Ancient Monuments Laboratory
Report 63/91

ARCHAEOMAGNETIC DATING:
HUNTS FARM, UPMINSTER, LONDON

P Linford

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Summary

A fired clay surface, thought to have been the floor of a Roman pottery kiln, was discovered during archaeological excavation at Hunts Farm near Upminster. Archaeomagnetic dating suggests that the feature was last fired during the 4th century AD and, whilst the precision of the mean direction of magnetisation was excellent, the precision of the date range derived was not as high as can be achieved for other periods.

Author's address :-

P Linford

Ancient Monuments Laboratory
English Heritage
23 Savile Row
London
W1X 2HE

Archaeomagnetic Dating: Hunts Farm, Upminster, London.

Introduction

A baked clay surface, thought to have been the floor of a Roman pottery kiln, was discovered during an excavation at Hunts Farm near Upminster (site code: UPHH89) undertaken by the Passmore-Edwards Museum. This layer, context number 117, was sampled for archaeomagnetic dating to help establish a chronology for the site. The kiln remains had the general feature number 122 and the archaeomagnetic samples were given accession number UP/060; their AML reference code is HFU. Sampling was carried out on the 10th of October 1990 by the author and A David of the Ancient Monuments Laboratory.

Method

Samples were collected using the disc method (see Appendix, section 1a) and orientated to true north with a gyro-theodolite. Seventeen samples were recovered and all were of well baked clay, yellow in colouration, blackened on their top surfaces by firing. Whilst the feature appeared to be intact, there was some evidence of small scale cracking on its surface.

Results

All the measurements discussed below were made using the equipment described in section 2 of the Appendix. Measurements of the directions of Natural Remanent Magnetisation (NRM) of the samples are tabulated in Table 1; the corrections discussed in sections 3b and 3c of the Appendix have been applied. A graphical representation of the distribution of these directions is depicted in Figure 1.

Inspection of this figure shows that the NRM directions of all the samples form a tight cluster and their intensities of magnetisation, listed in Table 1, were all high. It is thus likely that the clay surface was heated well above its blocking temperature during the firing event and that subsequent disturbance of the feature has been minimal. The tight grouping of the samples further suggests that virtually no viscous remanence is present in the samples' magnetisation.

The mean thermoremanent direction was calculated (see Appendix, section 3d) and found to be:

Dec = 1.309 +/- 1.235^{o}; Inc = 64.889 +/- 0.524^{o};
Alpha-95 = 0.953^{o};

This mean is depicted graphically in Figure 2, superimposed on the calibration curve. The alpha-95 statistic shows that the precision of this estimate of the mean thermoremanent direction is excellent. Furthermore, as can be seen in the figure it coincides exactly with a point on the calibration curve. The date range derived from this mean direction is:

332 - 373 cal AD at the 68% confidence level.
309 - 405 cal AD at the 95% confidence level.

The precision of this mean is close to the potential limit for the technique (see Tarling 1983, p151), thus it was decided that no further improvement of the date range could be achieved by further examination.

Conclusions

Both the accuracy and precision of the mean thermoremanent direction were extremely high so there is no reason to doubt the date range derived on archaeomagnetic grounds. Unfortunately the feature appears to date from a period when the magnetic pole position was changing slowly. Hence, the precision of the final date range is not as high as can be achieved for other periods.

Paul Linford
Archaeometry Branch
Ancient Monuments Laboratory

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Table 1; Corrected NRM measurements for all samples.

Sample	Declination (deg)	Inclination (deg)	Intensity (Am^2x10^{-8})
HFU01	7.629	65.954	1431.683
HFU02	3.537	65.653	408.475
HFU03	0.689	66.454	1161.975
HFU04	4.158	64.720	1668.529
HFU05	-0.300	66.493	1510.422
HFU06	2.002	66.819	2463.914
HFU07	1.305	67.143	2236.935
HFU08	2.000	63.440	1107.152
HFU09	5.512	64.226	1102.295
HFU10	2.587	66.166	2573.522
HFU11	-4.763	64.153	4177.731
HFU12	-0.675	61.784	3554.312
HFU13	-1.724	65.899	2568.348
HFU14	0.533	64.698	2726.313
HFU15	-4.367	62.416	2584.379
HFU16	4.653	63.980	816.527
HFU17	0.378	62.529	1271.439

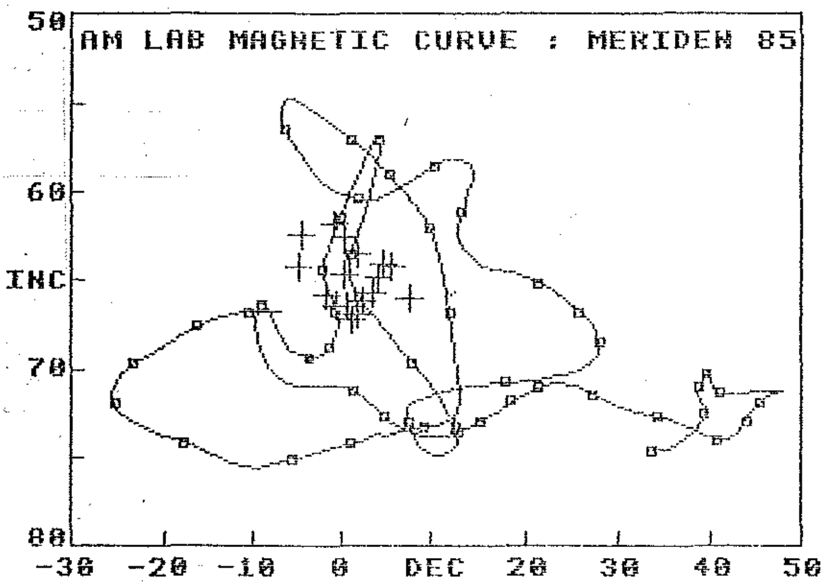

Figure 1; Distribution of NRM results (crosses), superimposed on the calibration curve.

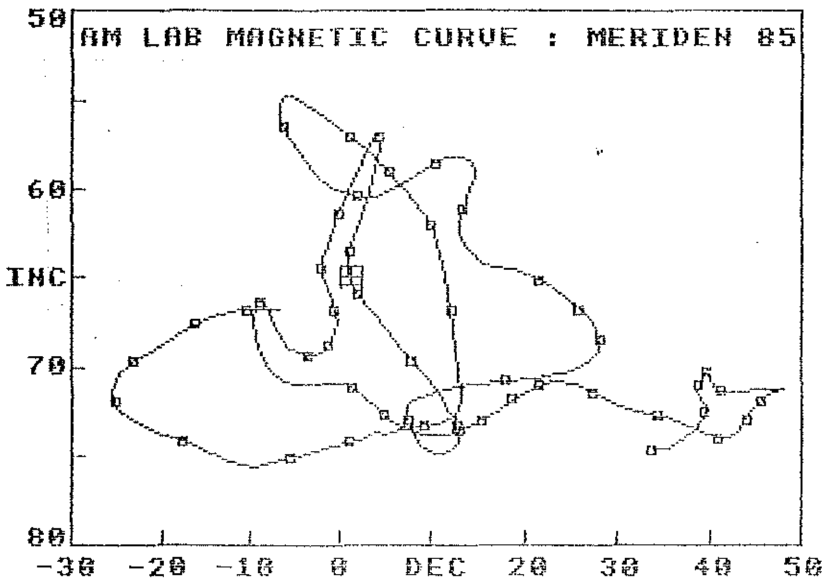

Figure 2; Mean of NRM results with 68% confidence limits.

Appendix: Standard Procedures for Sampling and Measurement

1) Sampling

One of three sampling techniques is employed depending on the consistency of the material (Clark, Tarling and Noel 1988):

a) Consolidated materials: Rock and fired clay samples are collected by the disc method. Several small levelled plastic discs are glued to the feature, marked with an orientation line related to True North, then removed with a small piece of the material attached.

b) Unconsolidated materials: Sediments are collected by the tube method. Small pillars of the material are carved out from a prepared platform, then encapsulated in levelled plastic tubes using plaster of Paris. The orientation line is then marked on top of the plaster.

c) Plastic materials: Waterlogged clays and muds are sampled in a similar manner to method 1b) above; however, the levelled plastic tubes are pressed directly into the material to be sampled.

2) Physical Analysis

a) Magnetic remanences are measured using a slow speed spinner fluxgate magnetometer (Molyneux *et al*. 1972; see also Tarling 1983, p84; Thompson and Oldfield 1986, p52).

b) Partial demagnetisation is achieved using the alternating magnetic field method (As 1967; Creer 1959; see also Tarling 1983, p91; Thompson and Oldfield 1986, p59), to remove viscous magnetic components if necessary. Demagnetising fields are measured in milli-Tesla (mT), figures quoted being for the peak value of the field.

3) Remanent Field Direction

a) The remanent field direction of a sample is expressed as two angles, declination (Dec) and inclination (Inc), both quoted in degrees. Declination represents the bearing of the field relative to true north, angles to the east being positive; inclination represents the angle of dip of this field.

b) Aitken and Hawley (1971) have shown that the angle of inclination in measured samples is likely to be distorted owing to magnetic refraction. The phenomenon is not well understood but is known to depend on the position the samples occupied within the structure. The corrections recommended by Aitken and Hawley are routinely applied to measured inclinations, in keeping with the practise of Clark, Tarling and Noel (1988).

c) Remanent field directions are adjusted to the values they would have had if the feature had been located at Meriden, a standard reference point. The adjustment is done using the method suggested by Noel (Tarling 1983, p116), and allows the remanent directions to be compared with standardised calibration data.

d) Individual remanent field directions are combined to produce the mean remanent field direction using the statistical method developed by R. A. Fisher (1953). The quantity "alpha-95" is quoted with mean field directions and is a measure of the precision of the determination (see Aitken 1990, p247). It is analogous to the standard error statistic for scalar quantities; hence the smaller its value, the better the precision of the date.

4) Calibration

a) Material less than 3000 years old is dated using the archaeomagnetic calibration curve compiled by Clark, Tarling and Noel (1988).

b) Older material is dated using the lake sediment data compiled by Turner and Thompson (1982).

c) Dates are normally given at the 68% confidence level. However, the quality of the measurement and the estimated reliability of the calibration curve for the period in question are not taken into account, so this figure is only approximate. Owing to crossovers and contiguities in the curve, alternative dates are sometimes given. It may be possible to select the correct alternative using independent dating evidence.

d) As the thermoremanent effect is reset at each heating, all dates for fired material refer to the final heating.

e) Dates are prefixed by "cal", for consistency with the new convention for calibrated radiocarbon dates (Mook 1986).

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