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SOUTHGATE CAR PARK, CHICHESTER, WEST SUSSEX, ARCHAEOMAGNETIC DATING REPORT, 2000

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Summary

Excavations at the Southgate car park in Chichester uncovered the remains of a medieval pottery kiln constructed from ceramic tiles mortared together with clay. Archaeomagnetic study revealed that the structure acquired a stable thermoremanent direction when it was last fired. Despite some scattering of the individual sample remanent directions, it was possible to derive a date for the last firing of the kiln of 1218 to 1262 cal AD which is in good agreement with the pottery typology chronologies for the city.

Author's address :-

Mr P K Linford
ENGLISH HERITAGE
Centre For Archaeology   Fort Cumberland
Fort Cumberland Road   Eastney
Portsmouth
HANTS
UK
PO4 9LD

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Introduction

During excavations at the Southgate car park in Chichester (SU 858 045, Latitude 50.9°N, Longitude 0.8°W), the remains of a medieval pottery kiln were discovered. The kiln had been constructed from ceramic tiles mortared together with clay and the surviving structure consisted of the flues and footing of the outer wall of the kiln, standing to about 20cm in height. There are few fixed dates in the typological sequence of pottery for Chichester and it was hoped that an archaeomagnetic date for the last firing of the kiln would provide a rare opportunity to associate an absolute date with the pottery found on the site. Sampling was carried out on the 26th of May 2000 by the author and A. David of the Centre for Archaeology; subsequent measurement and evaluation was performed by the author.

Method

Samples were collected using the disc method (see appendix, section 1a) and orientated to true north using a gyro-theodolite. Thirteen samples were recovered (a further four samples were lost owing to the epoxy resin failing to adhere in the wet conditions prevailing at the time of sampling).

Two of the samples (CH08 and CH09) were of tile and two more were of what appeared to be burnt natural near the stoke hole (CH16 and CH17). The remaining samples were all of fired clay mortar from between the stacked tiles that formed the wall of the kiln. All the laboratory measurements were made using the equipment described in section 2 of the appendix.

Results

The natural remanent magnetisation (NRM) measurements for all samples, corrected according to the procedures described in section 3 of the appendix, are listed in Table 1. However, no correction for magnetic refraction has been applied (see note 3b). The distribution of their directions is depicted in Figure 1.

The NRM of the samples is assumed to be caused by thermoremanent magnetisation (TRM) at the time that the kiln was last fired. However, a secondary component acquired in later geomagnetic fields can also be present, caused by diagenesis or partial reheating. Additionally, the primary TRM may be overprinted by a viscous component, depending on the grain size distribution within the magnetic material. These secondary components are usually of lower stability than the primary TRM and can thus be removed by partial demagnetisation of the samples.

Hence two representative pilot samples (CH01 and CH15) were demagnetised incrementally to peak alternating fields of 64mT and 96mT respectively and the changes in their remanence recorded to identify the components of their magnetisation. The measurements are tabulated in Table 2 and those from CH01 are depicted graphically in Figure 2. Analysis of this figure suggests that a secondary magnetisation is present in sample CH01 at low coercivities but partial demagnetisation in a peak alternating field (AF) of 4mT removed it. Hence all the fired clay samples were demagnetised in a 4mT peak AF field.

The two tile samples would also have acquired a primary TRM when they were made. This would have been overprinted by a new TRM when they were incorporated into the kiln wall and the kiln was fired. However, if they were not subjected to as high a temperature during this latter heating the overprinting may only be partial and a component of the initial magnetisation may still be present in magnetic domains with high unblocking temperatures. For this reason the two tile samples (CH08 and CH09) were also partially demagnetised incrementally to a peak alternating field of 96mT. These measurements are tabulated in Table 3 and, for CH09, depicted in Figure 3. In Figure 3 a secondary magnetisation is present and affects the declination of the sample magnetisation in all measurements with peak AF demagnetising fields less than 16mT. Hence it was decided to use the measurements made after demagnetisation in a peak AF field of 16mT for two tile samples.

The distribution of sample TRMs after partial demagnetisation is depicted in Figure 4 and it is clear from this stereogram that the magnetisation of sample CH16 lies some distance away from the main group. This sample was of burnt natural clay at the side of the stoke hole and it is likely that it was not heated to such high temperatures as samples taken from the kiln itself. It was thus rejected from the mean TRM calculation on the assumption that it had not acquired a stable magnetisation.

The mean TRM of the remaining samples corrected to Meriden was calculated to be:

$$\mathbf{Dec = 11.9^{o} \qquad Inc = 57.7^{o} \qquad \alpha_{95} = 3.5^{o}}$$

This mean is depicted on a Bauer plot, superimposed on the UK archaeomagnetic calibration curve in Figure 5. The date of last firing of the kiln calculated from this mean is

1218 to 1262 cal AD at the 63% confidence level.

Conclusions

Archaeomagnetic study of the remains of the medieval kiln at Southgate, Chichester has revealed that the structure did acquire a stable thermoremanent direction when it was last fired. Some scattering of the individual sample remanent directions was present. This was, in part, due to low stability secondary magnetisations but also probably indicates some slight disturbance to components of the kiln since it was last used. Nevertheless, it was possible to derive a date for the last firing of the kiln of 1218 to 1262 cal AD which is in good agreement with pottery typology chronologies for the city.

P. Linford
Archaeometry Branch,
Centre for Archaeology, English Heritage.

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	NRM Measurements			After partial demagnetisation			
Sample	Dec°	Inc°	J(mA/m)	AF(mT)	Dec°	Inc°	J(mA/m)
CH01	12.5	59.8	681.1	4	15.9	56.8	475.8
CH02	17.5	52.2	363.8	4	17.3	53.5	275.0
CH03	3.4	64.5	18051.7	4	6.7	65.4	17532.7
CH05	14.4	53.7	164.0	4	12.5	52.1	101.9
CH08	16.6	52.2	2784.9	16	15.6	52.0	2436.8
CH09	25.8	50.9	7416.3	16	25.3	52.0	6400.7
CH11	14.9	51.1	34.6	4	8.4	55.8	22.5
CH12	18.7	63.1	132.0	4	10.2	60.8	94.1
CH13	11.8	58.4	180.7	4	13.0	57.7	129.4
CH14	4.1	59.3	129.1	4	1.5	54.2	79.1
CH15	6.9	65.9	23325.8	4	6.6	66.8	22550.6
CH16	6.0	55.4	26.0	4	-24.0	63.2	9.2
CH17	22.9	56.3	23.3	4	3.2	62.9	11.6

Table 1: NRM measurements and measurements after partial demagnetisation for all samples. J = magnitude of magnetisation vector; AF = peak alternating field strength of applied demagnetising field.

AF (mT)	CH01			CH15		
	Dec°	Inc°	J (mA/m)	Dec°	Inc°	J (mA/m)
00	8.1	57.1	656.9	6.5	65.8	23561.7
01	12.9	56.5	626.7	6.0	65.7	23261.1
02	14.4	56.3	581.9	6.8	65.7	23208.6
04	15.8	55.5	475.8	6.4	65.7	22550.6
08	16.1	54.3	212.2	6.5	65.6	18950.4
12	13.0	53.7	81.5	6.1	65.7	14343.7
16	1.9	54.1	45.7	6.0	65.5	10019.1
32	6.7	47.3	23.4	4.8	64.2	4013.8
64	12.5	19.8	13.3	5.8	64.0	2072.6
96	-	-	-	5.6	64.3	1570.5

Table 2: Incremental partial demagnetisation measurements for samples CH01 and CH15 (both fired clay).

AF (mT)	CH08			CH09		
	Dec°	Inc°	J (mA/m)	Dec°	Inc°	J (mA/m)
00	15.2	51.2	2720.5	24.7	51.2	7354.9
01	15.3	51.3	2730.8	24.4	50.8	7336.3
01	16.1	51.3	2725.6	24.4	50.8	7336.3
02	15.7	51.0	2717.8	22.1	51.1	7341.9
04	15.2	51.2	2689.5	24.6	51.0	7284.9
08	16.0	51.0	2643.3	24.9	51.0	7089.7
12	15.0	50.7	2573.1	25.5	50.9	6755.4
16	15.6	50.6	2436.8	25.2	50.8	6400.7
32	15.8	50.4	1948.1	25.6	50.3	4739.9
64	15.4	48.9	999.7	26.9	49.1	2505.6
96	13.6	47.4	460.3	24.6	48.3	1364.7

Table 3: Incremental partial demagnetisation measurements for samples CH08 and CH09 (both tile).

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 α_{95}, "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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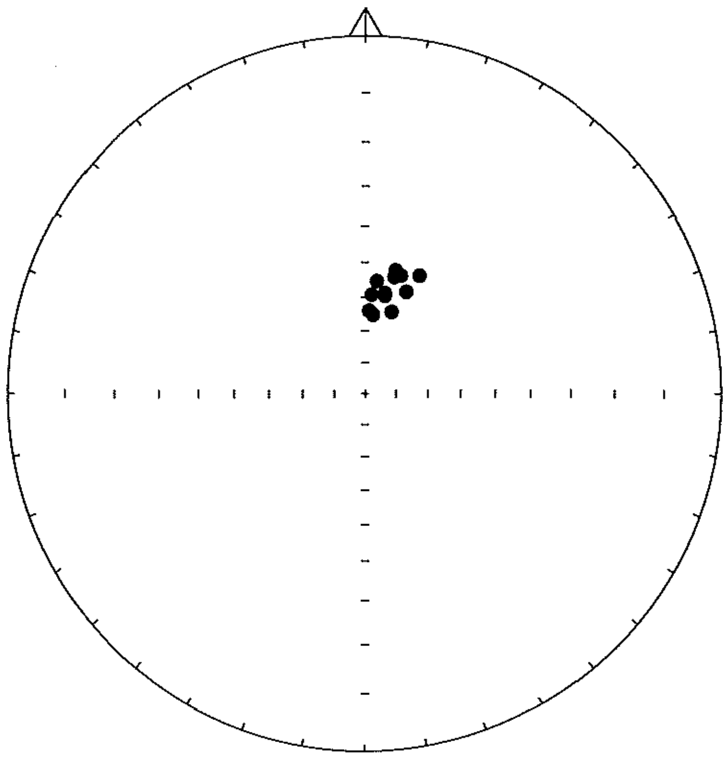

Figure 1: Distribution of NRM directions represented as an equal area stereogram. In this projection declination increases clockwise with zero being at 12 o'clock while inclination increases from zero at the equator to 90 degrees in the centre of the projection.

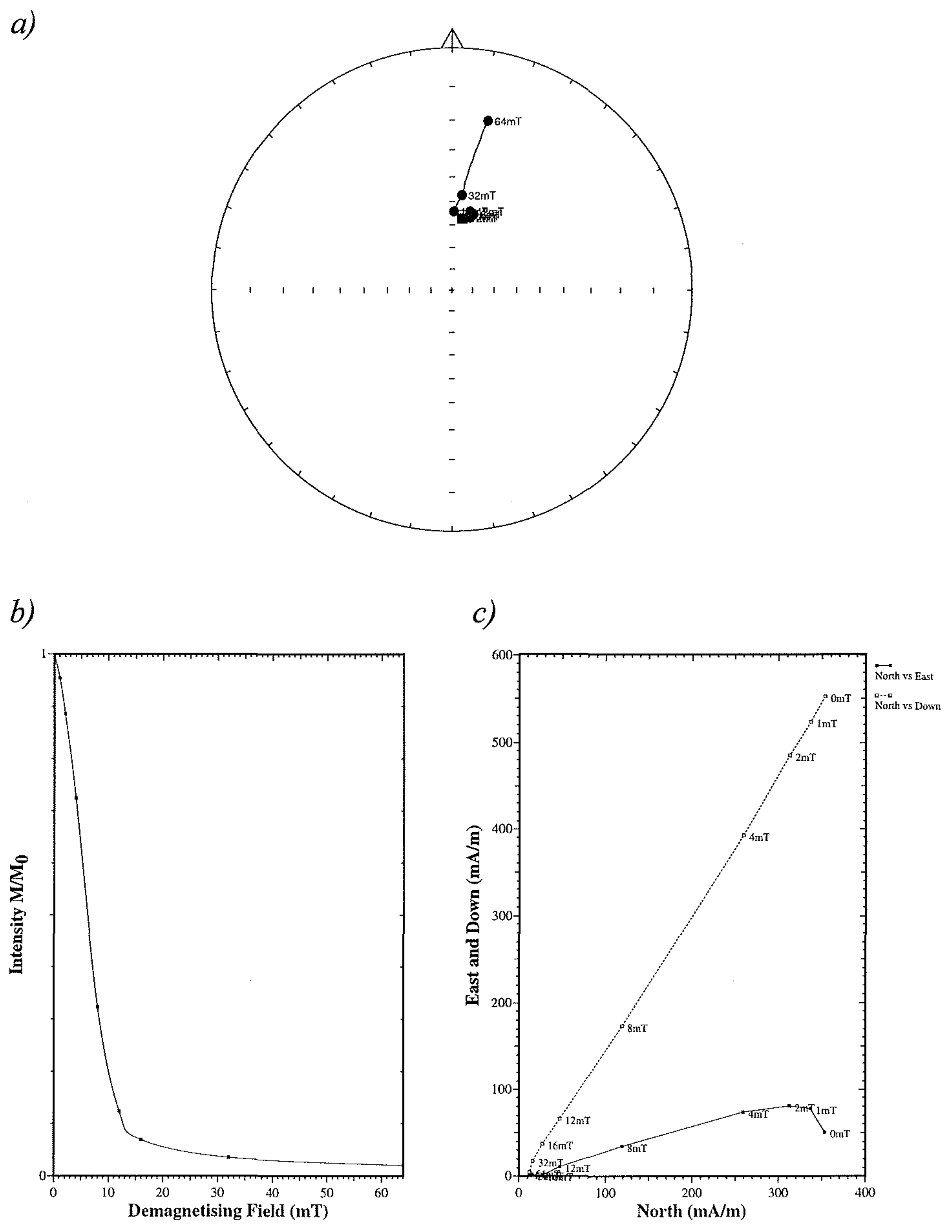

Figure 2: Stepwise AF demagnetisation of sample CH01. Diagram a) depicts the variation of the remanent direction as an equal area stereogram (declination increases clockwise, while inclination increases from zero at the equator to 90 degrees at the centre of the projection); b) shows the normalised change in remanence intensity as a function of the demagnetising field; c) shows the changes in both direction and intensity as a vector endpoint projection.

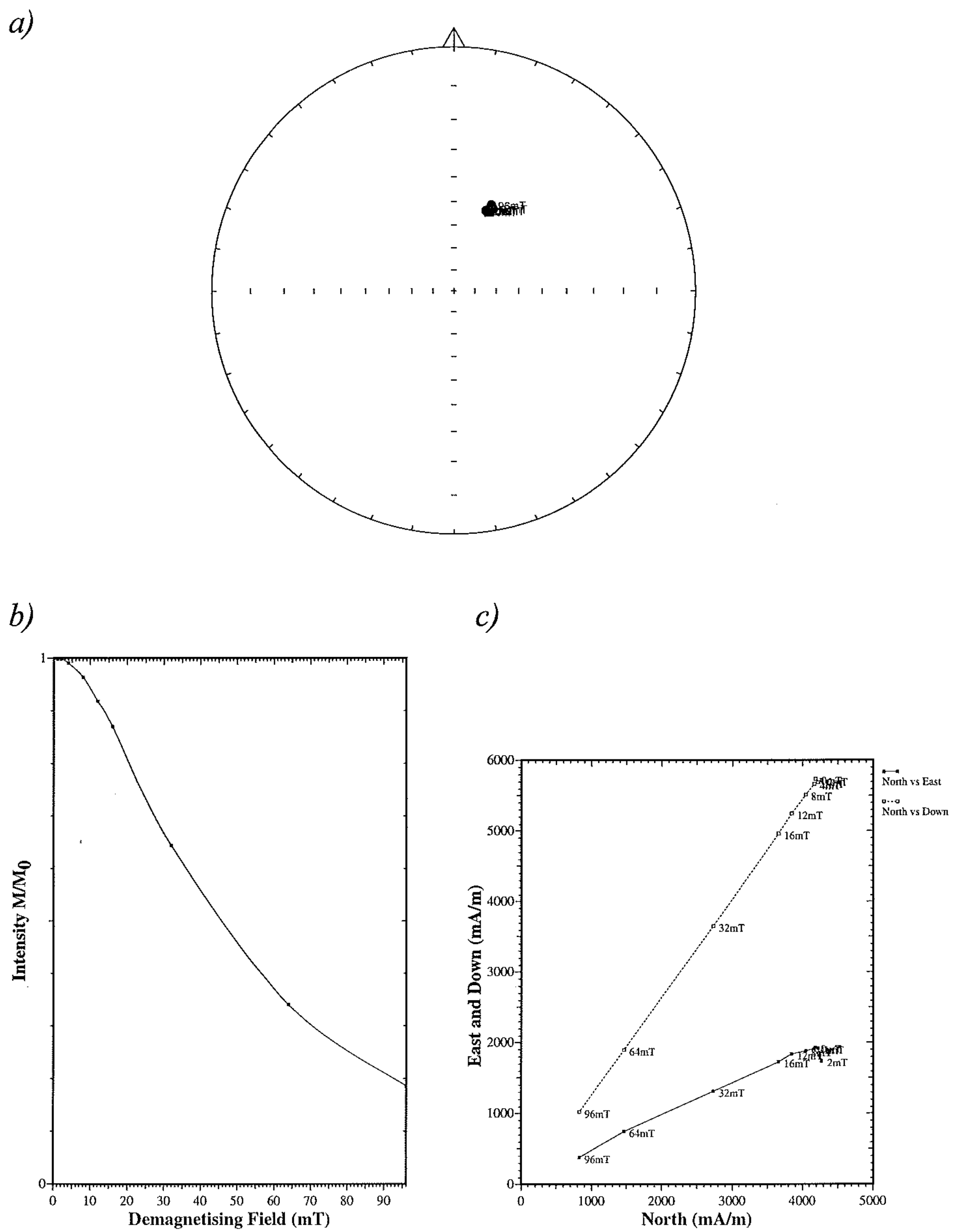

Figure 3: Stepwise AF demagnetisation of sample CH09. Diagram a) depicts the variation of the remanent direction as an equal area stereogram (declination increases clockwise, while inclination increases from zero at the equator to 90 degrees at the centre of the projection); b) shows the normalised change in remanence intensity as a function of the demagnetising field; c) shows the changes in both direction and intensity as a vector endpoint projection.

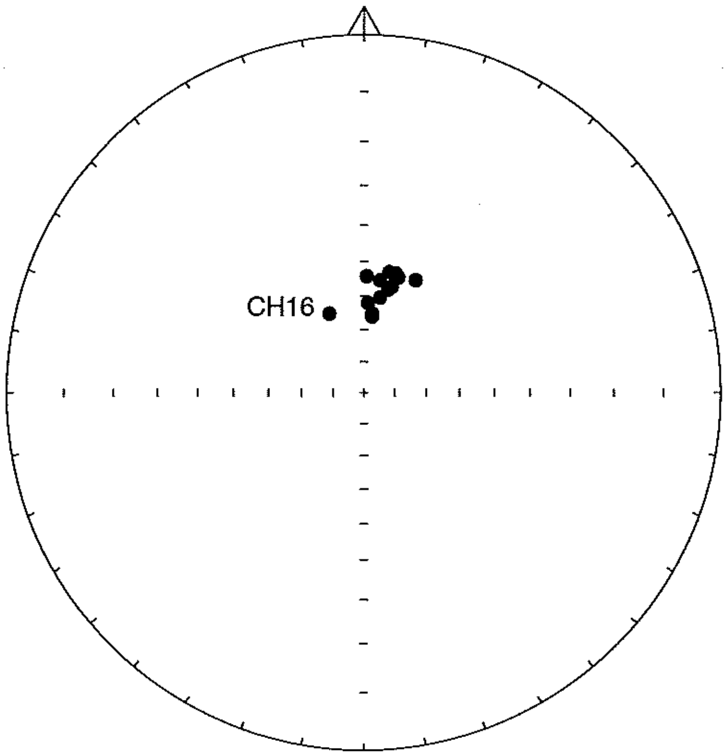

Figure 4: Distribution of remanent magnetisation directions after partial demagnetisation represented as an equal area stereogram. In this projection declination increases clockwise with zero being at 12 o'clock while inclination increases from zero at the equator to 90 degrees in the centre of the projection. Note the outlier, sample CH16, to the left of the main grouping.

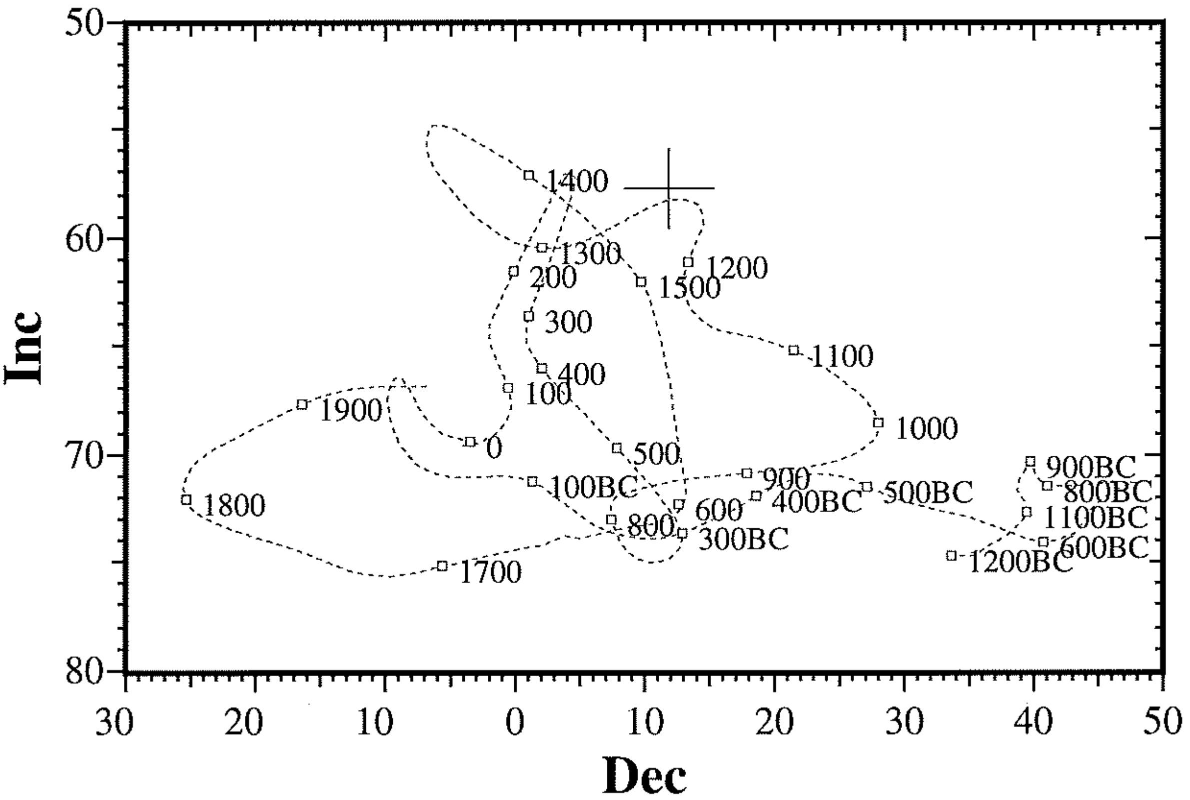

Figure 5: Comparison between the mean thermoremanent vector after thermal demagnetisation and the UK master calibration curve.