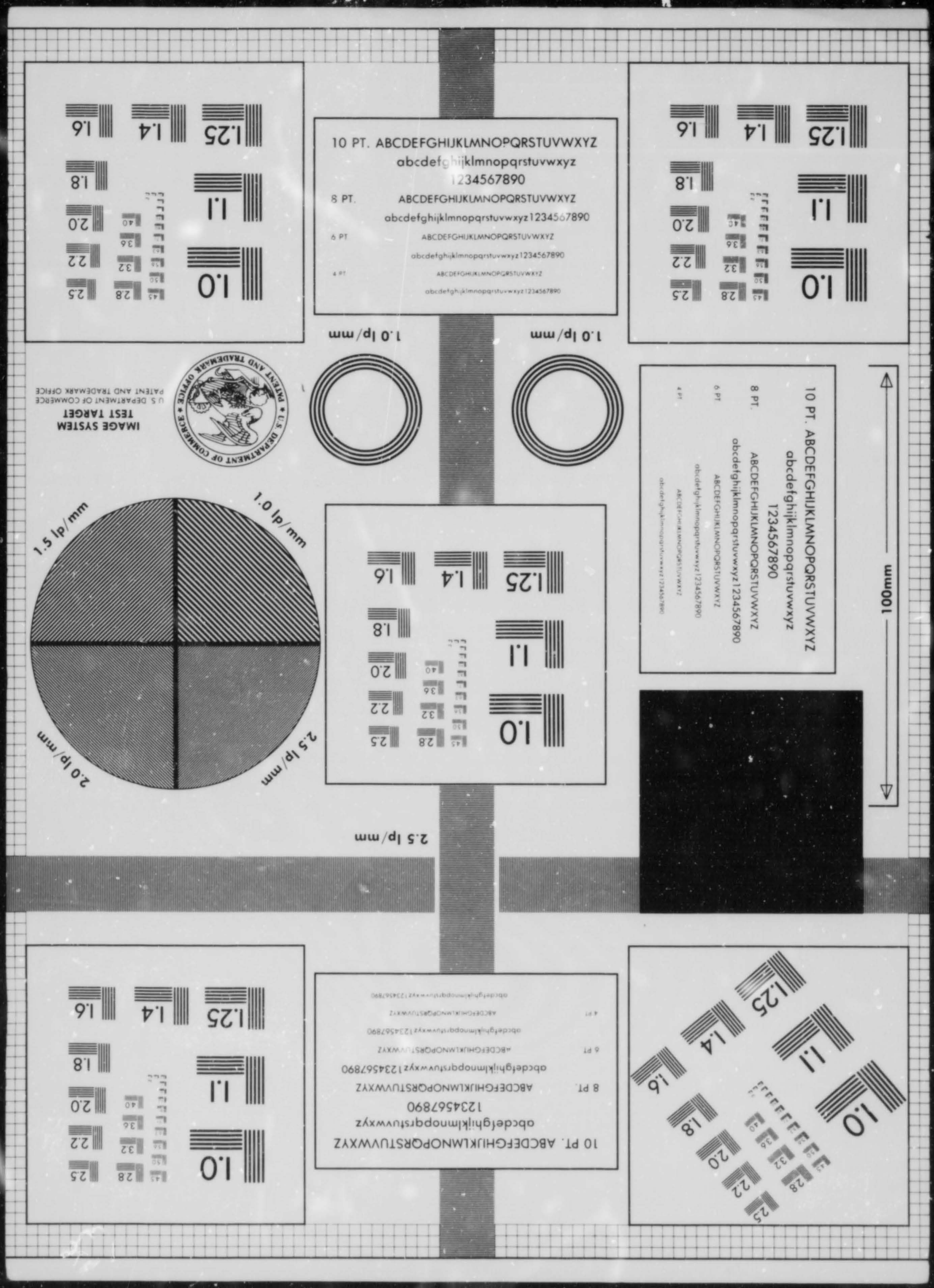
IMAGE SYSTEM
TEST TARGET
U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
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10 PT. ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz
1234567890
8 PT. ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz1234567890
6 PT ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz1234567890
4 PT ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz1234567890
1.0 lp/mm
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The Archaeology of the Essex Coast, Volume I: The Hullbridge Survey

by T.J. Wilkinson and P. L. Murphy

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A2

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Cover Illustration Oblique aerial view of the Hullbridge Site on the River Crouch. South Woodham Ferrers is to the left of the photograph.
Photo: P. Rogers

A3

Contents of Microfiche

APPENDIX A

PRELIMINARY MAGNETOSTRATIGRAPHIC DATING OF INORGANIC ESTUARINE CLAY SEQUENCES ALONG THE ESTUARY OF THE RIVER CROUCH, ESSEX

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Appendix A by T J Austin

1. INTRODUCTION

A large number of sedimentary sequences exposed around salt marshes and the adjacent intertidal zone along the River Crouch Estuary and tributary creeks have been examined in order to relate archaeological sites to their contemporary environment (Wilkinson & Murphy 1986). The generalised Holocene stratigraphy of the Crouch estuary is presented in figure 1. The almost constant waterlogging in the intertidal zone has preserved wooden structures and artifacts of wood, organic soil horizons and, in certain localities, complete landscapes providing a wealth of well-preserved archaeological information. The chronological framework for the sedimentary sequences has been obtained principally from radiocarbon dating of the organic components in the sediments (Table 1) and from the artifacts themselves. However, although the ages of the top and base of the estuarine clay units (II, IV & VI) can be estimated from the radiometric dates, the precise age and sedimentation rates for the clays are much more difficult to determine. It is possible that hiatuses in sedimentation between the peats and the clays and within the clays occur, but as the clays are generally uniform with no visible internal structure and lacking in organic material for radiocarbon dating, the detailed history of sedimentation cannot be established. As archaeological remains were found within and associated with the clays it is of paramount importance to determine their ages and sedimentation rates. It was with this aim in mind that a palaeomagnetic study of the intertidal clay sequences at four sites along the Crouch Estuary was undertaken (figure A1).

2. BACKGROUND TO THE PALAEOMAGNETIC TECHNIQUE

Palaeomagnetic dating is based on the known fact that the direction and intensity of the Earth's magnetic field vary through time. Palaeomagnetism is the study of the geomagnetic field through geological time as recorded in the permanent magnetisation of rocks. Palaeomagnetism is used in Quaternary stratigraphic studies both as a tool for correlation and relative age dating of related strata, and for the absolute dating of deposits.

The basic phenomenon on which palaeomagnetism rests is the acquisition by rocks at or near the time of their formation of a permanent magnetisation derived from and parallel to the then existing Earth's magnetic field at the site. This original magnetisation is termed the primary magnetisation. Between the time of formation of the rock and the present, other, secondary magnetisation may be acquired and the vector sum of the primary and secondary magnetisations as they exist at present in the rock is called the natural remanent magnetisation (NRM).

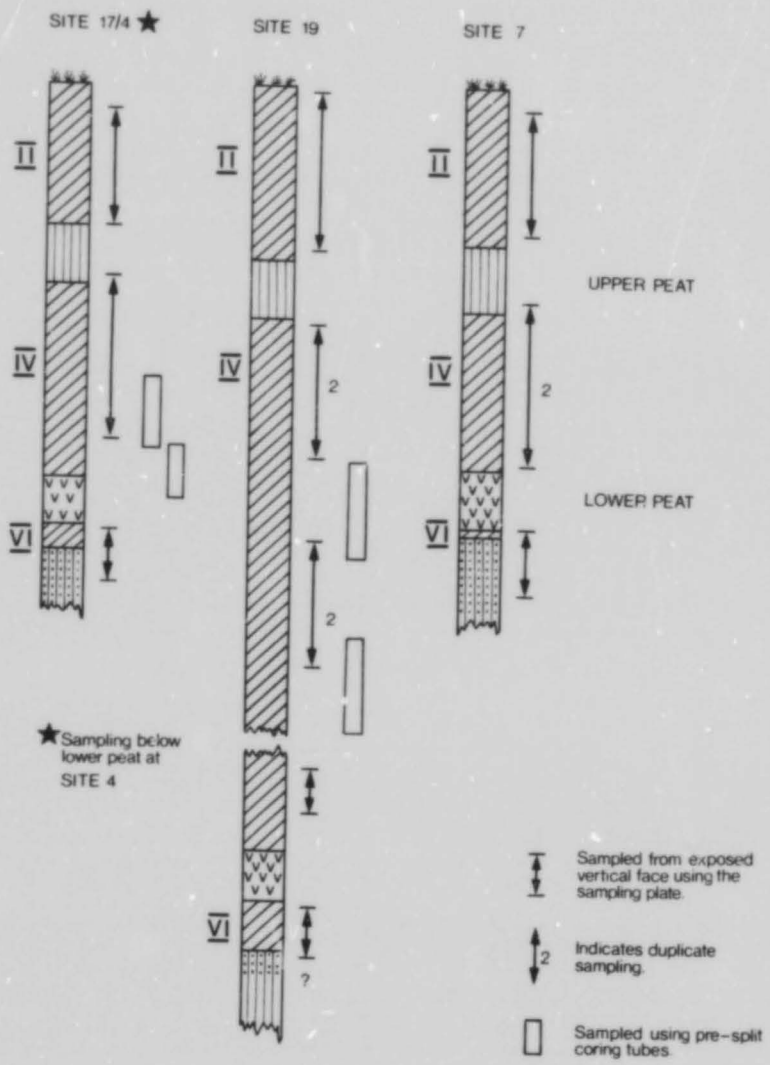
SITE 17/4 ★
SITE 19
SITE 7
II
IV
VI
UPPER PEAT
LOWER PEAT
2
?
★Sampling below lower peat at SITE 4
Sampled from exposed vertical face using the sampling plate.
Indicates duplicate sampling.
Sampled using pre-split coring tubes.

Figure A1

2.1 Magnetisation of sediments.

Sedimentary rocks can acquire a primary magnetisation through two processes, detrital and chemical remanent magnetisation (DRM and CRM). This may be overprinted by a later secondary magnetisation.

Small magnetic particles in a sediment, magnetised during their previous histories, are able to align themselves to the ambient geomagnetic field at or shortly after the time of deposition of the sediment. This alignment of detrital magnetic particles in a sediment gives rise to a DRM. DRM can be divided into two types.

i). Depositional DRM (dDRM). This magnetisation is acquired as the magnetic particles align themselves to the ambient magnetic field whilst settling through the water column, interacting with the substrate at the sediment/water interface, and then coming to rest on the substrate. The magnetisation acquired by the dDRM process may not accurately record the ambient magnetic field, because the orientation of the magnetic particles can be affected by their shape, the nature and especially the slope of the substrate and water currents (King 1955; Hamilton and King 1964; Rees 1961).

ii). Postdepositional DRM (pDRM). This magnetisation is acquired by alignment of the magnetic particles to the ambient field after they have come to rest on the substrate. Small magnetic particles are free to move in fluid filled voids of a newly deposited sediment and their magnetic axes align with the ambient magnetic field. During dewatering and compaction of the sediment these magnetic particles become locked in position giving the sediment an overall magnetic moment parallel to the ambient magnetic field. The main control on the occurrence of pDRM was thought to be the initial water content of the sediment, however more recent information suggests that pDRM processes are also controlled by the size-distribution and concentration of the magnetic minerals and the bulk particle size-distribution of the sediment (Tucker 1979; Barton et al. 1980; Payne & Verosub 1982). Verosub *et al.* (1979) and Tucker (1980a) have shown that only 10-20% of the magnetic grains in a synthetic sediment were able to re-align post-depositionally. Tucker (1980b) concludes that an external perturbation, such as stirring of the sediment, is required to liberate a wide spectrum of grain coercivities (sizes) for prospective realignment. This stirring is analogous to bioturbation processes, occurring at or near the sediment/water interface, which disturbs the original depositional magnetic fabric, increases the water content of the sediment and breaks the constraining forces within the sediment so facilitating post-depositional realignment. pDRM is acquired on a time scale ranging from minutes to years after deposition, depending primarily on the sedimentation rate and bulk sediment grain size. Also pDRM is not susceptible to the alignment errors

as in dDRM and laboratory experiments have demonstrated that such a magnetisation accurately records the ambient magnetic field (Irving & Major 1964; Kent 1973; Graham 1974; Lovlie 1974, 1976; Tucker 1979, 1980a, 1980b; Verosub *et al.* 1979; Payne & Verosub 1982). The fact that analysis of world-wide ocean sediment palaeomagnetic data (Opdyke & Henry 1969) provides no evidence for the presence of an inclination error and that the inclinations from lake sediments appear to accurately record the geomagnetic field variations (Turner & Thompson 1981, 1982) suggests that pDRM is the primary means whereby many sediments acquire their palaeomagnetic signal.

The relative role of depositional versus postdepositional processes in the magnetisation of sediments has been reviewed at length by Verosub (1977).

Chemical remanent magnetisation (CRM) can be acquired either by precipitation of a magnetic mineral out of solution or by the alteration of one mineral to another at low temperatures (below the Curie point) in the presence of an applied magnetic field. Henshaw and Merrill (1980) review the magnetic and chemical changes that can occur in marine sediments.

Secondary components of magnetisation may be acquired by rocks between the time of formation and the present. The most common is a viscous remanent magnetisation (VRM). As the stability and hardness of VRM is generally less than that of the primary NRM, VRM can be removed by magnetic cleaning using alternating field or thermal demagnetisers.

From the above discussion it is apparent that the remanent magnetisation of a sediment may not always provide an accurate record of the direction of the ancient geomagnetic field at the time of deposition of the sediment. This can lead to the mistaken interpretation of fluctuations in palaeomagnetic directions as ancient geomagnetic field changes. The palaeomagnetic directions must be shown to be stable, and the magnetic mineral carrying the NRM identified as this will provide evidence of the likely age of the magnetisation and also of the mechanism by which such remanence was acquired. However the confirmation of the existence of geomagnetic field changes must be based on observations from a number of cores (outcrops) from a given locality as well as on spatial and temporal consistency among several localities.

2.2 The Geomagnetic field and Secular Variation.

The direction and intensity of the geomagnetic field varies on all measurable timescales between two extremes: from abrupt impulsive changes or transients, with periods of a fraction of a second; to changes in polarity reversal frequency with periods in excess of

100 million years. The transient magnetic variations which include micropulsations, magnetic storms and diurnal variations have their origin outside the Earth, being due to a variety of solar-terrestrial phenomena. Spherical harmonic analysis of the observed geomagnetic field demonstrate that the source of the Earth's magnetic field is predominantly of internal origin and that the external sources are not important in palaeomagnetic studies.

Magnetic field variations occurring on timescales ranging from years to thousands of years are known as secular variation, and result from both dipole and more localised non-dipole changes involving both westward and eastward drift. A fairly detailed knowledge of the global behaviour of the field on the timescale of about 100 years and less has been accumulated from direct observations of the Earth's magnetic field. Archaeomagnetic observations based on well dated baked clay materials (pottery or kiln walls) provide information on changes in the Earth's magnetic field during the past few thousand years. Also detailed geomagnetic secular variation records are now available from lake sediments from Europe, the Near East, North America, South America, Australia and Japan for the past 10,000 years. Many of these results are described in contributions to the book "Geomagnetism of Baked clays and Recent sediments" (Creer *et al.* Eds. 1983) and others are summarised in papers by Thompson (1983) and Creer (1985). Type-curves depicting secular variations in declination and inclination through Holocene time have been constructed by stacking data from individual cores for each continental area (Creer & Tucholka 1982, 1983; Thompson 1983). A British Holocene Geomagnetic Master Curve has been constructed from palaeomagnetic records from 10 British lake sediment records (Thompson & Turner 1979). This can be used to date declination and inclination oscillations recorded in Holocene sediments that were deposited at rates of the order of 1mm yr^{-1}, by comparison of the magnetic signatures. The accuracy of this type of magnetostratigraphic dating depends upon the quality of the match between the new data and the master curve and the accuracy of the dating of the master curve.

2.3 Previous palaeomagnetic studies of inter-tidal sediments.

There have been few previous studies of the magnetic properties of inter-tidal sediments. Graham (1974) working on modern tidal-flat sediments from San Francisco Bay, concluded that the acquisition of their NRM, which was a post-depositional remanence recording the present geomagnetic field direction, was related to the churning of wet sediments by organisms. Suttill (1980) showed that the NRM of a sequence of tidal-flat sediments from the Wash, possessed a record of the secular variation of the Earth's magnetic field for the period 0-1000 years BP. The record was offset down the sequence by approximately 16cm, being equivalent to about 100 years, the period required in this case for the

alignment of magnetite particles during the acquisition of the post-depositional remanence. These studies indicate that inter-tidal clays may record palaeomagnetic signatures of past geomagnetic field which can be used for magnetostratigraphic correlations.

3. SAMPLING AND MEASUREMENT

A total of in excess of 300 specimens for palaeomagnetic analysis were taken at approximately 5cm intervals from the estuarine clays, located at four sites (sites 4, 17, 19, & 7) where the clays were exposed in an approximately vertical section. The extent of the sampling of the clay units at the sites is detailed in figure A1 and summarised as follows:

	CLAY UNIT		
SITE No.	II	IV	VI
4	S		
17		S	S
19	S	S	S
7	S	S	S

S = Site sampled.

At each site a vertical section was prepared and carefully cleaned. Then $8cm^3$ cubic perspex boxes were pressed horizontally into the sediment face by means of a sampling device, designed and built to obtain accurately orientated undisturbed samples for palaeomagnetic analysis (Austin & Baldwin 1984). By using the two-way spirit level attached to the ram assembly of the sampler the specimen boxes can be pushed exactly horizontally into the sediment requiring only the horizontal orientation of the face plate of the sampler to be measured with a compass and noted for each set of specimens. Sampling orientation errors are believed to be less than $\pm 1°$ in the vertical and less than $\pm 3°$ in the horizontal. The boxes were labelled and their heights in the section were recorded, then the boxes were dug out and sealed to prevent drying of the sediment before measurement.

Additional samples were obtained at sites 17 and 19 using pre-split 6cm diameter plastic core tubes. The tubes were hammered vertically into the clay where it proved impossible to excavate a vertical exposure. The tubes were orientated by means of a spirit level and compass and then dug out. Specimens for palaeomagnetic analysis were obtained by splitting the cores longitudinally on site and pressing perspex boxes into the split

sediment faces. The orientation errors for these specimens is estimated to be less than 5° in the vertical and 10° in the horizontal.

The natural remanent magnetisation (NRM) of the specimens was measured using a Digico balanced fluxgate spinner magnetometer (Molyneux 1971). The samples were spun (=7Hz) successively about 3 orthogonal axes in each sense (*i.e.* a total of 6 spins). Random noise is reduced by increasing the total spin time, which is the time over which the signal is integrated, measured in terms of 2^n spins. The number of spins used in this study was 2^7 spins, corresponding to a one-axis measuring time of 18 seconds and a noise level of approximately 6.4×10^{-10} Am^2 total moment, which is an order of magnitude smaller than the lowest NRM signal observed in this study.

Susceptibility measurements were carried out using a bridge marketed by Highmoor Electronics, similar to that of Stephenson and de Sa (1970). The bridge consists of two identical coils connected in an A.C. circuit. The insertion of a sample within either coil causes the bridge to go off balance and, provided the sample is not too strongly magnetic, a D.C. output proportional to the total susceptibility of the sample is obtained. This output was measured using a digital voltmeter. The bridge was calibrated, before each set of measurements, using six chemical standard samples. The noise level of the susceptibility bridge is quoted by Highmoor as being $<5 \times 10^{-11}$ m^3. Multiple measurement of samples indicates that the measured volume susceptibility of sediment samples are probably accurate to within $\pm 1 \times 10^{-7}$ SI units.

Alternating field (AF) demagnetisation of pilot specimens was carried out using a Highmoor instrument, which operates at a working frequency of 275Hz. It is based on the design of de Sa and Widdowson (1975), in which the current increase and decrease is controlled by a LED and photo-resistor. It has a 2-axis tumbler and a maximum field of 100mT. The specimens are demagnetised within a low direct field ($\leq$50nT) achieved by the use of Helmholtz coils. The pilot specimens were stepwise demagnetised up to peak fields of 40-60mT in steps of 5 or 10mT. The remanence of the samples was measured between steps using a Digico spinner magnetometer. Unfortunately the intensity of initially weakly magnetic specimens (NRM $<0.5 \times 10^{-3}$ Am^{-1}) becomes very small after demagnetisation approaching the noise level of the Digico magnetometer. Thus changes in remanent direction and intensity after demagnetisation in high peak fields may not be distinguishable from the acquisition of spurious magnetisations (*e.g.* ARM) in the demagnetiser, or magnetometer noise.

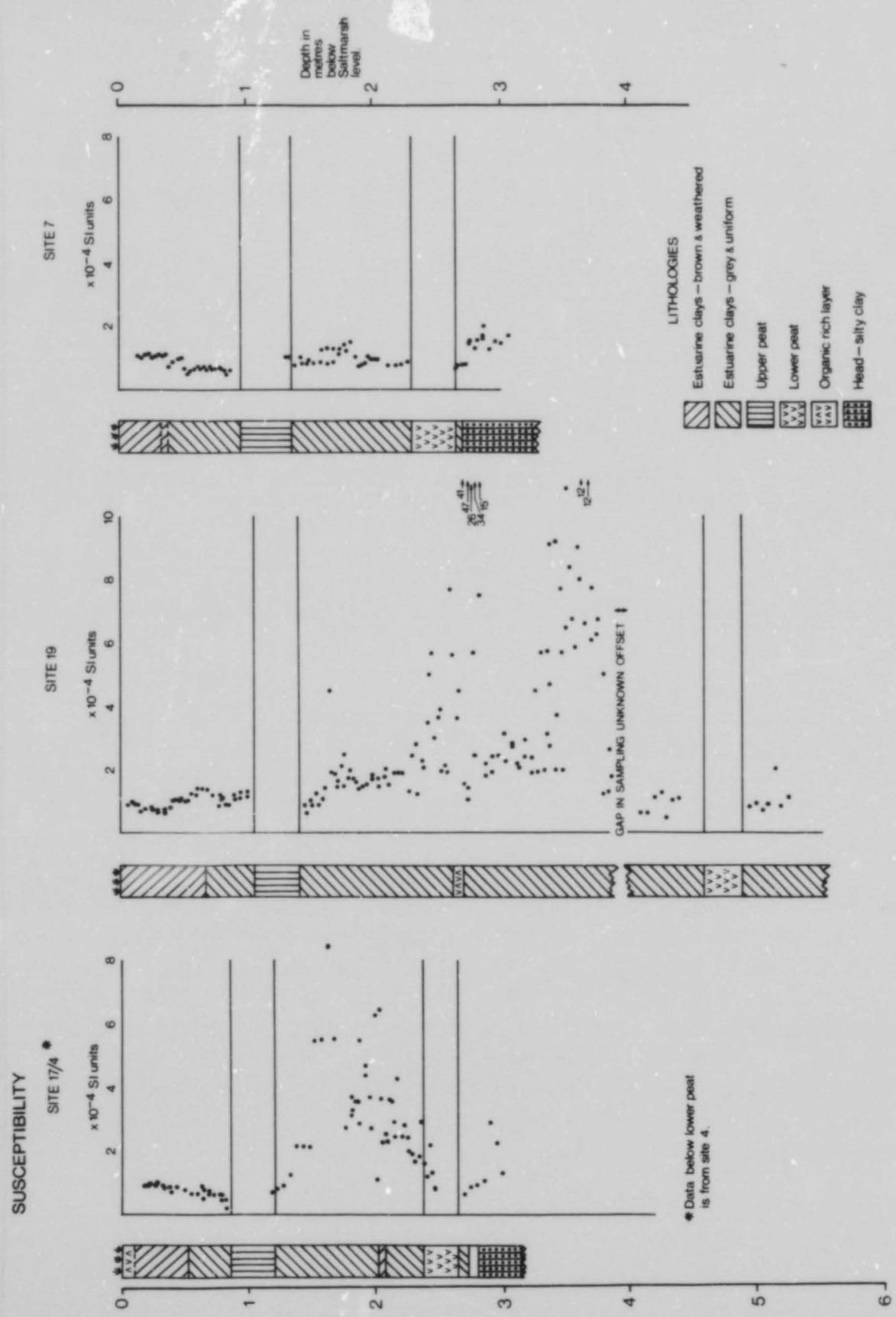
SUSCEPTIBILITY
SITE 17/4 *
x 10⁻⁴ SI units
SITE 19
x 10⁻⁴ SI units
GAP IN SAMPLING UNKNOWN OFFSET
SITE 7
x 10⁻⁴ SI units
Depth in metres below Saltmarsh level
LITHOLOGIES
Estuarine clays – brown & weathered
Estuarine clays – grey & uniform
Upper peat
Lower peat
Organic rich layer
Head – silty clay
* Data below lower peat is from site 4.

Figure A2

Fig 3b
NRM INTENSITY

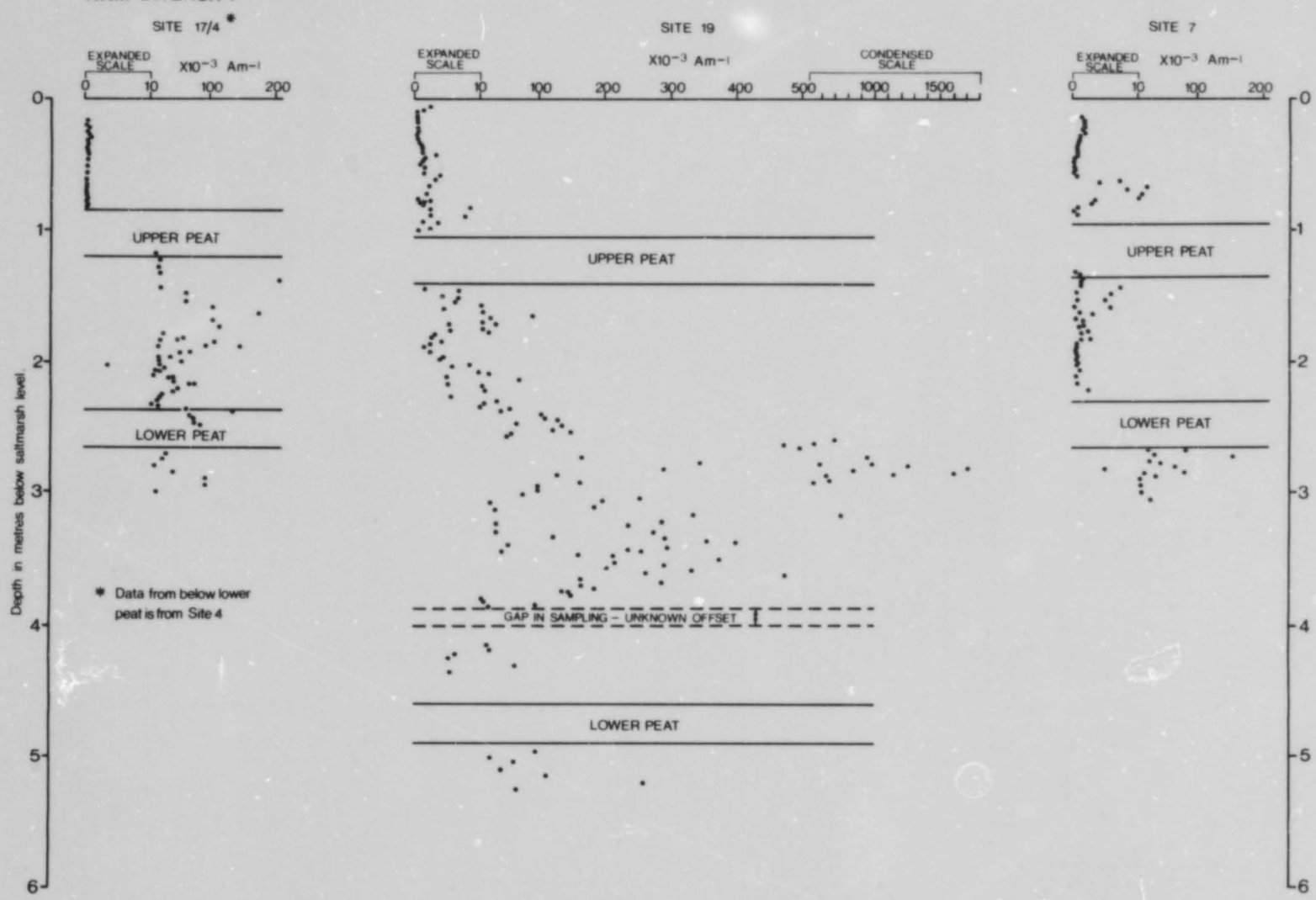

Figure A3

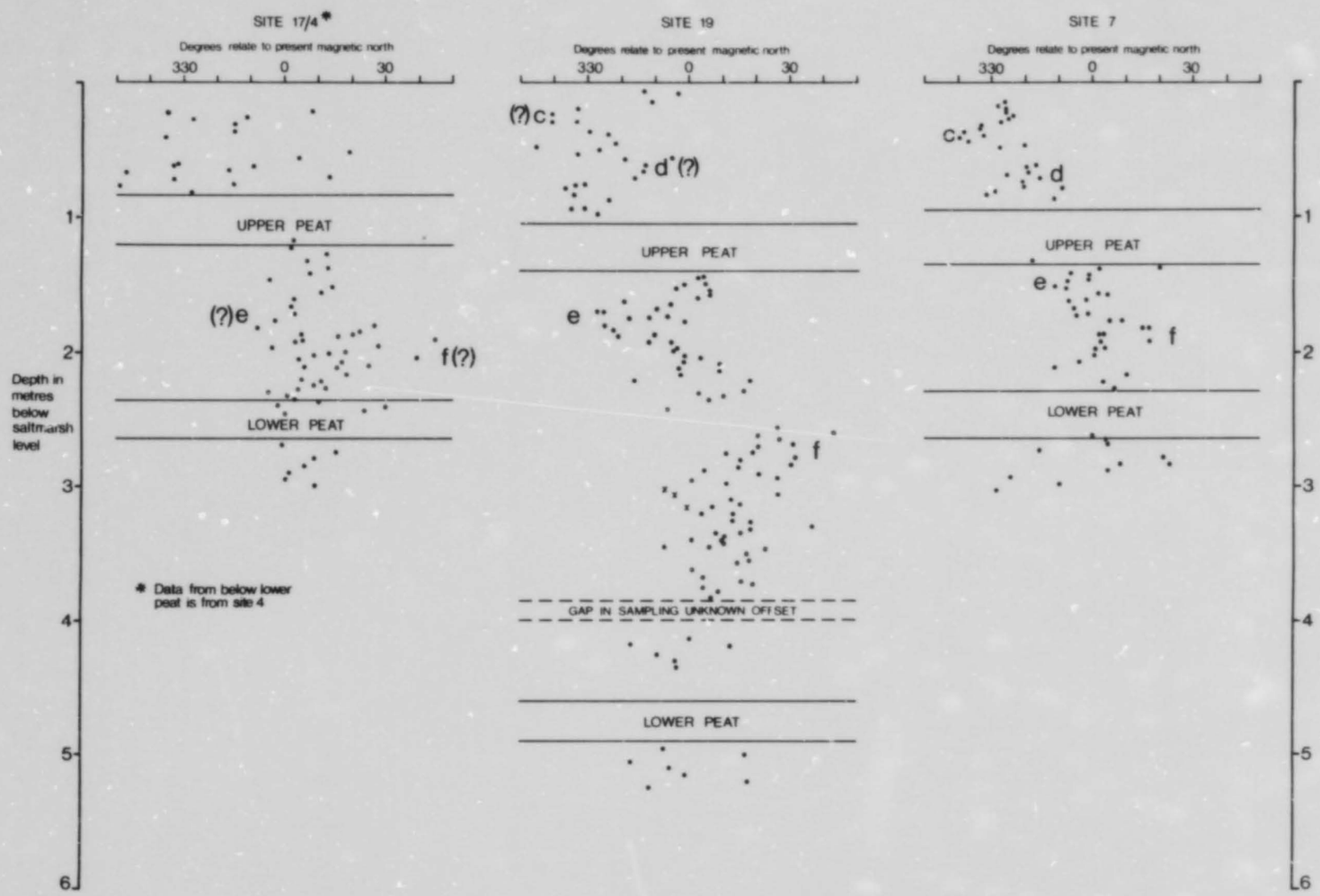
NRM DECLINATATION.
SITE 17/4*
Degrees relate to present magnetic north
330
0
30
UPPER PEAT
(?)e
f(?)
LOWER PEAT
* Data from below lower peat is from site 4
SITE 19
Degrees relate to present magnetic north
330
0
30
(?)c
d(?)
UPPER PEAT
e
f
GAP IN SAMPLING UNKNOWN OFFSET
LOWER PEAT
SITE 7
Degrees relate to present magnetic north
330
0
30
c
d
UPPER PEAT
e
f
LOWER PEAT
Depth in metres below saltmarsh level
1
2
3
4
5
6

Figure A4

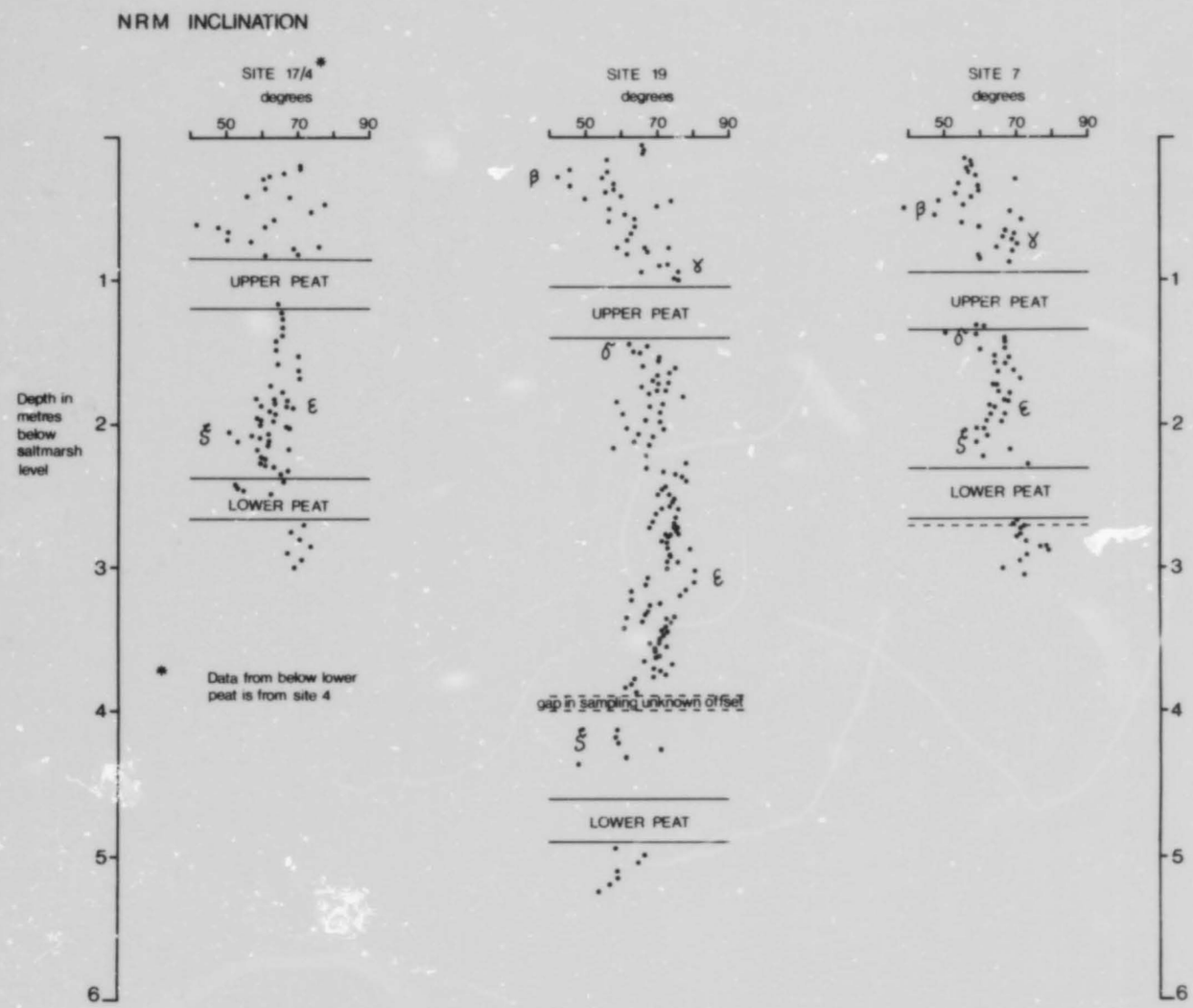
NRM INCLINATION
SITE 17/4*
degrees
50
70
90
SITE 19
degrees
SITE 7
degrees
UPPER PEAT
LOWER PEAT
Depth in metres below saltmarsh level
1
2
3
4
5
6
β
γ
δ
ε
ζ
gap in sampling unknown offset
* Data from below lower peat is from site 4

Figure A5

B2

4. RESULTS AND DISCUSSION

The palaeomagnetic results from the estuarine clays are presented in figure 5 as logs of susceptibility (A2), NRM intensity (A3), declination (A4) and inclination (A5) for each site plotted against depth.

The estuarine clays are weakly magnetised with NRM intensities generally less than 10×10^{-3} Am^{-1} increasing in zones to a maximum of greater than 500×10^{-3} Am^{-1}. The susceptibility values are generally less than 2×10^{-4} SI units although layers with higher susceptibilities, up to 47×10^{-4} SI units, are present corresponding to the zones of increased NRM intensity. Susceptibility values are controlled principally by the concentration and grain size of the magnetic minerals. The similar pattern of the NRM intensity and susceptibility logs suggests that the NRM intensity is also mainly controlled by magnetic mineral variations and does not reflect changes in the past Earth's magnetic field strength.

The previous palaeomagnetic studies of intertidal clays, discussed above, suggest that the dominant remanence carrying magnetic mineral in the sediments is detrital magnetite. In this study no experiments to identify the magnetic minerals have been carried out, although it is believed that magnetite is likely to be the dominant magnetic mineral in the sediments of the Crouch estuary. However the presence of other magnetic minerals, such as authigenic ferrimagnetic iron sulphides, cannot be ruled out.

Determination of the nature and grain size of the magnetic minerals would help to confirm that the source and origin of the NRM signal, in particular whether it is geomagnetic and acquired at the time of deposition.

The estuarine clays yield consistent directions, with the majority of inclinations being between 60 and 75 degrees which is similar to both the dip of the present Earth's magnetic field at the Crouch Estuary (dip= 67°) and that of a geocentric axial dipole field at this latitude (lat = 51.6°, dip = 68.4°). The inclination logs define a number of smooth swings with peak-to-peak amplitudes of 10-20 degrees. The declination logs record well-defined oscillations, with peak-to-peak amplitudes of generally 20-30° and up to 50°, the declinations all being within 40° of present magnetic north. The records from the three sites are not identical, but appear to display the same general features. This may be explained in terms of the variability of the palaeomagnetic recording mechanism. Differences in the records, particularly in the amplitude of the palaeomagnetic oscillations, may be expected if the sediments have been deposited at different rates. The large amplitude declination feature observed at Site 19 may therefore be explained by

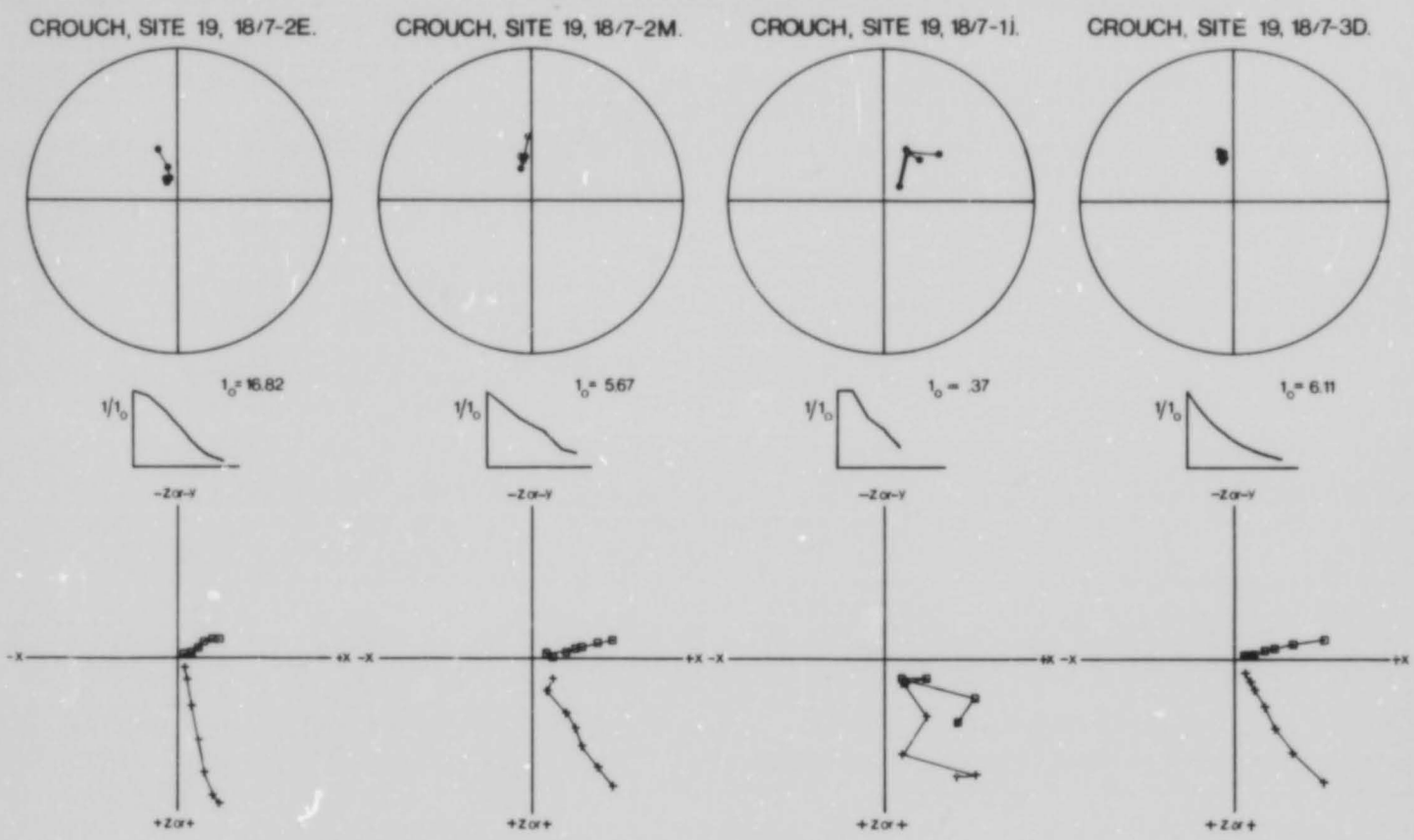
CROUCH, SITE 19, 18/7-2E.
CROUCH, SITE 19, 18/7-2M.
CROUCH, SITE 19, 18/7-1I.
CROUCH, SITE 19, 18/7-3D.
1_o = 16.82
1_o = 5.67
1_o = .37
1_o = 6.11
$1/1_o$
-Z or -Y
+Z or +
-X
+X

Figure A6

the apparently greater rate of sedimentation, as the estuarine clay unit IV, between the upper and lower peats, at site 19 is approximately three times as thick as that at sites 17 and 7 therefore providing a higher resolution record. The magnetostratigraphic correlation between the sites is therefore based on the shape of the declination and inclination logs rather than on the amplitudes of the magnetic features. An additional potential cause for differences in the records and scatter in the palaeomagnetic logs may be due to secondary magnetisations. The scatter in directions appears greatest where lowest NRM intensities occur. However, AF-demagnetisation of pilot specimens (figure A6) indicates that the NRM signal is a stable magnetisation with a very weak viscous component, and demagnetisation results in no significant change in NRM direction.

The declination and inclination oscillations observed in the estuarine clays, best defined at sites 19 and 7, are comparable to the secular variation record from Holocene lake sediments in Britain (Creer *et al.* 1972; Turner & Thompson 1981; Thompson and Edwards 1982) and it is believed they also reflect a pattern of Holocene Geomagnetic secular variation. However, additional chronological information is required in order to establish a magnetostratigraphic correlation between the palaeomagnetic records from the estuarine clays and the British Holocene Geomagnetic Master Curve (Thompson & Turner 1979) as the palaeomagnetic directional swings can be correlated in a number of ways depending which magnetic features are assumed synchronous. A chronological framework for the clays is provided by the radiocarbon dates of the Upper and Lower peats. These are listed in Table 1: Using these dates to constrain the age of the palaeomagnetic records from the clay units a magnetostratigraphic correlation has been established. The declination and inclination features recorded in the estuarine clays have been labelled with the corresponding feature label from the Holocene Geomagnetic Master Curve (Thompson and Turner 1979), the ages of which are listed in Table 2. Using these "magnetic ages" for the estuarine clays it is possible to construct age-depth plots for two of the three sites investigated (figure A7) and to propose sedimentation rates for the deposition of the estuarine clays forming units IV and VI (figure A1). The "magnetic dates" are comparable with the radiocarbon ages determined for the peat units, and allowing for errors in the picking of the positions of the magnetic features, indicate more or less continuous sedimentation at rates varying between approximately 45 and 250 cm ka^{-1}.

5. CONCLUSIONS

The estuarine clay units along the River Crouch estuary yield palaeomagnetic signatures which appear to be of geomagnetic origin allowing a magnetostratigraphic correlation with the British Geomagnetic Master Curve which has already been established from well dated lake sediment palaeomagnetic records.

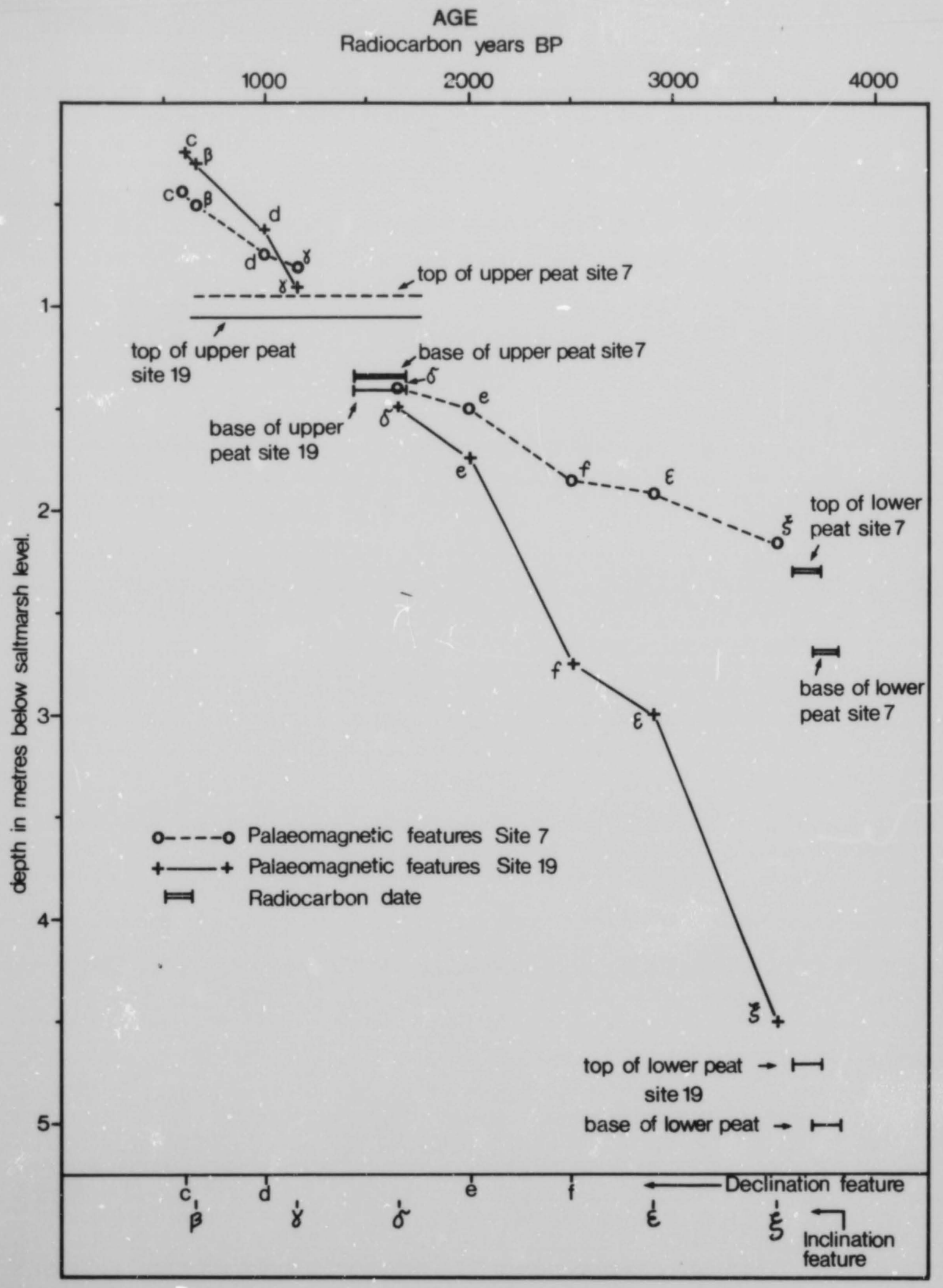

Figure A7

Age-depth plot for sites 19 and 7 showing the sedimentation rates at the two sites.

The "magnetic ages" derived for the clay units are comparable with the radiocarbon determinations from the adjacent peat layers, and indicate a more or less continuous sedimentation at rates of approximately 45 to 250 cm ka^{-1}. A hiatus in sedimentation may be present if it was less than 100 years in duration, which is the expected resolution of this magnetostratigraphic dating technique. An offset in the age may also be expected if the NRM is of postdepositional origin, being acquired at some time after deposition.

However these results must be regarded as tentative as further palaeomagnetic analysis are required to establish:

i) the magnetic mineralogy of the clay units, in order to determine the origin of the NRM signal.

ii) the palaeomagnetic signatures of the clay units at additional sites along the estuary to confirm the secular record which has been obtained from the estuarine clays at sites 19 and 7.

iii) the stability of the NRM signal and the presence of any secondary magnetisations. However, the demagnetisation results from this study suggest that the NRM directions are stable and that routine AF-cleaning of the specimens in a field of 10 or 20mT would not significantly alter the pattern of declination and inclination variations, although they may reduce some of the observed scatter in the directional data.

This study indicates the potential of palaeomagnetic techniques in establishing relative and absolute ages of inorganic estuarine sediments that cannot be dated by radiometric methods.

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TABLE 1

Radiocarbon determinations from the Upper and Lower peats.

Lab. No.	Site No.	Type of context.	Years b.p.
5224	Site 9	Base of Upper Peat	1500 ± 70
5225	Site 4	Base of Upper Peat	1610 ± 70
5223	Site 4	Top of Lower Peat	3660 ± 70
5737	Site 23	Wood from Lower Peat	3660 ± 70
5226	Site 4	Base of Lower Peat	3760 ± 70
5227	Site 8	Roots in Lower Peat	4100 ± 70

TABLE 2

Radiocarbon ages for the declination and inclination features of the British Holocene Geomagnetic Master Curve. From Thompson & Turner (1979).

Declination Feature	Years b.p.	Inclination Feature	Years b.p.
a	150	α	250
b	450	β	650
c	600	γ	1150
d	1000	δ	1650
e	2000	ε	2900
f	2500	ξ	3500
g	4200		

APPENDIX B CHARCOAL SCATTERS ON THE OLD LAND SURFACE

Charcoal and other carbonised plant material were extracted from soil samples by water flotation, using a 0.5 mm. collecting mesh. Charcoal fragments larger than 6mm were identified and the finer fractions of the flots from each sample were then sorted under binocular microscope at low power, extracting any fruits, seeds or other identifiable macrofossils.

1. Blackwater Estuary.

Site 7 St Lawrence Bay

A 2.6kg sample was taken from context 43 part of the dense charcoal deposit, 1-3cm thick between the head surface and overlying peat. The charcoal is almost entirely of oak (*Quercus* sp) with one small fragment of *Prunus* sp. The oak charcoal was from large wood (not twiggy) and includes some fragments from slow-grown wood with narrow rings. After identification the sample was submitted for dating.

Site 8 Bradwell-on-Sea

Conspicuous charcoal scatters between the head surface and peat (contexts 31, 32, 35) and fill from features with associated pottery or fired clay (contexts 37 and 78) were sampled.

Context No.	31	32	35	37	78
Sample wt (kg)	6.2	4.6	1.1	2.5	9.6
Quercus sp. (charcoal)	+++	+++	++	+	-
Fraxinus sp (charcoal)	-	-	-	+	-
Prunus sp (charcoal)	-	-	-	+	-
Crataegus-group (charcoal)	-	-	-	+	-
Indeterminate charcoal	+	-	-	-	+
Carbonised buds	+	-	-	-	-
Carbonised roots/rhizomes	+	-	-	-	-
Vicia sp (seeds/cotyledons)	7	-	-	-	-

37 contained a small fragment of burnt bone. The indeterminate charcoal from 31 consists of diffuse porous twigs 6mm in diameter. The charcoal fragments from 78 are too small for reliable identification. The oak charcoal from 32, 35 and 37 is from large wood and includes fragments of slow-grown wood with narrow rings. Oak charcoal from 31 includes some twigs up to 10mm diameter and some charcoal from larger wood with both narrow and wide rings. 31 and 32 produced sufficient charcoal for radiocarbon dating.

Site 18 Tollesbury

Two charcoal spreads on the 'head' surface, sealed by peat, were sampled.

Context No.	83	90
Sample wt (kg)	2.2	1.0
Quercus sp (charcoal: mature wood)	+	+++
Quercus sp (charcoal: twigs)	+	-
Indeterminate root and bark charcoal	+	+

These samples also contained a few uncharred seeds and fruitstones of *Sambucus nigra* and *Rubus fruticosus*.

Site 24 Tolleshunt

A 2.4kg sample from a diffuse charcoal spread on the 'head' surface (context 93) at this site produced a small quantity of charcoal. Fragments larger than 6mm were mostly of oak (*Quercus* sp) with one fragment of indeterminate diffuse porous charcoal.

Site 28 The Stumble

A 1.6kg sample of 125, a dense charcoal spread at the western end of the site and a 3kg sample from 142, a more diffuse scatter on the head surface near the excavated area, were examined.

125 produced large quantities of oak (Quercus sp) charcoal with a 10mm twig probably of gorse or broom (Ulex/Sarothamnus). Several poorly preserved carbonised seeds including seeds of Sambucus nigra and Solanum nigrum were also recovered. 142 contained only small, unidentified charcoal fragments.

2. Crouch Estuary

Site 17

A 1.6kg sample was taken from a thin charcoal scatter on the 'head' surface. It contained the following carbonised plant remains:-

Chenopodiaceae indet (embryo)	1
Trifolium sp (seeds)	225
Rubus fruticosus (fruitstone)	1
Plantago lanceolata (seed)	1
Roots/rhizomes	+
Quercus sp (charcoal)	+

During re-examination of this site in 1987 a dense charcoal spread (Context 115) was found to have been newly exposed by erosion on the head surface. A 2.2 kg. sample was examined. It consisted almost entirely of very large fragments of oak charcoal (Quercus sp) representing in situ large timbers. No smaller macrofossils were noted.

3. Dovercourt Bay

Site 1

A 2 kg sample from Context 4 was examined. It contained abundant charcoal of oak (Quercus sp) from mature wood with some small twig fragments (2-3mm) which were not identified. No small macrofossils were noted.

Site 2

A 1.5kg sample from context 3 produced large quantities of oak charcoal. 50% of the fraction under 6mm was sorted and this produced a cotyledon of Vicia/Lathyrus sp.

4. Walton-on-the-Naze

Site 2

Three small charcoal concentrations (15, 16 and 17) were sampled. The charcoal-rich deposits filled shallow depressions (c. 3 cm deep) in the head surface. The following charred plant material was identified.

Context No.	15	16	17
Sample wt (kg)	0.1	1.4	0.25
Quercus sp. charcoal	+	+	+
Indeterminate diffuse porous twigs	+	-	-
Indeterminate fragments	+	+	-
Prunus cf. *spinosa* L. (fruitstone frags)	-	+	-

The indeterminate charcoal either has very deformed cell structure or had iron depositions obscuring details of vessel structure. There is insufficient charcoal for radiocarbon dating.

APPENDIX C

HULLBRIDGE PROJECT: SOIL MICROMORPHOLOGICAL ANALYSIS

Description and Preliminary Interpretation

The samples examined come from the Purfleet section (on the River Thames), from the Stumble sites A and B, and profile 28 (on the River Crouch), and from the Blackwater, area 23 and profile 18. Descriptions and interpretation of the Purfleet profile are given here. Results from the other sites will be presented and discussed in Vol II of The Archaeology of the Essex Coast by Dr R I MacPhail. All soils and sediments had been affected by marine inundation and sodium salts (NaCl). These have had a deleterious effect on the palaeosol microfabric and has to be borne in mind when reading the descriptions and interpretations. Secondly, although attempts were made to leach out the salts from the samples with acetone, prior to impregnation, this was only fully successful in the last batch of samples from the Stumble B site, after experience with the technique. Some materials such as sodium carbonate are preserved in the former samples, and even after re-impregnation was not always fully successful with the result that some thin sections are rather patchy.

Purfleet: (2 thin sections) (Thames 2, Section 2)

Thin section A.0-6.5 (7.5) cm. (rooted sediment/soil below "Neolithic" woodland peat).

Structure: massive (possible prismatic) with coarse channel microstructure.
Porosity: 30%, dominant very coarse (1-1.5cm) moderately smooth wall channels extending full length (7.5cm) of thin section; within main sediment frequent moderately smooth wall fine to medium channels. Mineral Coarse: Fine (limit 10mm), 70:30 Coarse well sorted; very dominant angular to subangular silt and very fine sand-size quartz; very few mica and glauconite: including medium size mica; calcite/aragonite, mollusc shell and phytoliths present. Fine pale to dark brown (according to degree of sodium carbonate impregnation), speckled (PPL); medium to moderately low birefringence; strong orange to pale orange (OIL; according degree of iron impregnation) red areas near surface. Organic Coarse very dominant woody (lignified) very coarse (>1cm) probable tree roots, generally non or very poorly birefringent; towards sediment surface roots are impregnated with iron. Fine occasional plant and organ fragments, and amorphous material. Groundmass close porphyric, speckled to weakly crystallitic (some micritic calcite/sodium carbonate impregnation). Pedofeatures Textural abundant silt in fills of root channels and empty root centres. Depletion general moderate decalcification of whole sediment. Also loss of iron at one stage Crystalline very abundant impregnation and void in filling by dirty grey brown

APPENDIX E

(PPL), moderately high birefringent, yellowish orange (OIL) sodium carbonate. Many micritic patches, associated with sodium bicarbonate; sometimes with sparitic centres. Occasional (probably first phase) micro-sparite to sparite void infills and hypocoatings associated with roots and root holes. Amorphous toward surface and associated with some root material abundant ferruginous impregnation, less at depth. Ferruginisation has concentrated in (and post dates) sodium carbonate areas. (associated with some depletion of the carbonate) many iron sulphide (black under PPL; brassy under OIL) spherolites; pyrite. Fabric strong homogenisation of original sediment. No obvious excrements but faunal burrows and mixing is apparently evident.

Interpretation Probably the alluvial sediment was calcareous when it was first deposited. It was moderately depleted of calcium carbonate during woodland growth as shown by roots and root holes being affected by microsparite and sparite (calcite) growth. Also the sediment became homogenised, probably through some faunal activity although it is hard to prove this, and some possible prismatic and channel structures formed. The surface was probably dry ground and surface woodland molluscs (Murphy, pers. comm.) were worked into the soil. The sediment (and woodland) was then inundated and a wood peat developed. At the same time most of the soil became depleted and structureless. Hence lack of surface soil features. As the Thames water became estuarine /saline what calcium carbonate remained was influenced by sodium chloride and sodium carbonate began to impregnate and form nodules. Laterally, exposure had brought some further minor decarbonisation and its replacement by iron. Roots have been affected by this gleying effect.

APPENDIX D

PREHISTORIC POTTERY RECORDING

Context: (1-800)

Fabric: (A-Z) see separate sheet

Class: (I-V) for definitions all below or (C - coarse, F - fine)

Form: (A-U) see separate sheet

Rim Form: (1-13) see separate sheet

Base Form: (1-5) see separate sheet

Misc. features: A - Lug/handle, B - Boss, L - Lid, P - Perforation, D - Disc, V - overfired, X - sooting/residue on int. Y - sooting/residue on ext.

Decoration: B - burnished, A - applied, C - cordoned, F - fingered, G - grooved, H - furrowed, I - incised, W - finger nail, T - impressed, S - slashed, Z - stamped, D - twisted cord, E - combed, M - stabbed, X - stab and drag, Y - light stroke pattern

Position: A - all over, B - base, N - neck, R - rims, S - shoulder, D - interior, C - exterior, E - interior of rim/neck

Surface treatment and condition: F - finger wiped, S - slipped, T - smoothed, Vegetable wiped, J - scored, A - abraded.

Manuf. Features: 1 - Finger pinching as result of vessel formation
2 - Coils visible
3 - Rectangular fracture

Rim diameter (1-500)

Rim %

Sherd number

Sherd Weight

Class definition:

I	= Coarse jar
II	= Fine jar
III	= Coarse bowl
IV	= Fine bowl
V	= Cup

Fabrics

Size of inclusions	S = less than 1 mm diameter
	M = 1-2 mm diameter
	L = more than 2 mm diameter
Density of inclusions	1 = less than 6 per cm^2
	2 = 6-10 per cm^2
	3 = more than 10 per cm^2

Fabric

A Flint, S 2 well sorted.

B Flint, S-M 2

C Flint, S-M with occasional L2

D Flint, S-L 2 poorly sorted.

E Flint, and sand, S-M 2

F Sand, S-M, 2-3, with addition of occasional L flint.

G Sand, S, 3.

H Sand, S 2.

I Sand, S-M, 2-3.

J Sand, S, 2 with veg. voids particularly on surfaces.

K Quartz Flint and grog (often with deep rounded or sub-angular voids) S-L, 1-2.

L Quartz sometimes with some sand, S-L, 2.

M Grog, often with some sand or flint and occasional small rounded or sub-angular voids.

N Vegetable temper.

O Quartz and Flint and some sand S-L, 2 poorly sorted.

P Sparse Very fine sand may have occasional M-L flint or sparse irregular voids.

Q S-L flint, S-M grog. 2.

R Shell M-L 2, soft fabric.

S Glauconite.

T Chalk

U Flint S-L 2 with occasional irregular voids

V Flint S-M 1

W Flint S-L 2, some sand and veg. voids often on exterior.

X Quartz sand S-L, some S-L flint, 3.

Z Unclassifiable

Vessel Forms

A Jar, round shouldered with short upright or flared rim.

B Jar, hooked rim with smoothly curved body.

C Jar, bipartite road or slightly angular shoulder.

D Jar, round or slightly angular shoulder with concave neck and everted or upright rim.

E Jar, slack shouldered with upright or slightly everted rim.

F Jar, tripartite angular shoulder flared rim.

G Bowl, round bodied closed.

H Bowl, round bodied open.

I Bowl, Bipartite, angular.

J Bowl, tripartite round shouldered, flared or everted rim.

K Bowl, tripartite angular shoulder, flared rim.

L Bowl, flared, open.

M Bowl, as H but with flared rim.

N Jar, as F but with upright rim.

O Bowl, bipartite bead rim.

P Bag shaped vessel.

Q Bucket

R Barrel

S Bowl, tripartite rounded

T Bowl, carinated open.

U. Bowl, carinated closed.

Prehistoric Pottery

Rim Forms

1. Flat topped.
2. Flat topped, flared.
3. Rounded.
4. Rounded, flared.
5. Expanded.
6. T shaped.
7. Bead.
8. Flat topped with cabled dec.
9. Rounded, everted.
10. Flat topped everted.
11. Rolled.
12. Rounded with internal flange/bevel.
13. Externally thickened.

Base Form

1. Flat.
2. Footring.
3. Pedestal.
4. Omphalos.
5. Round.

HULLBRIDGE SURVEY PREHISTORIC POTTERY

Crouch

SITE	CONTEXT	FABRIC	FORM	CLASS	RIM	BASE	MISC.	DECORATION METHOD	DECORATION POS.	SURFACE TREAT METHOD	SURFACE TREAT POS.	MANUF.	RIM%	DIAM.	SHERDS	WEIGHT
2	91	D	Q	I	1	1							19	180	47	168
2	95	D		C											1	7
													TOTAL		48	175
4	113	C		C						A	C				1	11
4	19	D		C						A	C				2	4
													TOTAL		3	15
7	+	V								A	A				1	2
													TOTAL		1	2
11	21	D		C	?3					A	A				1	8
11	73	B								A	A				2	21
													TOTAL		2	29
16	33	V	D	I	9								14	160	1	42
16	33	V				1				A	A				8	12
16	33	D		F						A/T					1	20
													TOTAL		10	74
17	+	B								A	C				5	21
													TOTAL			
29	100	D		F				D	C						1	14
29	100	V								A	A				1	1
													TOTAL		2	15
60	101	V		I		1									1	13
													TOTAL		1	13
Clacton																
1	1	Chip sherd								A	A				3	2
1	1	B		C				F	I						1	7
1	1	P								A	A				1	9
1	1	B				1							/30	/50	1	16
1	1	B		F		1		D/T	C				/45	/70	6	106
													TOTAL			
															12	140
2	12	H								A	A				1	3
2	19	Flint tempered chip sherds													19	8
2	20	P		C						A	A				1	50
													TOTAL		21	61

Blackwater

								DECORATION		SURFACE TREAT						
SITE	CONTEXT	FABRIC	FORM	CLASS	RIM	BASE	MISC.	METHOD	POS.	METHOD	POS.	MANUF.	RIM%	DIAM.	SHERDS	WEIGHT
1	+	C		F						T/A	A				1	43
1	+	C								A	C				2	12
1	+	D		C											1	7
1	+	B								A	A				1	4
1	+	A		F						T/A	A				1	1
1	+	E								A	A				1	3
1	4	D								A	A				2	6
1	4	C		C	11					A	A				1	5
													TOTAL		10	81
2	+	E		I	I										1	8
													TOTAL		1	8
8	+	D		C											8	50
8	+	F								T/A	D/C				2	6
8	24	D		C											2	40
8	24	G								A	A				2	4
8	37	C		C											1	6
8	37	V		III	11					T	A		6	190	3	8
8	38	D		C											1	26
8	38	D		C											1	9
													TOTAL		20	149
9	+	A		F						T/A	C/D				1	3
9	+	D		C	9					A					4	41
9	6	V		C						A					3	12
9	6	B								A					1	1
9	6	D		C						A					1	19
9	6	Flint tempered chip sherds													4	2
9	10	Flint tempered chip sherds													68	30
9	10	D		C											6	54
9	10	V		C											5	23
9	49	D		III	11										3	20
9	49	C		IV	5			I	R						1	18
9	50	B		?IV				W	C	A	A				1	4
9	50	C								A	A				2	6
9	50	C		C						A	O				2	3
9	51	C		C	5					A	A				1	4
9	57	D		C											1	8
													TOTAL		104	248
10	+	A								A	A				1	2
10	+	D								A	A				3	29
													TOTAL		4	31
17	71	D		C						A					1	5
													TOTAL		1	5
18	+	Flint tempered chip sherds								A	A				37	68
18	+	D								A	A				20	148
18	+	B								A	A				11	68
18	+	C								A	A				6	50
18	+	D								T/A	A				7	77
18	+	B								T/A	A					
18	+	A								T	A				1	4

								DECORATION		SURFACE TREAT						
SITE	CONTEXT	FABRIC	FORM	CLASS	RIM	BASE	MISC.	METHOD	POS.	METHOD	POS.	MANUF.	RIM%	DIAM.	SHERDS	WEIGHT
18	+	B		F						T	A				1	4
18	+	B		F						T/A	A				1	3
18	+	V								A	A				8	40
18	+	E								A	A				9	69
18	+	B								A	A				11	29
18	+	E								A	A				3	35
18	+	A		F						T/A	A				1	13
18	+	A		F						T	A				2	7
18	+	A		F						T/A	D/C				2	14
18	+	A								A	A				1	2
18	+	A		F						T	A				19	47
18	+	V		C	1										1	8
18	+	C	T	IV						T	A				1	18
18	+	B	T							A	A				1	7
18	+	C													1	11
18	+	B	T	IV						T	A				1	8
18	+	B			3					A	A				1	7
18	+	B		IV	11					A	A				1	7
18	+	A		IV	11					A	A		14	170	1	18
18	+	C		III	9					A	C				1	8
18	+	A		IV	11					T/A	A				1	2
18	+	A						G	C						1	3
18	+	A			11					A	A				1	4
18	+	D			11					A	A				1	7
18	+	D						T	C	A	A				1	8
18	+	D		III	11										1	11
18	+	C			11					A	A				1	2
18	+	A			11					A	A				1	4
18	+	C			11					A	A				1	3
18	+	A		F	5					T	A				1	2
18	+	C		?IV	11					A	A		8	160	1	16
18	+	B		?IV	11					A	A		7	150	1	14
18	+	C		III	11					A	A				1	5
18	+	A		IV	10					T	A				1	9
18	+	A		IV	11					T	A		10	140	1	10
18	+	B			11					A	A				1	2
18	+	B			11					A	A				1	5
18	+	C			11					A	A				1	16
18	A.0M	B								A	A				2	6
18	A.5M	A								A	A				2	15
18	A.10M	D								A	A				2	7
18	A.10M	Flint tempered chip sherds								A	A				6	5
18	A.15M	Flint tempered chip sherds								A	A				2	3
18	A.20M	C			11					A	A		8	180	1	17
18	A.20M	C								A	A				1	9
18	A.20M	A		F						T/A	A				3	8
18	A.25M	Flint tempered chip sherds								A	A				2	2
18	A.30M	D								A	A				2	28
18	A.30M	A								A	A				1	5
18	A.35M	D								A	A				1	1
18	A.35M	C		F						T/A	A				2	9
18	A.35M	A								A	A				2	4
18	84	D		C							A				1	10
18	105	Flint tempered chip sherds								A	A				2	2
18	106	E								A	A				1	6
														TOTAL	203	1033

								DECORATION		SURFACE TREAT						
SITE	CONTEXT	FABRIC	FORM	CLASS	RIM	BASE	MISC.	METHOD	POS.	METHOD	POS.	MANUF.	RIM%	DIAM.	SHERDS	WEIGHT
18	+	B		F						T	A				1	4
18	+	B		F						T/A	A				1	3
18	+	V								A	A				8	40
18	+	E								A	A				9	69
18	+	B								A	A				11	29
18	+	E								A	A				3	35
18	+	A		F						T/A	A				1	13
18	+	A		F						T	A				2	7
18	+	A		F						T/A	D/C				2	14
18	+	A								A	A				1	2
18	+	A		F						T	A				19	47
18	+	V		C	1										1	8
18	+	C	T	IV						T	A				1	18
18	+	B	T							A	A				1	7
18	+	C													1	11
18	+	B	T	IV						T	A				1	8
18	+	B			3					A	A				1	7
18	+	B		IV	11					A	A				1	7
18	+	A		IV	11					A	A		14	170	1	18
18	+	C		III	9					A	C				1	8
18	+	A		IV	11					T/A	A				1	2
18	+	A						G	C						1	3
18	+	A			11					A	A				1	4
18	+	D			11					A	A				1	7
18	+	D						T	C	A	A				1	8
18	+	D		III	11										1	11
18	+	C			11					A	A				1	2
18	+	A			11					A	A				1	4
18	+	C			11					A	A				1	3
18	+	A		F	5					T	A				1	2
18	+	C		?IV	11					A	A		8	160	1	16
18	+	B		?IV	11					A	A		7	150	1	14
18	+	C		III	11					A	A				1	5
18	+	A		IV	10					T	A				1	9
18	+	A		IV	11					T	A		10	140	1	10
18	+	B			11					A	A				1	2
18	+	B			11					A	A				1	5
18	+	C			11					A	A				1	16
18	A.0M	B								A	A				2	6
18	A.5M	A								A	A				2	15
18	A.10M	D								A	A				2	7
18	A.10M	Flint tempered chip sherds								A	A				6	5
18	A.15M	Flint tempered chip sherds								A	A				2	3
18	A.20M	C			11					A	A		8	180	1	17
18	A.20M	C								A	A				1	9
18	A.20M	A		F						T/A	A				3	8
18	A.25M	Flint tempered chip sherds								A	A				2	2
18	A.30M	D								A	A				2	28
18	A.30M	A								A	A				1	5
18	A.35M	D								A	A				1	1
18	A.35M	C		F						T/A	A				2	9
18	A.35M	A								A	A				2	4
18	84	D		C							A				1	10
18	105	Flint tempered chip sherds								A	A				2	2
18	106	E								A	A				1	6
														TOTAL	203	1033

SITE	CONTEXT	FABRIC	FORM	CLASS	RIM	BASE	MISC.	DECORATION METHOD	DECORATION POS.	SURFACE TREAT METHOD	SURFACE TREAT POS.	MANUF.	RIM%	DIAM.	SHERDS	WEIGHT
22	+	D		C											2	8
22	+	C		C											5	17
													TOTAL		7	25
26	+	D		C						A	A				1	2
26	+	C								T/A	C/D				1	6
26	+	V													1	5
26	+	M								A	A				1	4
													TOTAL			
28	+	D		C						A	A				3	29
28	+	C								A	A				1	3
28	+	V								A/C	A/C				1	3
28	+	M				G	C								1	7
													TOTAL		6	42
30	108	C								A	A		TOTAL		2	11
31	103	D								A	A				1	5
31	101	C													1	10
31	+	Flint tempered chip sherds													5	7
31	–	D													4	6
31	+	B								A	A				4	15
													TOTAL		15	68
Other Blackwater sites																
Steeple																
12	V	C								A	A				1	28
													TOTAL			
Mundon																
21	52			C			P								1	16
													TOTAL		1	16
Near Site 11																
11	85									A	A				1	9
													TOTAL			
Osea Island																
-	115									A	A				1	24
													TOTAL		1	24

								DECORATION		SURFACE TREAT						
SITE	CONTEXT	FABRIC	FORM	CLASS	RIM	BASE	MISC.	METHOD	POS.	METHOD	POS.	MANUF.	RIM%	DIAM.	SHERDS	WEIGHT
28	+	P		F?				Y?	C	A	A				1	12
28	+	R?								A	A				1	4
28	+	P		F				Y	C	A	A				1	9
28	+	M		F				E	C						1	2
28	+	C		F				T	C	A	A				1	7
28	+	D		C	9		P			A	A		13	180	1	31
													TOTAL		6	65
28	A+	D	G	C	3										1	6
28	A+	B		C	9					A	A				1	3
28	A+	D	H		3					A	A		9	130	1	8
28	A+	A		F	11?					T/A	C/D				1	2
28	A+	A		F						T/A	C/D				1	14
28	A+	C		F						T/A	C/D				1	9
28	A+	F		C											1	17
28	A+	C		C				H	C						1	11
28	A+	D		C						A	A				16	104
28	A+	D		C						T	A				5	1
28	A+	B								A	A				5	16
28	A+	B													5	10
28	A+	A		F											5	13
28	A+	A													7	13
28	A+	Chip sherds													16	13
													TOTAL		75	270
28	123	B	H		3					A/T	C/D		7	90	1	6
28	123	O		C						A/T	C/D				1	18
28	123	C		C	9										1	6
28	123	B			5					A	A				1	7
28	123	D		C						A	A				16	164
28	123	D		C						A/T	C/D				5	44
28	123	C								A	A				6	18
28	123	C		C											2	10
28	123	A		F						T	A				2	6
28	123	B		F						T/A	C/D				3	10
28	123	D		C	3?		F?	R?							1	4
28	123	Chip sherds								A	A				5	4
													TOTAL		44	297
28	124	D		C	11										1	16
28	124	M?		F				T	C	A	A				1	6
28	124	P					Y?			A	A				3	35
28	124	D						F	C	A	A				1	6
28	124	C								T/A	C/D				3	14
28	124	E		F											1	8
													TOTAL		10	85
28	125	B		F				T	C	T	A				1	11
28	125	F		C						A	A				1	12
28	125	D		C	11										1	6
28	125	C		F	5					T	A				1	9
28	125	C		C											1	5
28	125	D		C											1	7
28	125	C		C						A/C	C/D				1	9
													TOTAL		7	59

								DECORATION		SURFACE TREAT						
SITE	CONTEXT	FABRIC	FORM	CLASS	RIM	BASE	MISC.	METHOD	POS.	METHOD	POS.	MANUF.	RIM%	DIAM.	SHERDS	WEIGHT
28	135	A		F						T	A				7	63
28	135	I		C											1	5
28	135	C		F						T/A	A				2	28
28	135	D								A	A				14	151
28	135	D		C											10	120
28	135	C		C											7	108
28	135	F		C											2	34
28	135.1.1	B			11					A	A				1	16
28	135.1.2	C			11					A	A				1	9
28	135.1.3	C		F	5					A/T	A		9	160	1	15
28	135.1.4	D		C	3		P			A	A		11	120	1	9
28	135.1.5	F		C	11		P			A	A				1	20
28	135.1.6	D		C	13								7	200	1	20
28	135.2.1	B			9					A	A		9	180	1	7
28	135.2.2	D			13										1	19
28	135.2.3	D			3										1	18
28	135.2.4	F		C	13										1	20
28	135.2.5	D		C	11					A	A		7	210	1	52
28	135.3.1	C		F	9					T	A		5	160	1	11
28	135.3.2	C			11								9	150	1	21
28	135.3.3	B		F	3			Y	E				7	160	1	19
28	135.3.4	P	G		3								7	110	1	13
28	135.3.5	C			13			Y	C	A	A				1	13
28	135.3.6	D			13					A	A				1	13
28	135.4.1	C		F	9					T	A		7	250	1	23
28	135.4.2	C	G		3					A	A		9	120	1	11
28	135.4.3	C		F	5										1	6
28	135.4.4	B			11					A	A		5	200	1	5
28	135.4.5	B			9					A	A		7	180	1	7
28	135.4.6	A		F	11			Y	E	T/A	D/C		10	160	1	9
28	135	B		F	9?					T/A	C/D				1	15
28	135	V			5					A	A				1	7
28	135	A		F	3										1	2
28	135	F		F	5			Y	E	A/T	C/D		6	180	1	26
28	135	A		F	5					T	A				1	3
28	135	C		F	13					T/A	D/C		6	160	1	14
28	135	D		C	11										1	4
28	135	D			13					A	A		7	180	1	8
28	135	D	G?		3					A	A		9	160	1	11
28	135	B			9					A	A		6	160	1	11
28	135	B		F	9					T/A	D/C				1	5
28	135	D		C	11										1	13
28	135	C			1					A	A				1	8
28	135	V	G	C	5								6	150	1	11
28	135	A		F	11					T	A				1	5
28	135	D		C	9					A	A		6	180	1	17
28	135	C		F	9					T/A	C/D				1	10
28	135	D		C	5		P			A	A				1	12
28	135	A	T	F				Y	C	A/T	A/C				1	11
28	135	V			1					A	A				1	9
														TOTAL	86	1057
18	T	B		F	11					T	A				1	3
18	T	D		C	1								8	180	1	26
18	T	E			11					A	A		7	160	1	7
														TOTAL	3	36
														GRAND TOTAL	718	4173

APPENDIX E

TREE-RING ANALYSIS OF BRONZE AGE WOOD FROM THE HULLBRIDGE SURVEY, ESSEX: RIVER CROUCH SITE 29

Jennifer Hillam
December 1988

Abstract

The examination of twelve oak samples from context 68 is described. All were small pieces of wood from the outside of larger tree trunks and usually containing less than 50 annual rings. No relative or absolute dating was achieved.

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Tree-ring analysis of Bronze Age wood from the Hullbridge Survey, Essex:

River Crouch Site 29

Introduction and methods

Twelve oak samples were collected by Peter Murphy from context 68 of the River Crouch Site 29. The wood was part of a Bronze Age structure which had been dated by radiocarbon to 3250±90bp (Murphy pers comm). Although the samples were small, it was hoped that some of them would contain sufficient rings for dating purposes.

At present there are few dated chronologies for the prehistoric period from the British Isles (Hillam 1987). Prehistoric tree-ring samples therefore are being examined in the hope of building up chronologies which can eventually be dated by comparison with long chronologies from Ireland and Germany (*e.g.* Brown et al 1986).

The samples were prepared and measured following the method described by Hillam (1985). The ring widths of any sample with more than 20 rings were measured. Generally only samples with more than 50 rings are measured but there are exceptions (Hillam *et al* 1987). In this study, some or all of the samples could have come from the same tree and therefore it might be possible to match the short ring patterns relative to each other.

The widths were plotted as graphs to facilitate visual comparison between the ring sequences. A computer program (Baillie & Pilcher 1973) was used to compare sequences of more than 50 rings with dated references chronologies from England (Hillam unpubl), Ireland (Brown *et al* 1986) and Germany (Becker pers comm). The sequences were also compared with undated Bronze Age chronologies from England.

Results

Although the samples were small, the annual rings were relatively narrow and the samples had 21-60 growth rings. The only exception was 13 which had 6 rings and was rejected. The orientation of the rings (Table 51) indicated that the pieces of wood came from larger tree trunks. None of the samples had sapwood.

No matching was found between any of the ring sequences. If any of the samples did come from the same tree, the ring patterns either did not overlap or the sequences were too short to detect any similarities.

Three samples (8, 10, 15) had more than 50 rings (Table52). These were tested against all the available tree-ring data of Bronze Age date, but no relative or absolute dating was obtained.

Conclusion

Lack of absolute dating is not really surprising since samples with 50-60 rings are difficult to date from the historic period where there are many dated reference chronologies (Hillam et al 1987; Mills 1988). If excavations from other Bronze Age sites in Essex produce site chronologies, it may eventually be possible to date the three samples with more than 50 rings.

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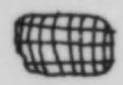
Table 51 : Details of the tree-ring samples. Sketches are not to scale.

Sample	Number of rings	Average ring width (mm)	Sketch	Dimensions (mm)
2	25	1.86		50 x 35
3	35	1.76		65 x 45
5	21	2.58		55 x 30
6	28	2.34		65 x 50
7	26	2.02		55 x 40
8	60	1.18		70 x 55
10	55	1.00		55 x 50
11	25	1.24		40 x 35
12	38	1.10		45 x 20
13	6	-		35 x 25
14	30	1.71		55 x 40
15	54	1.47		100 x 20

DS

Table 52: Ring width data of samples with more than 50 rings.

Sample 8

Years	Ring widths (0.02 mm)									
1	87	73	64	64	49	68	102	88	110	91
11	72	71	67	66	54	29	44	48	45	60
21	85	67	60	53	52	67	110	69	52	69
31	64	68	61	38	41	48	75	65	49	53
41	56	45	58	50	60	37	31	43	54	49
51	33	58	45	34	43	53	62	38	45	42

Sample 10

Years	Ring widths (0.02 mm)									
1	87	92	76	68	65	94	55	42	53	65
11	75	49	59	45	54	65	54	45	32	44
21	47	30	42	38	31	54	34	29	37	38
31	43	34	28	30	43	36	33	52	29	48
41	44	61	62	48	82	48	39	42	39	53
51	53	69	51	44	52					

Sample 15

Years	Ring widths (0.02 mm)									
1	124	97	130	102	63	125	105	98	137	33
11	92	49	73	87	82	51	72	120	86	112
21	47	103	71	78	67	89	110	69	43	55
31	59	68	57	60	49	108	52	74	42	58
41	27	44	38	43	77	51	102	38	51	79
51	68	58	40	48						

APPENDIX F

DETAILS OF WOOD SAMPLES FROM CONTEXT 182 (BLACKWATER SITE 3) AND CONTEXTS 86, 192 AND 193 (BLACKWATER SITE 18)

Sample no.	Taxon	Description and dimensions
1	Quercus sp.	Roundwood. 22mm diam.
2	Quercus sp.	Branched roundwood. 36mm diam.
3	Quercus sp.	Roundwood. 18mm diam.
4	Quercus sp.	Roundwood. 17mm diam.
5	Quercus sp.	Roundwood. 17mm diam.
6	Quercus sp.	Split roundwood. c.25mm diam.
7	Quercus sp.	Split roundwood. c.30mm diam.
8	Quercus sp.	Split segment. 27mm radially.
9	Quercus sp.	Split segment. 35 (radially) x40mm
10	Indet.	Decayed fragment.
11	Quercus sp.	Split segment. 65 (radially) x35mm
12	Fraxinus sp.	Roundwood. 53mm diam.
13	Indet.	Decayed fragment.
14	Prunus sp.	Roundwood. 21mm diam.
15	Quercus sp.	Split segment. 27 (radially) x15mm
16	Quercus sp.	Roundwood. 20mm diam.
17	Quercus sp.	Split segment. 20 (radially) x35mm
18	?Salix/Populus sp.	Roundwood, decayed. c.35mm diam.
19	Quercus sp.	Roundwood. 15mm diam.
296	-	Sample of fibrous plant material.
297	-	Roundwood for C14 dating.
298	Quercus sp.	Split segment.
299	Quercus sp.	Split segment.
300	Corylus sp.	Roundwood. 25mm diam.

Table 1: Samples from context 182 (Site 3)

Samples 1-19 were collected from the top 8cm of clay; 296-300 (part of the running sample number series used later in the 1987 season) were from the S. half of the structure, excavated to 18cm depth.

Sample numbers in this and following Tables refer to the original field drawings.

Sample No.	Taxon	Stem Diameter (mm)
1	Acer sp	22
2	Acer sp	34
3	Corylus sp	22
4	Acer sp	20
5	Acer sp	18
6	Acer sp	18
7	Corylus sp	20
8	Corylus sp	15
9	Acer sp	19
10	Acer sp	12
11	Corylus sp	16
12	Acer sp	14
13	Corylus sp	16
14	Quercus sp	20
15	Acer sp	25
16	Corylus sp	13
17	Quercus sp	19
18	Acer sp	20
19	Corylus sp	15
20	Corylus sp	18
21	Acer sp	15
22	Corylus sp	15
23	Corylus sp	11
24	Quercus sp	15
25	Corylus sp	11
26	Acer sp	11

Table 2: Wood samples from context 86 (Site 18)

Nos. 1-2 were from probable coppice heels; 3-5 from longitudinal stems with cut ends; 6-7 from lateral stems; and 8-26 from other longitudinal stems. Stems identified as Acer show almost all the characteristics of the genus (Schweingruber 1978, 70) but the rays are rarely more than 3-seriate, occasionally 4-seriate. This is probably because they are all young stems.

Sample No.	Taxon	Diameter (mm)	Sample No.	Taxon	Diameter (mm)
221	Acer sp	48	249	Corylus sp	13
222	Corylus sp	40	250	Indet. (a)	8
223	Corylus sp	27	251	Indet. (a)	7
224	Corylus sp	38	252	Quercus sp	11
225	Corylus sp	39	253	?Acer sp (a)	13
226	Corylus sp	31	254	Quercus sp	21
227	Acer sp	50	255	Corylus sp	16
228	Quercus sp	21	256	Corylus sp	17
229	Quercus sp	73	257	Corylus sp	18
230	Quercus sp	45	258	?Acer sp	9
231	Quercus sp	39	259	Corylus sp	21
232	Corylus sp	17	260	Corylus sp	19
233	Corylus sp	42	261	Corylus sp	19
234	Quercus sp	30	262	Corylus sp	17
235	Quercus sp	28	263	Corylus sp	13
236	Quercus sp	20	264	Corylus sp	14
237	Indet. (a)	9	265	Corylus sp	c.20
238	?Acer sp (a)	10	266	Quercus sp	7
239	Indet. (a)	7	267	Corylus sp	15
240	Quercus sp	16	268	Indet.	8
241	Acer sp	20	269	?Acer sp	10
242	Quercus sp	?	270	Quercus sp	20
243	Quercus sp	18	271	Corylus sp	18
244	Acer sp	11	272	Acer sp	15
245	Corylus sp	12	273	Quercus sp	13
246	Corylus sp	12	274	Quercus sp	20
247	Corylus sp	15	275	Quercus sp	11
248	Corylus sp	11	276	Quercus sp	49

Table 3: Wood samples from 192 (Site 18)

(a) Heavily mineralised young stems. Sample 277 was thought to be a bone, but subsequently proved to be a pebble. The Acer stems, as in 86, mostly have 2-3 seriate rays, rarely 4-seriate.

Sample No.	Taxon	Stem Diameter (mm)
278	Quercus sp	40
279	Indet.	c.40
280	Populus sp	41
281	Quercus sp	35
282	Indet.	Compressed 22x12
283	Populus sp	21
284	Fraxinus sp	37
285	Quercus sp	24
286	Quercus sp	29
287	Quercus sp	21
288	Indet.	Compressed 18x11
289	Indet.	14
290	Quercus sp	17
291	Quercus sp	18
292	Fraxinus sp	13
293	Populus sp	7
294	Indet.	Compressed 22x13
295	Indet.	c.20

Table 18: Wood samples from context 193 (Site 18)