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Ancient Monuments Laboratory
Report 26/90

ARCHAEOMAGNETIC DATING: FLIXBOROUGH, HUMBERSIDE.

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Summary

Three clay hearths from a Saxon site near Flixborough in Humberside were sampled for archaeomagnetic dating. Unfortunately, it was not possible to date any of them. In the case of two of the features, post-depositional disturbance was the most likely cause of corruption and, for the third feature, failure was due to the low intensity of remanent magnetisation in the samples recovered.

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Archaeomagnetic Dating: Flixborough, Humberside.

Introduction

Three clay hearths from an excavation near Flixborough in Humberside were sampled for archaeomagnetic dating. The site was located on windblown sand and preliminary finds indicated occupation during the Saxon period.

The features were sampled on two separate dates; feature 466 on the 22nd of November 1989, features 817 and 850 on the 30th of November 1989. On-site assistance was provided on both occasions by Dave Atkinson of the Humberside Archaeology Unit.

Method

Sampling and dating followed the standard procedures outlined in the Appendix. The samples from all three features were collected using the disc method (see Appendix, 1a) and orientated to true north with a gyro-theodolite. Discussion of the composition of the samples is deferred until the results section below.

Results

<u>Feature 466 (AML code: 1FLX)</u>

This feature, apparently a square hearth, was composed primarily of clay. Pieces of tile were also present in places along one edge, however. It was in a poor state of preservation, having been damaged both by ploughing and by burrowing animals. The fourteen samples recovered are described below:

Samples 1 to 6; taken from two of the surviving tiles which were subdivided in the Laboratory.

Samples 8, 9, 11 and 14; composed of a red sandy clay.

Samples 7, 13, 15 and 16; composed of a plastic red-orange clay.

Measurements of the directions of natural remanent magnetisation (NRM) of these samples are tabulated in table 1; the corrections discussed in notes 3b and 3c of the Appendix have been applied. In almost all cases the intensity of magnetisation was reasonable, well above the level of measurement noise, however, the thermoremanent directions are highly anomalous and appear to be randomly scattered. It was thus concluded that the feature had been too severely disturbed to be dated.

Feature 850 (AML code: 2FLX)

This feature was composed entirely of a plastic red-orange clay similar to that mentioned above, the clay being baked hard in some parts. The feature was incomplete, the clay surviving only in small areas probably due to the effects of burrowing animals. Fourteen samples were recovered; all with the composition mentioned above.

Measurements of the NRM directions are tabulated in table 2, corrected as discussed in notes 3b and 3c of the Appendix; with the exception of samples 1, 5, 6 and 9, the intensity of remanent magnetisation was high. The distribution of these NRM directions is represented graphically in figure 1.

It is clear from figure 1 that the inclination of remanent magnetisation in most samples falls within a narrow range, consistent with a Saxon date. However, their declinations are widely scattered. The mean remanent direction of magnetisation was calculated to be:

$$\textbf{Dec} = 17.709 \pm 7.865^\circ;\ \textbf{Inc} = 75.561 \pm 1.961^\circ;$$
$$\textbf{Alpha-95} = 3.617^\circ$$

This mean is plotted in figure 2, superimposed on the magnetic dating calibration curve (see Appendix, 4a). The wide scatter of the declinations is reflected in the large value of the 68% confidence limit for declination. Furthermore, the mean direction is not close to any point on the curve; it is thus meaningless to ascribe a date range to this distribution.

Two samples, 2FLX04 and 2FLX13, were partially demagnetised in 2mT increments to investigate the stability of the remanent magnetisation. The resulting measurements are tabulated in tables 3 and 4 respectively. The decline in the intensity of magnetisation with increasing partial demagnetisation for sample 2FLX04 is plotted in figure 3 and the corresponding graph for 2FLX13 in figure 4. The shape of the curves produced demonstrates that the magnetisation in both samples was stable; the presence of a small degree of viscous remanence in sample 2FLX04 being indicated by the steepening of the curve in figure 3 at low demagnetisation values.

The variation of the direction of remanent magnetisation for sample 2FLX04 is plotted in figure 5, the corresponding graph for sample 2FLX13 being figure 6; in both cases the figures have been corrected as discussed in notes 3b and 3c of the Appendix. It can be seen in these graphs that the variation in direction was not large for either sample. Furthermore, in both cases the direction of magnetisation converged to a stable direction, little different from the NRM direction, at a partial demagnetisation between 6 and 8mT.

These results demonstrate that viscous remanent magnetism was not the primary cause scatter in the angles of declination, and that partial demagnetisation of all samples would not significantly improve the mean direction of remanent magnetisation obtained.

Feature 817 (AML code: 3FLX)

This feature was composed of a pink sandy clay which contained many, very small, chalk-like inclusions. The surface of the clay appeared to be hard and was extremely friable. It was the least disturbed of the three and appeared to be reasonably intact. Fifteen samples were recovered, all with the composition described above.

Measurements of the directions of natural remanent magnetisation are tabulated in table 5; corrected as discussed in notes 3b and 3c of the Appendix. The resulting directions are widely scattered, almost certainly because the intensities of magnetisation in all the samples were little above the level of measurement noise. There is thus nothing to be obtained either from calculating the mean remanent direction or from further measurement.

Conclusions

It was not possible to obtain a date for any of the features sampled. Features 466 and 850 both appeared to have been disturbed since they were last fired and this is the most probable cause of the scatter in the measured remanent directions of magnetisation. Feature 850 was the least disturbed of the two, the scatter in remanent direction being confined mainly to the angle of declination measured for each sample, this being more sensitive to disturbance than inclination.

Feature 817 appeared to be largely undisturbed but was composed of a different type of clay. It is likely that few ferrimagnetic minerals were present in this clay and that their blocking temperature was high. Thus there was little realignment of magnetic domains at the temperatures reached by firing the feature for its routine use.

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Table 1; Corrected NRM measurements for feature 466 (1FLX).

Sample	Declination (deg)	Inclination (deg)
1FLX01	73.156	73.117
1FLX02	53.313	83.310
1FLX03	68.037	78.938
1FLX04	79.080	75.891
1FLX05	81.812	66.212
1FLX06	71.920	78.093
1FLX07	-7.729	79.307
1FLX08	49.848	52.803
1FLX09	68.422	81.769
1FLX11	33.609	57.330
1FLX13	39.010	41.004
1FLX14	21.177	67.216
1FLX15	-32.478	43.816
1FLX16	25.324	83.657

Table 2; Corrected NRM measurements for feature 850 (2FLX).

Sample	Declination (deg)	Inclination (deg)
2FLX01	9.888	83.913
2FLX02	6.418	77.238
2FLX03	46.632	73.350
2FLX04	33.496	71.920
2FLX05	-8.761	74.594
2FLX06	27.054	75.261
2FLX07	48.053	87.949
2FLX08	27.067	70.819
2FLX09	3.638	62.453
2FLX10	21.670	75.734
2FLX11	30.981	71.721
2FLX12	24.190	74.711
2FLX13	-9.170	74.914
2FLX14	6.981	74.930

Table 3; Variation of remanent field with increasing partial demagnetisation for sample 2FLX04.

demagnetisation (mT)	Declination (deg)	Inclination (deg)	Intensity (M/M_O)
0	33.399	71.852	1.000
2	34.249	71.335	0.964
4	34.723	70.827	0.904
6	34.323	70.580	0.827
8	34.114	70.518	0.717
10	34.391	70.494	0.615
12	32.203	70.056	0.502
14	30.835	69.739	0.389
16	34.637	70.483	0.311
18	33.430	69.837	0.240
20	33.958	69.167	0.203
22	29.483	69.225	0.179

Table 4; Variation of remanent field with increasing partial demagnetisation for sample 2FLX13.

demagnetisation (mT)	Declination (deg)	Inclination (deg)	Intensity (M/M_o)
0	-10.928	75.658	1.000
2	-9.990	75.206	0.989
4	-9.345	75.023	0.971
6	-10.147	75.151	0.913
8	-10.072	74.946	0.867
10	-11.537	75.259	0.793
12	-12.653	75.152	0.716
14	-13.208	75.239	0.634
16	-14.801	74.873	0.536
18	-13.832	75.261	0.448
20	-14.972	75.014	0.361
22	-14.681	74.746	0.295

Table 5; Corrected NRM measurements for feature 817 (3FLX).

Sample	Declination (deg)	Inclination (deg)
3FLX01	-1.759	41.953
3FLX02	-6.929	81.812
3FLX03	11.230	45.713
3FLX04	11.810	45.599
3FLX05	-20.540	80.366
3FLX06	-13.665	75.283
3FLX07	13.456	44.881
3FLX08	-32.651	67.655
3FLX09	-12.690	68.205
3FLX10	-27.831	84.420
3FLX11	-12.173	78.722
3FLX12	-4.984	73.875
3FLX13	-9.304	69.842
3FLX14	-10.412	60.324
3FLX15	-14.604	76.024

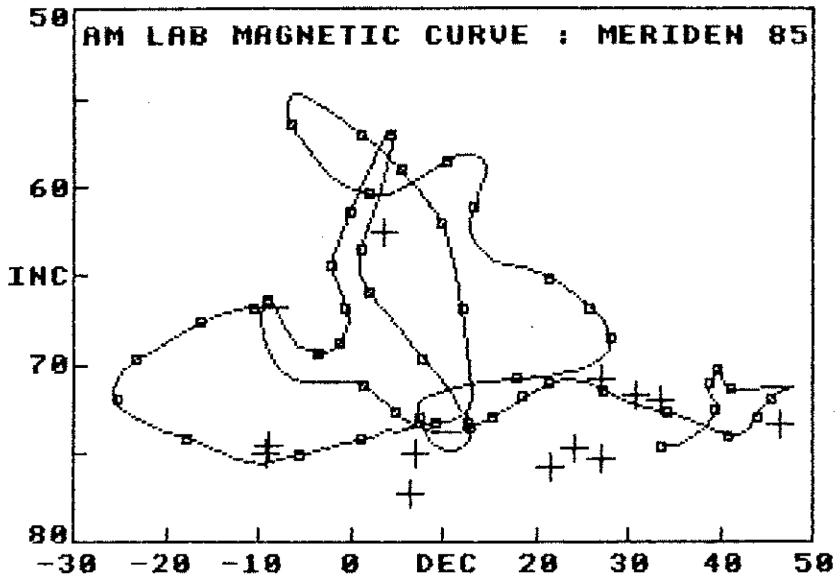

Figure 1; Distribution of NRM results for feature 850, (2FLX).

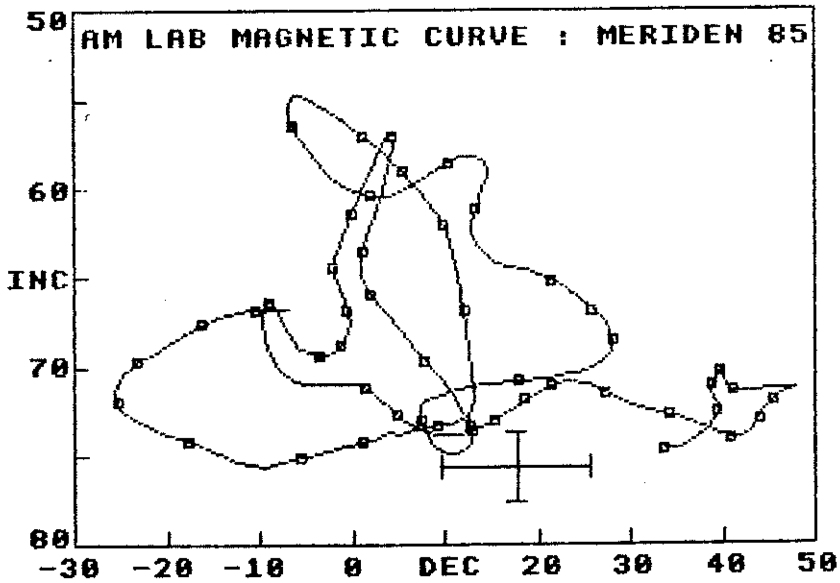

Figure 2; Mean of NRM results for feature 850, (2FLX), with 68% confidence limits.

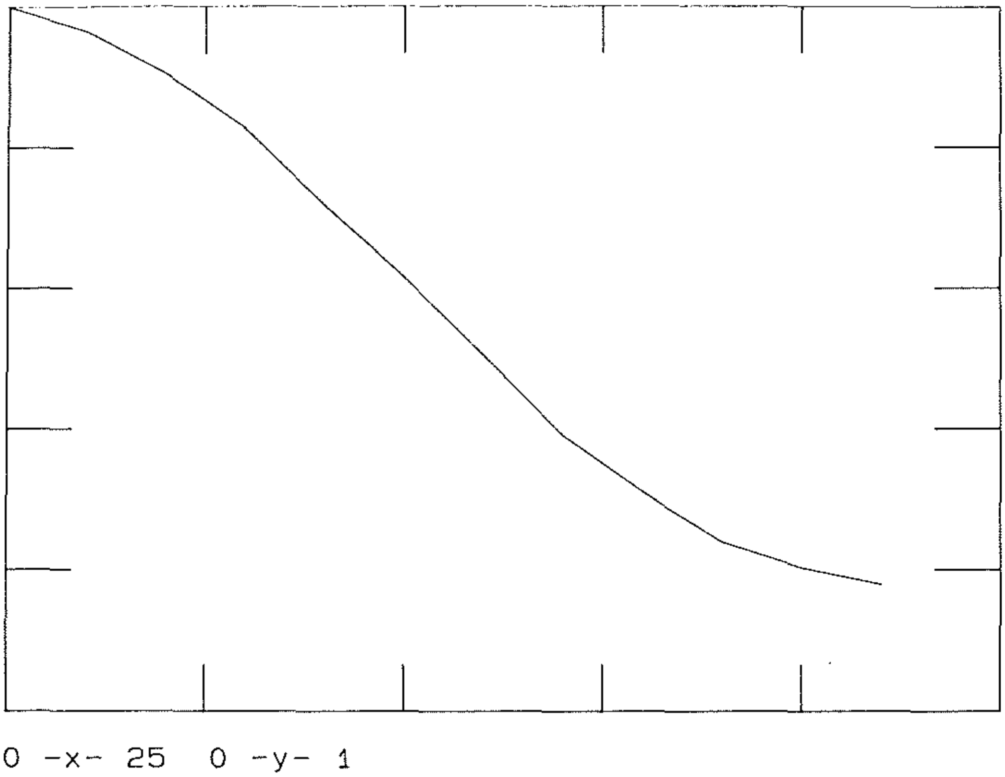

Figure 3; Variation of remanence intensity M/M_o (y axis), with increasing partial demagnetisation in mT (x axis), for sample 2FLX04.

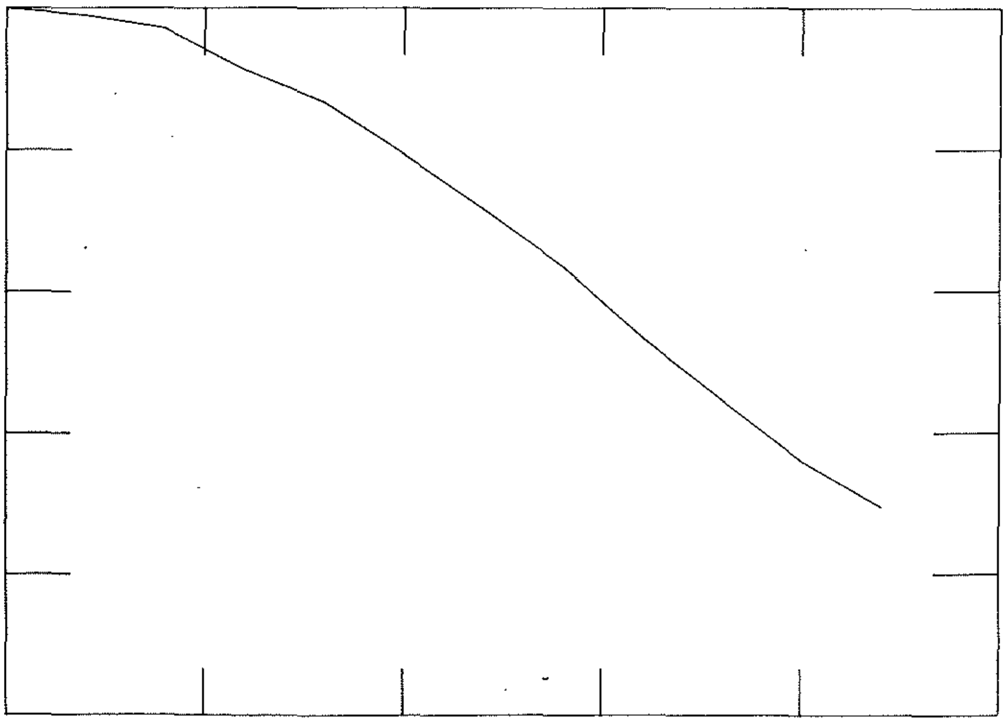

Figure 4; Variation of remanence intensity M/M_o (y axis), with increasing partial demagnetisation in mT (x axis), for sample 2FLX13.

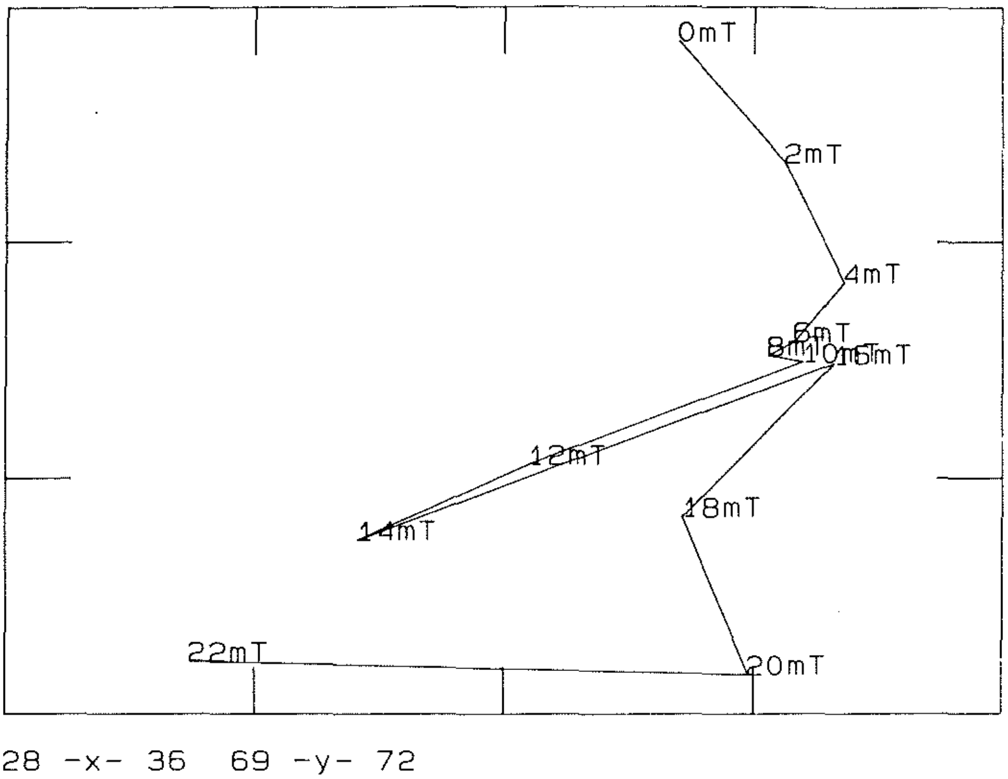

Figure 5; Variation of Dec (x axis) and Inc (y axis) with increasing partial demagnetisation, for sample 2FLX04.

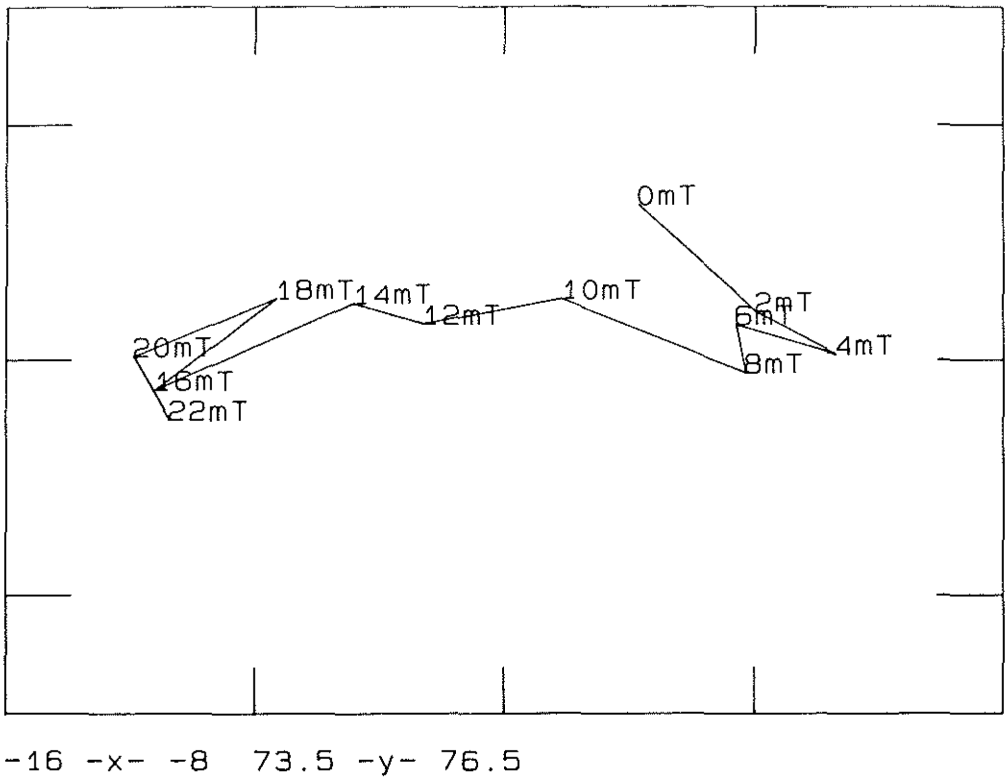

Figure 6; Variation of Dec (x axis) and Inc (y axis) with increasing partial demagnetisation, for sample 2FLX13.

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 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; the smaller its value, the better the precision.

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 varve data compiled by Turner and Thompson (1982).

c) Dates are normally given at the 68% confidence level. However, both the quality of the measurement and the estimated reliability of the calibration curve for the period in question are 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).

References

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