excavations in Norfolk, 1950–82*, E. Anglian Archaeol. 29, 70–103

Pitt-Rivers, A.L.F., 1898 *Excavations in Cranborne Chase near Rushmore Vol. 1V*, (privately printed)

Robinson, M.R., 1995 ‘Coleoptera from High Fen Drove, Northwold, Norfolk’, in Murphy, P.L. (ed.), *Fenland Management Project Environmental Archaeology Assessment Report: 40, High Fen Drove, Northwold, Norfolk (NWD 36/23860 NWD)*, (internal report to Norfolk Archaeological Unit, Fenland Management Project, English Heritage)

Round, F.E., 1981 *The Ecology of Algae*, (Cambridge)

Royal Commission on Historical Monuments for England and English Heritage, 1998 *The Thesaurus of Monument Types*, (2nd edition)

Rozanski, K., Stichler, W., Gonfiantini, R., Scott, E.M., Beukens, R.P., Kromer, B. and van der Plicht, J., 1992 ‘The IAEA ^{14}C intercomparison exercise 1990’, *Radiocarbon* 34, 506–19

Schweingruber, F.H. 1978 *Microscopic wood anatomy,* (2nd edition, F. Flueck-Wirth: Teufen)

Sheehan, J., 1991 ‘The excavation of a fulacht fiadh at Coarhamore, Valentia Island, Co. Kerry’, in Buckley, V. M. (ed.), *Burnt Offerings: International Contributions to Burnt Mound Archaeology*, (Dublin), 127–37

Shennan, S.J., 1999 ‘The excavation of a burnt mound at Harbridge, Hampshire’, *Proc. Hampshire Field Club Archaeol. Soc.* 54 (1999), 172–9

Silvester, R.J., 1991 *The Fenland Project Number 4: Norfolk Survey, The Wissey Embayment and Fen Causeway*, E. Anglian Archaeol. 52

Smith, D.C. and Douglas, A.E., 1987 *The biology of symbiosis*, (London)

Stace, C., 1991 *A new Flora of the British Isles*, (Cambridge)

Steier, P. and Rom, W., 2000 'The use of Bayesian statistics for ^{14}C dates of chronologically ordered samples: a critical analysis', *Radiocarbon* 42 (2), 183–198

Stockmarr, J., 1972 'Tablets with spores used in absolute pollen analysis', *Pollen et Spores* 13, 615–21

Stuiver, M. and Kra, R.S., 1986 'Editorial comment', *Radiocarbon* 28, ii

Stuiver, M. and Polach, H.A., 1977 'Discussion: reporting of ^{14}C data', *Radiocarbon* 19, 355–63

Stuiver, M. and Reimer, P.J., 1986 'A computer program for radiocarbon age calculation', *Radiocarbon* 28, 1022–30

Stuiver, M. and Reimer, P.J., 1993 'Extended ^{14}C database and revised CALIB 3.0 ^{14}C age calibration program', *Radiocarbon* 35, 215–30

Tans, P.P., Mook, W.G. and de Jong, A.F.M., 1978 'Chemical pretreatment and radial flow of ^{14}C in tree-rings', *Nature* 271, 234–5

University of Leicester Archaeological Services, n.d. *A Bronze Age Burnt Mound, Willington, South Derbyshire*, Available: http://www.le.ac.uk/ulas/annualreports/ar99–00/willington/willington.html Accessed: 26 February 2004

Van de Noort, R., Fletcher, W., Thomas, G., Carstairs, I. and Patrick, D., 2002 *Monuments at Risk in England's Wetlands v.3*, (document prepared for English Heritage)

van der Plicht, J., 1993 'The Gröningen radiocarbon calibration program', *Radiocarbon* 35, 231–7

van Strydonck, M., Nelson, D.E., Crombé, P., Bronk Ramsey, C., Scott, E.M., van der Plicht, J. and Hedges, R.E.M., 1999 'Rapport du groupe de travail sur les limites de la méthode du ^{14}C appliquée à l'archéologie', in Evin, J., Oberlin, C., Daugas, J-P. and Salles, J-F. (eds), 'Actes du 3ème congrès international «Archéologie et ^{14}C», Lyon, 6–10 Avril 1998', *Revue d'Archéométrie Suppl. 1999 et Soc. Préhist. Fr. Mémoire* 26, 433–48

Walker, P., and de Rouffignac, C., 2000 'Introduction', in Crowson, A., Lane, T. and Reeve, J. (eds), *Fenland Management Project Excavations 1991–1995*, Lincolnshire Heritage and Archaeol. Rep. Ser. No. 3, 1–3

Waller, M., 1994 The Fenland Project Number 9: Flandrian Environmental Change in Fenland, *E. Anglian Archaeol.* 70

Ward, G.K. and Wilson, S.R. 1978 'Procedures for comparing and combining radiocarbon age determinations: a critique', *Archaeometry* 20, 19–31

Wilkinson, T.J. and Murphy, P.L., 1995 *The Archaeology of the Essex Coast Vol. I: The Hullbridge Survey Project*, E. Anglian Archaeol. 71

Williams, G.H., 1990 'Burnt mounds in south-west Wales', in Buckley, V. M. (ed.), *Burnt Offerings: International Contributions to Burnt Mound Archaeology*, (Dublin), 129–40

Wiltshire, P.E.J., 1995 'Northwold (NWD 36/23860 NWD) Pollen Assessment', in Murphy, P.L. (ed.), *Fenland Management Project Environmental Archaeology Assessment Report: 40, High Fen Drove, Northwold, Norfolk (NWD 36/23860 NWD)*, (internal report to Norfolk Archaeological Unit, Fenland Management Project, English Heritage)

Wiltshire, P.E.J., 1997 'The pre-Roman environment', in Wilmott, T., *Birdoswald: Excavations of a Roman fort on Hadrian's Wall and its successor settlements 1987–1992*, English Heritage Archaeol. Rep. 14, 25–40

Wiltshire, P.E.J., 1999a *Palynological assessment of organic layers in barrow turf stack at Thursley Common, Surrey*, (unpublished report for Surrey Archaeological Society)

Wiltshire, P.E.J., 1999b 'Folly Lane, St Albans: Palynological analysis of turves deposited within a funerary shaft of *c.* AD 50–55', in Niblett, R., *The Excavation of a Ceremonial Site at Folly Lane, Verulamium*, Britannia Monograph 14 [PAGE NOS]

Wiltshire, P.E.J., forthcoming a 'Palynological analysis of Iron Age 'pond' sediments at Salford Quarry, Bedfordshire'

Wiltshire, P.E.J., forthcoming b 'Palynological analysis of organic sediments in the Long Barrow ditch', in Healy, F. and Harding, J., *Raunds Area Project. The Neolithic and Bronze Age landscapes of West Cotton, Stanwick and Irthlingborough, Northamptonshire*, English Heritage Archaeol. Rep.

Wiltshire, P.E.J., Edwards, K.J. and Bond, S., 1994 'Microbially-derived metallic sulphide spherules, pollen and the waterlogging of archaeological sites', in Davis, O.K. (ed.), *Aspects of archaeological palynology methodology and applications*, American Association of Stratigraphic Palynologists Contributions Series 29, 206–21

Wiltshire, P.E.J. and Murphy, P.L., 1998 'An analysis of plant microfossils and macrofossils from waterlogged deposits at Slough House and Chigborough Farms', in Wallis, S. and Waughman, M., *Archaeology and Landscape in the Lower Blackwater Valley*, E. Anglian Archaeol. 82, 172–96

Wood, M., 1995 *Environmental Soil Biology*, (2nd edition, London)

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