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Ancient Monuments Laboratory
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ARCHAEMAGNETIC DATING: COWBIT, LINCOLNSHIRE

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Summary

A fired clay hearth, associated with salt production, was discovered during an archaeological excavation at Cowbit in Lincolnshire. Archaeomagnetic analysis of the feature revealed that it had been disturbed since it was last fired and it was therefore undatable.

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Archaeomagnetic Dating: Cowbit, Lincolnshire.

Introduction

During excavation of a saltmaking site at Cowbit, Lincolnshire a fired clay hearth, thought to be associated with the salt production, was discovered. This feature was sampled for archaeomagnetic dating to help establish a chronology for the site and was given the laboratory identification code COW. Sampling was carried out on the 11th of August 1992 by the author and N Linford of the Ancient Monuments Laboratory. Laboratory measurement and evaluation was conducted by the author.

Method

Samples were collected using the disc method (see appendix, section 1a) and orientated to True North with a gyro-theodolite. Eighteen samples were recovered, all orange-red in colouration. At the time of the sampling visit the hearth had not been completely excavated and samples were taken from all areas that appeared significantly fired. Subsequently it transpired that only nine of the samples, COW04 to COW08 and COW12 to COW15, came from areas that could be confidently associated with the superstructure of the hearth. So, whilst all samples were measured, detailed analysis was concentrated on these nine.

The basic outline of the hearth was intact but it exhibited evidence of plough damage; also, many parts of the site, including the hearth area, had been affected by prolific mole activity. Hence, there was concern that the feature may have been disturbed since it was last fired and thus be undatable using archaeomagnetism.

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 shown in figure 1.

From this figure it can be seen that the NRM directions of the individual samples form a broad scatter with little indication of any clustering. Seven of the samples, COW02, COW03, COW09, COW10, COW12, COW16 and COW17 have NRM directions that do not even fall within the graph area. Although the intensity of magnetisation in most of the samples is consistent with firing to above the blocking temperature, the observed scattering of NRM directions implies that the feature has been disturbed since its last firing. Whilst viscous remanent magnetism might produce such anomalous scattering of NRM directions, it would be unlikely to do so to this degree.

Hence, further analysis was restricted to those nine samples certain to be from the superstructure of the hearth. Their NRM directions are re-plotted in figure 2 and only one sample, COW12, has a direction outside the graph area. This supports the suggestion that these samples came from the least disturbed areas. The eight NRM directions in figure 2 fall into two loose clusters; one, consisting of COW04, COW05, COW06 and COW07, centred around Dec -15 and Inc 65; the other, consisting of COW08, COW13, COW14 and COW15, centred around Dec 10 and Inc 75.

The scattering of the NRM directions is still too great to allow a valid mean thermoremanent direction to be determined. Furthermore, the clustering of NRM directions matches well with the part of the structure from which the samples came; samples 4 to 8 all came from the same part of the superstructure and samples 12 to 15 all came from another, separate part. Sample 8 is the only exception, being closer to samples 13 to 15 than samples 4 to 7 but, as it came from the edge of an intact piece of superstructure, it is likely to represent clay that has been disturbed owing to the fracturing of the hearth. This explanation is also likely to account for the totally anomalous NRM direction of sample COW12.

From the above, it is probable that the hearth has been disturbed since firing, fragmenting into separate parts that were then displaced relative to each other. To ensure that this was the case and establish that viscous remanence did not significantly contribute to the anomalous scattering, two samples, one from each area, were partially demagnetised in 2mT increments, to a maximum value of 30mT (see appendix, section 2b). The samples selected were COW05 and COW13; measurements of the remaining remanent magnetisation at each stage are tabulated in tables 2 and 3 respectively. The decline in intensity of magnetisation with increasing AF demagnetisation for each is plotted in figures 3 and 5; the variation in the remanent direction is shown in figures 4 and 6.

The characteristic, smooth reverse "S" shape of figures 3 and 5 shows that the magnetisation of both samples was stable. Also the change in direction of magnetisation with increasing demagnetisation is small for both samples until high demagnetising fields are reached. Sample COW05 does exhibit some possible viscous remanence at the 0-2mT demagnetisation stage but, based on the evidence from both samples, this is unlikely to account for a deviation of more than +/-2.5 degrees in the NRM directions. Hence the anomalous scatter observed is almost certainly not caused by viscous remanence.

Conclusions

The magnetic measurements have confirmed the fears raised by visual indications on site, that the hearth has been disturbed since it was last fired. The displacement of the direction of thermoremanent magnetism within the hearth that this disturbance has caused unfortunately renders it undatable by archaeomagnetic analysis.

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Table 1; Corrected NRM measurements for all samples.

Sample	Declination (deg)	Inclination (deg)	Intensity (Am^2x10^{-8})
COW01	34.941	73.669	6.446
COW02	79.664	73.224	43.328
COW03	-66.358	87.432	9.590
COW04	-4.125	62.278	51.607
COW05	-10.571	65.294	90.193
COW06	-26.292	64.313	15.046
COW07	-20.587	63.592	20.028
COW08	14.368	75.520	50.066
COW09	-73.166	36.664	2.967
COW10	53.530	76.861	1290.440
COW11	-11.061	76.865	39.571
COW12	52.514	59.107	56.883
COW13	3.628	73.773	341.004
COW14	8.639	68.375	469.175
COW15	6.116	77.816	578.726
COW16	-12.292	18.380	5470.620
COW17	70.797	-75.574	1200.490
COW18	43.126	57.305	390.974

Table 2; Variation of remanent field with increasing partial demagnetisation for sample COW05.

Demagnetisation (mT)	Declination (deg)	Inclination (deg)	Intensity (M/M_o)
0	-11.904	64.605	1.000
2	-9.296	65.560	0.979
4	-9.329	65.423	0.964
6	-9.461	65.208	0.948
8	-9.763	64.932	0.873
10	-8.943	64.319	0.793
12	-9.918	64.512	0.692
14	-10.719	65.772	0.586
16	-7.529	63.809	0.496
18	-7.449	64.015	0.402
20	-6.872	64.015	0.301
22	-7.895	63.995	0.231
24	-13.646	64.872	0.183
26	-6.012	64.358	0.138
28	-12.220	64.254	0.106
30	1.867	63.923	0.094

Table 3; Variation of remanent field with increasing partial demagnetisation for sample COW13.

Demagnetisation (mT)	Declination (deg)	Inclination (deg)	Intensity (M/M_o)
0	0.107	73.121	1.000
2	0.971	73.005	0.974
4	0.198	72.956	0.910
6	0.434	72.992	0.810
8	0.685	72.752	0.664
10	-0.614	72.347	0.519
12	-1.173	72.218	0.379
14	-5.387	73.757	0.261
16	-0.415	71.997	0.173
18	-0.269	72.829	0.127
20	-8.081	74.761	0.091
22	-0.172	68.833	0.067
24	10.042	74.621	0.052
26	-3.505	74.960	0.043
28	4.769	72.281	0.037
30	-15.875	73.499	0.032

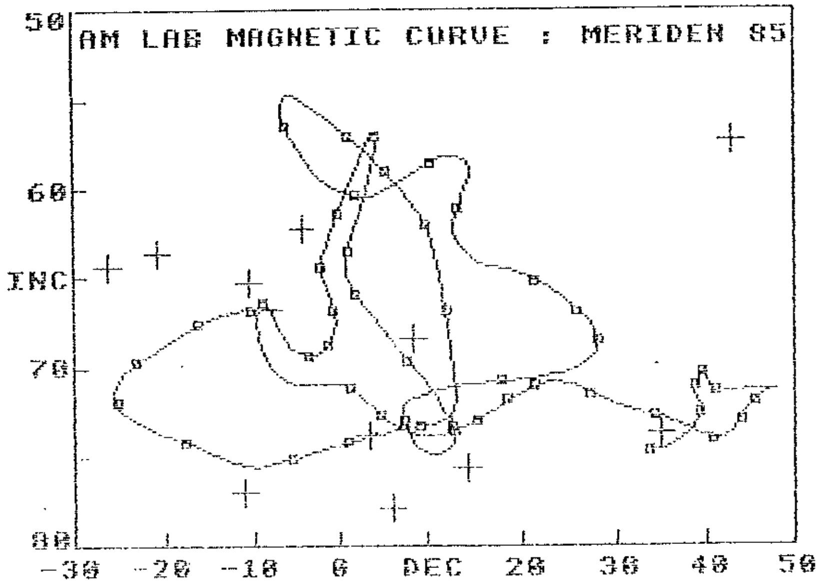


Figure 1; Distribution of NRM results.

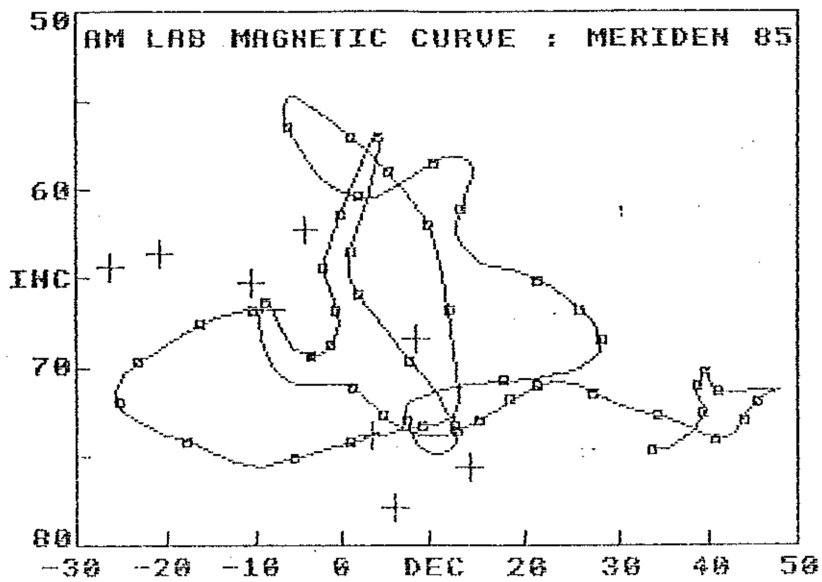
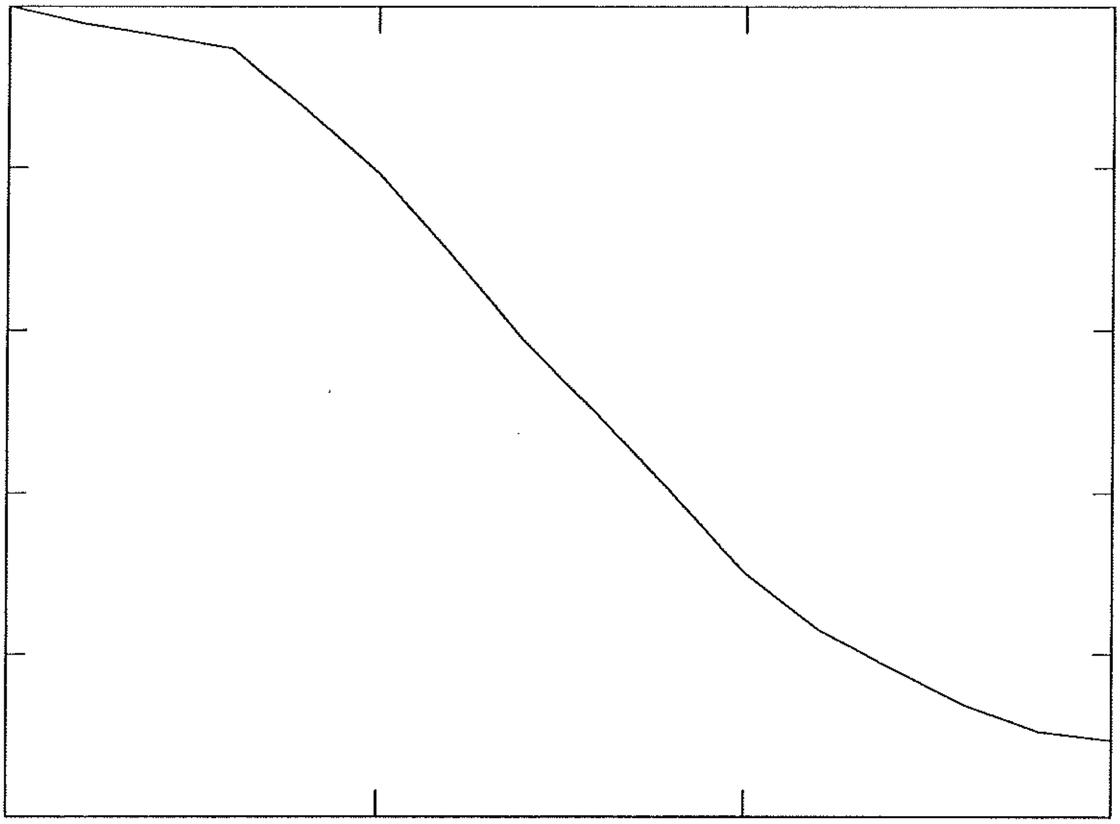
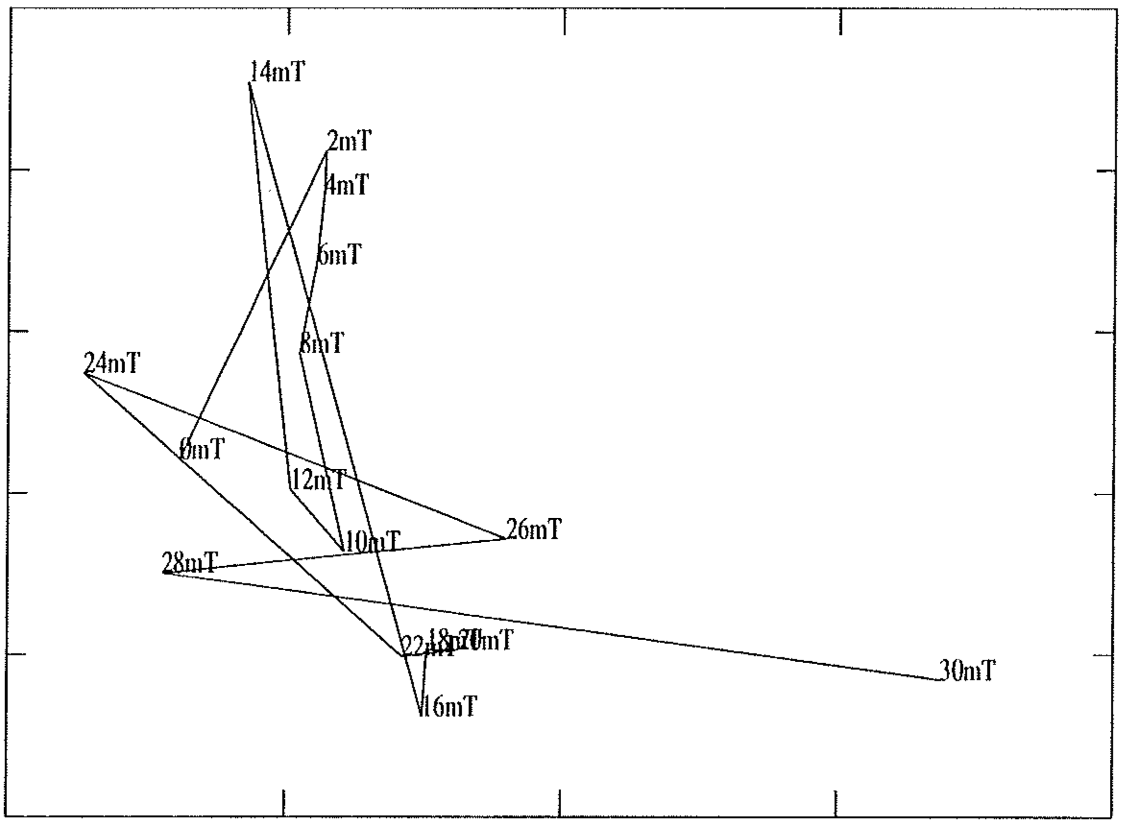


Figure 2; NRM results of samples COW04-08 and COW13-15.



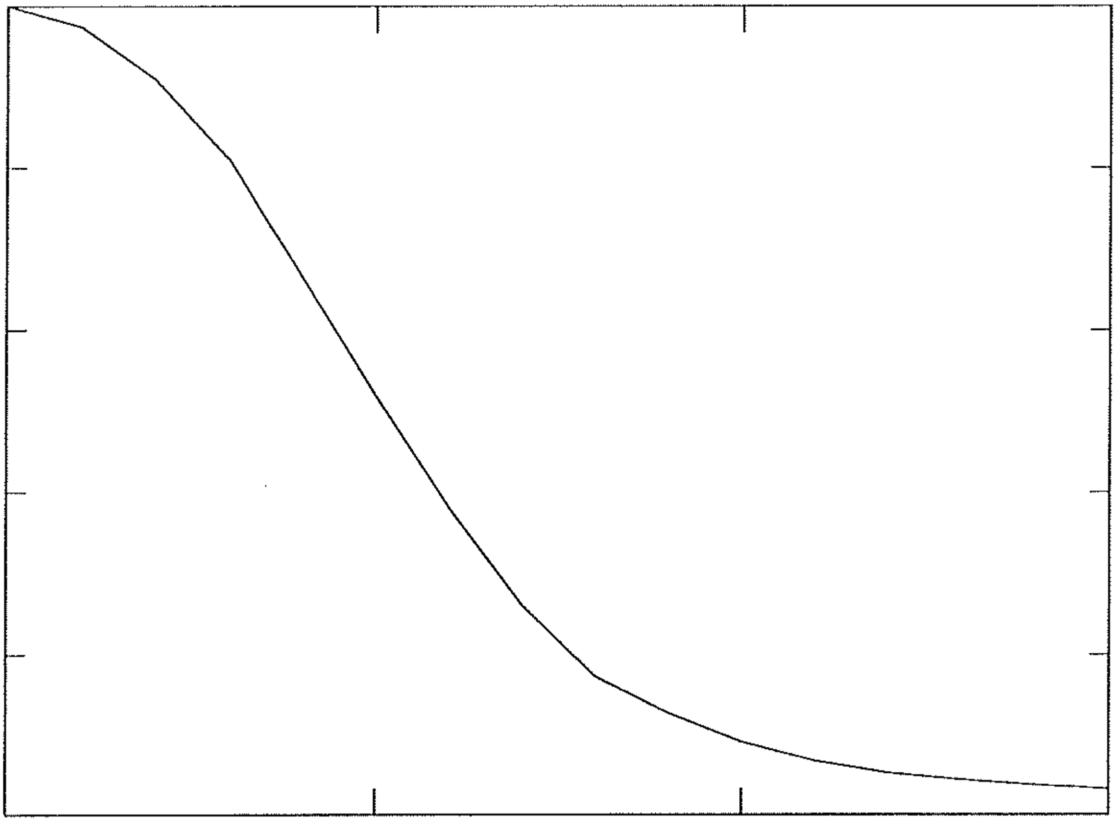
0 -x- 30 0 -y- 1

Figure 3; Variation of remanence intensity (y axis), M/Mo, with increasing partial demagnetisation in mT (x axis) for sample COW05.



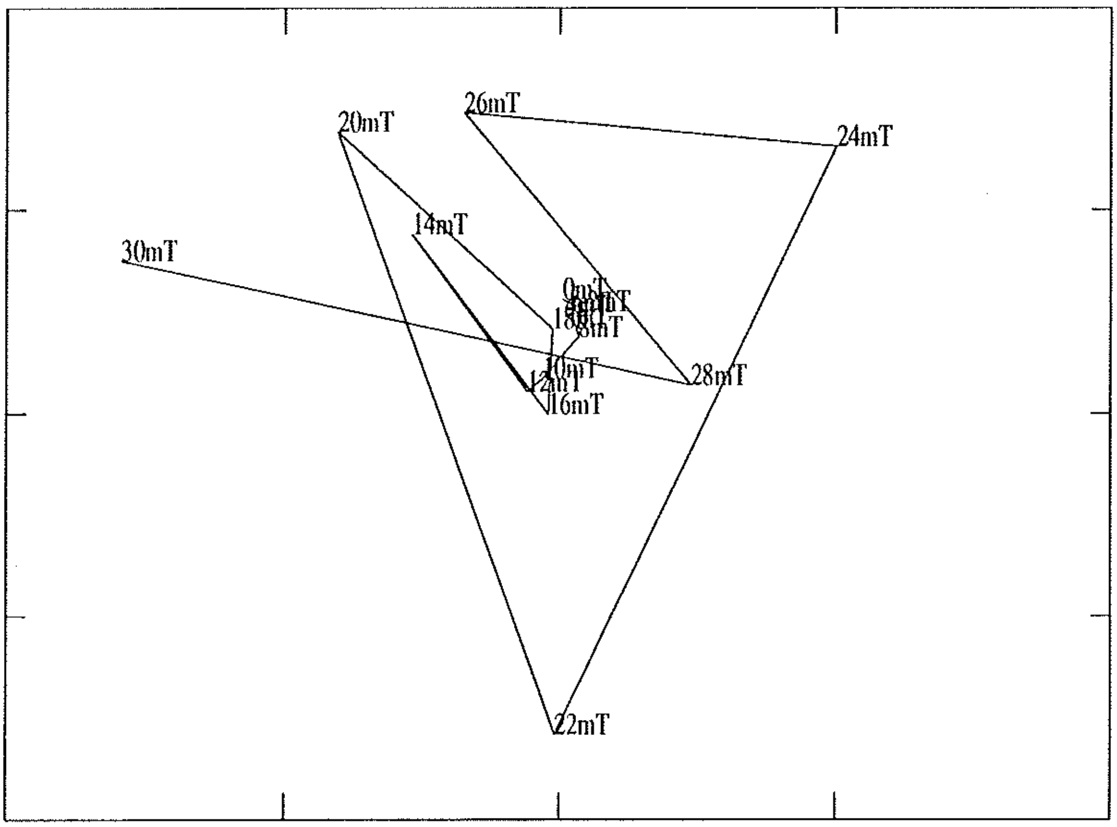
-15 -x- 5 63.5 -y- 66

Figure 4; Variation of Dec (x axis) and Inc (y axis) with increasing partial demagnetisation for sample COW05.



0 -x- 30 0 -y- 1

Figure 5; Variation of remanence intensity (y axis), M/Mo, with increasing partial demagnetisation in mT (x axis) for sample COW13.



-20 -x- 20 68 -y- 76

Figure 6; Variation of Dec (x axis) and Inc (y axis) with increasing partial demagnetisation for sample COW13.

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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