Centre for Archaeology Report 97/2002

Ickham Court Farm, Ickham, Kent : Archaeomagnetic Dating Report 2002

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ISSN 1473-9224

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Summary

During an archaeological evaluation by Canterbury Archaeological Trust in advance of a new housing development at Ickham in Kent, the remains of an early medieval sunken featured building were discovered. On the floor of this building, a circular area of the natural brickearth appeared to have been fired to a high temperature, leaving an extremely hard layer several centimetres thick. This may have been a hearth or possibly the base of an industrial feature such as a kiln or furnace. Archaeomagnetic analysis indicated that this surface was well fired and had acquired a stable thermoremanent magnetisation. The date of the last firing of the feature was determined to have occurred within a relatively short period in the early to mid twelfth century AD. This is in agreement with the date range suggested by the local pottery typology of about 1050 to 1125 AD, although the archaeomagnetic date is at the later end of this range.

Keywords

Archaeomagnetism

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ICKHAM COURT FARM, Ickham, Kent:
Archaeomagnetic Dating Report 2002

Introduction

During an archaeological evaluation by Canterbury Archaeological Trust (CAT) in advance of a new housing development at Ickham Court Farm, Ickham near Canterbury in Kent, early medieval remains were discovered (TR 221 581, Longitude 1.2°E, Latitude 51.3°N). The remains included evidence for a sunken featured building (SFB) measuring some 5m by 3m, cut into the brickearth clay that occurs in the locality. On the floor of the SFB, a circular area of the brickearth about 0.6m in diameter appeared to have been fired to a high temperature, leaving an extremely hard layer of purple/brown baked clay several centimetres thick. This may have been a hearth or possibly the base of an industrial feature such as a kiln or furnace, although no evidence for flues or superstructure was immediately apparent. Little evidence was visible of cracking or other any disturbance to the feature since its last firing.

Spot dates for pottery sherds found in association with the building suggested a date of 1050 to 1125 AD and this independent calibration evidence, along with the extremely well fired nature of the clay surface made it an ideal candidate for archaeomagnetic analysis. It was thus sampled for this purpose at the request of Andrew Linklater of CAT on the 17th October 2002 by the author who also performed the subsequent measurement and analysis at the English Heritage Centre for Archaeology (C*f*A).

Method

The surface was given the C*f*A archaeomagnetic feature code ICK. Samples were collected using the disc method (see appendix, section 1a) and orientated to magnetic north using a compass. Subsequently the International Geomagnetic Reference Field (IGRF 2000) was used to establish that magnetic north was 2.3° west of true north at the site on the date when the samples were taken and the sample orientations were corrected accordingly.

Sixteen samples of purple/brown fired clay were collected, a further two samples ICK08 and ICK12 failed to adhere. The relative locations of each sample are depicted in Figure 1.

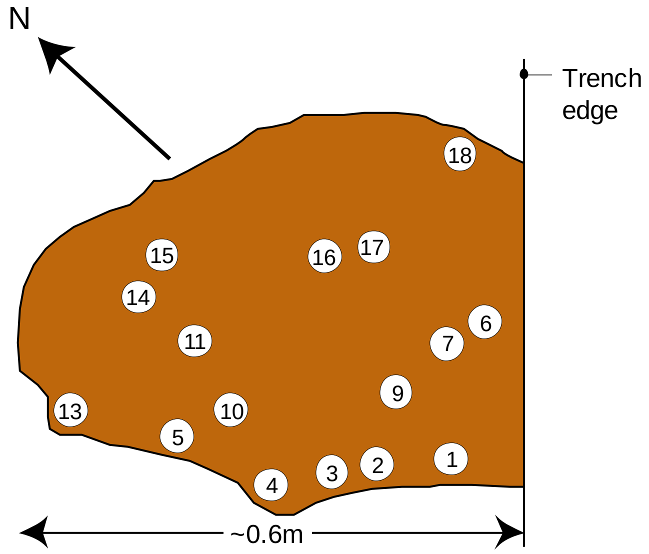

Figure 1; Sketch plan of feature ICK, showing the locations of the individual samples.

The natural remanent magnetisation (NRM) measured in archaeomagnetic samples is assumed to be caused by thermoremanent magnetisation (TRM) created at the time when the feature of which they were part 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.

A typical strategy used in archaeomagnetic analysis of a feature is first to measure the NRM field recorded in all the samples. Then a number of representative samples are selected for pilot partial demagnetisation depending upon their material composition and NRM characteristics. Partial demagnetisation involves exposing the sample to an alternating magnetic field of fixed peak strength then measuring the resulting changes in its magnetisation. This procedure is repeated with increasing peak field strengths to build up a complete picture of the coercivity spectrum of the sample. The equipment used for these measurements is described in section 2 of the appendix.

After inspection of the coercivity spectra of the pilot samples, an optimum field strength is selected where it is judged that the maximum amount of secondary magnetisation has been removed, whilst preserving the majority of the primary magnetisation. The remaining samples are then partially demagnetised using this optimum peak alternating field strength. In some cases the set of samples can be partitioned into groups with different material composition or magnetic characteristics. When this occurs several different field strengths may be used, each one judged to be the optimum for a particular group.

A mean TRM direction is calculated from the sample measurements made after partial demagnetisation at their optimum field strength. Some samples may be excluded from this calculation if their TRM directions are so anomalous as to make them statistical outliers from the overall TRM distribution. A “magnetic refraction” correction is often applied to the sample mean TRM direction to compensate for distortion of the earth’s magnetic field due to the geometry of the magnetic fabric of the feature itself. Then the mean is adjusted according to the location of the feature relative to a notional central point in the UK (Meriden), so that it can be compared with UK archaeomagnetic calibration data to produce a date of last firing for the feature. Notes concerning the mean calculation and subsequent calibration can be found in sections 3 and 4 of the appendix.

This measurement and calibration strategy was applied to the analysis of the samples from Ickham. As the samples were taken from a horizontal surface, a magnetic refraction correction of 2.4^{o} was added to the inclination of the calculated mean TRM direction before calibration (note 3b).

Results

Sample NRM measurements and measurements after partial demagnetisation are recorded in Table 1. Figure 2 depicts the distribution of the sample TRM directions before and after partial demagnetisation. Table 2 records the pilot demagnetisation measurements made on samples ICK03 and ICK09 whilst Figures 3 and 4 illustrate these results graphically.

The maximum stability of the TRM in each pilot sample was estimated using the method of Tarling and Symons (1967). The maximum stability parameters and ranges over which they persist are listed for each sample in Table 3. In this method, any sample with a maximum stability parameter greater than 2 is judged to record a stable TRM direction and a parameter value over 5 suggests extreme stability. The figures in Table 3 indicate that the magnetisations of both pilot demagnetisation samples are extremely stable, with maximum stability occurring between 5 and 10mT. Based upon these statistics and Figures 3 and 4 which indicate a viscous remanent component present in domains with coercivities less than 5mT, it was decided to partially demagnetise the remaining samples in a 7.5mT AF field.

It can be seen from Figure 2b that, after partial demagnetisation, the TRM direction of sample ICK13 has drifted away from the main cluster. The directions of samples ICK01 and ICK18 have also drifted, but to a lesser extent. All three samples came from the edge of the feature and had low intensities of magnetisation, suggesting that they did not experience such high temperatures during the firing of the surface. This would result in them acquiring less stable TRMs, as the most stable magnetic domains (with high unblocking temperatures) would not be realigned. This lack of stability was only considered a serious problem for sample ICK13 and its TRM direction was excluded from the mean TRM calculation below.

The TRM directions of the remaining 15 samples after 7.5mT partial demagnetisation were used to calculate the mean TRM direction for the feature (see note 3):

At site: Dec = 18.2^{o} Inc = 63.0^{o} α_{95} = 1.3^{o} k = 873.7
At Meriden: Dec = 17.9^{o} Inc = 63.5^{o}

Figure 5 shows the comparison of the mean TRM vector with the UK archaeomagnetic calibration curve depicted on a Bauer plot. The estimated date for the last firing of the feature deduced from it is:

1125 AD to 1150 AD at the 63% confidence level.
1115 AD to 1160 AD at the 95% confidence level.

Conclusions

Archaeomagnetic analysis of the fired clay surface from Ickham indicates that it was well fired and had acquired a stable TRM. Furthermore, the scattering of individual magnetisation directions between the samples was minimal and it was thus possible to determine the mean TRM direction to high precision. Hence, the last firing of the feature can be dated to a relatively short period in the early to mid twelfth century AD. This is in agreement with the date range suggested by pottery typology of about 1050 to 1125 AD, although the archaeomagnetic date is at the later end of this range.

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Date of report: 31/10/2002

Archaeomagnetic Date Summary

Archaeomagnetic ID:	**ICK**
Feature:	**Fired brickearth surface on floor of SFB**
Location:	**Longitude 1.2^{o}E, Latitude 51.3^{o}N**
Number of Samples (taken/used in mean):	**16/15**
AF Demagnetisation Applied:	**7.5mT**
Distortion Correction Applied:	**+2.4^o**
Declination (at Meriden):	**18.2^o (17.9^o)**
Inclination (at Meriden):	**63.0^o (63.5^o)**
Alpha-95:	**1.3^o**
k:	**873.7**
Date range (63% confidence):	**1125 to 1150 AD**
Date range (95% confidence):	**1115 to 1160 AD**
Independent date estimate:	**1050 to 1125 AD (pottery typology)**

Sample		NRM Measurements			After Partial Demagnetisation				
	Material	Dec^o	Inc^o	J(mAm^{-1})	AF(mT)	Dec^o	Inc^o	J(mAm^{-1})	R
ICK01	Clay	15.3	62.3	69.1	7.5	13.1	64.3	36.1	
ICK02	Clay	15.8	63.3	131.4	7.5	19.6	61.7	89.8	
ICK03	Clay	22.8	63.8	207.8	7.5	18.7	60.3	152.6	
ICK04	Clay	14.8	61.3	62.1	7.5	17.1	61.1	40.3	
ICK05	Clay	18.1	59.6	81.8	7.5	21.0	60.9	53.8	
ICK06	Clay	19.0	59.9	1841.8	7.5	19.7	59.7	1700.1	
ICK07	Clay	16.3	60.2	1945.5	7.5	17.8	59.8	1841.4	
ICK09	Clay	16.4	59.6	2660.0	7.5	18.1	59.5	2404.9	
ICK10	Clay	18.2	61.2	1755.8	7.5	19.8	59.5	1387.3	
ICK11	Clay	22.5	58.8	4100.0	7.5	20.6	58.8	3744.2	
ICK13	Clay	13.8	63.8	45.4	7.5	-1.7	67.5	23.7	R
ICK14	Clay	14.0	61.2	1187.6	7.5	17.2	58.2	933.6	
ICK15	Clay	17.6	60.7	942.8	7.5	17.9	59.9	793.4	
ICK16	Clay	17.6	59.9	3144.9	7.5	19.8	59.3	2902.1	
ICK17	Clay	20.5	59.7	3967.5	7.5	20.2	58.7	3733.5	
ICK18	Clay	13.8	63.3	39.5	7.5	8.7	67.4	18.7	

Table 1: NRM measurements of samples and measurements after partial AF demagnetisation for feature ICK. J = magnitude of magnetisation vector; AF = peak alternating field strength of demagnetising field; R = sample rejected from mean calculation.

AF(mT)		ICK03			ICK09	
	Dec^o	Inc^o	J(mAm^{-1})	Dec^o	Inc^o	J(mAm^{-1})
0.0	16.4	63.5	207.5	17.7	60.1	2670.7
1.0	18.1	62.5	200.2	17.4	60.0	2652.7
2.5	18.5	61.5	193.4	17.3	59.9	2621.9
5.0	18.9	60.6	176.5	17.9	59.6	2539.9
7.5	18.7	60.3	152.6	18.1	59.5	2404.9
10.0	19.6	60.0	126.4	17.9	59.7	2257.3
15.0	17.4	60.4	83.8	18.6	59.5	1668.8
20.0	15.8	60.9	53.1	18.3	59.3	1004.6
30.0	12.8	62.1	25.1	17.4	59.8	311.2
50.0	12.1	61.1	14.2	2.8	57.3	93.6

Table 2: Incremental partial demagnetisation measurements for samples ICK03 and ICK09.

Sample	Range min. (mT)	Range max. (mT)	Max. Stability	Dec°	Inc°
ICK03	5.0	15.0	19.3	18.7	60.3
ICK09	5.0	10.0	61.1	18.0	59.6

Table 3: Assessment of the range of demagnetisation values over which each sample attained its maximum directional stability for feature ICK, using the method of Tarling and Symons (1967). The declination and inclination values quoted are for the mean TRM direction for the sample calculated for all demagnetisation measurements in its range of maximum stability.

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 applied, where appropriate, to measured inclinations, in keeping with the practise of Clark, Tarling and Noel (1988).

c) 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 $\boldsymbol{\alpha_{95}}$, "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.

d) For the purposes of comparison with standardised UK calibration data, 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).

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 63% and 95% confidence levels. 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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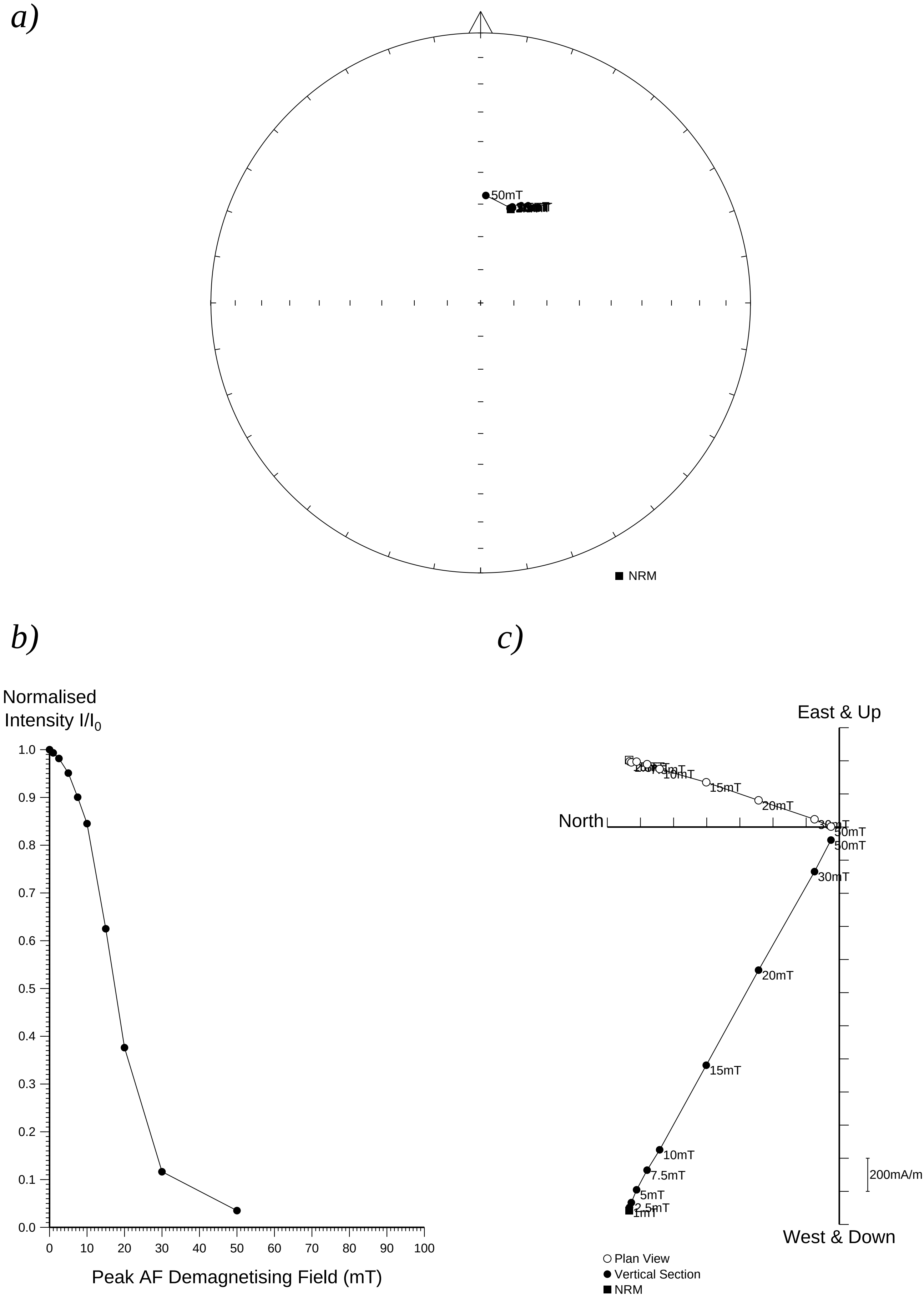


Figure 4: Stepwise AF demagnetisation of sample ICK09. Diagram a) depicts the variation of the remanent direction as an equal area stereogram (declination increases clockwise, while inclination increases from zero at the equator to 90 degrees at the centre of the projection); b) shows the normalised 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.

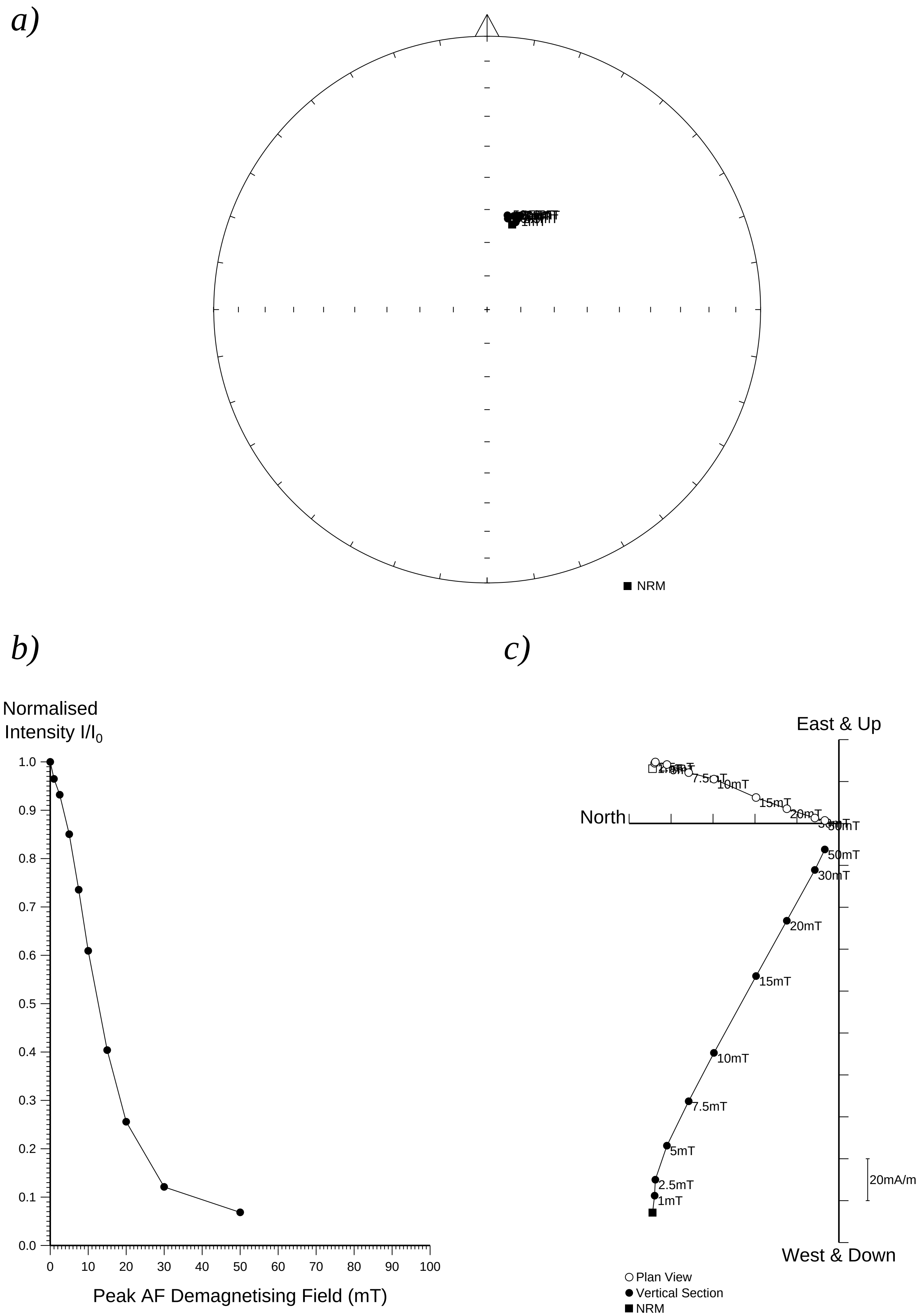
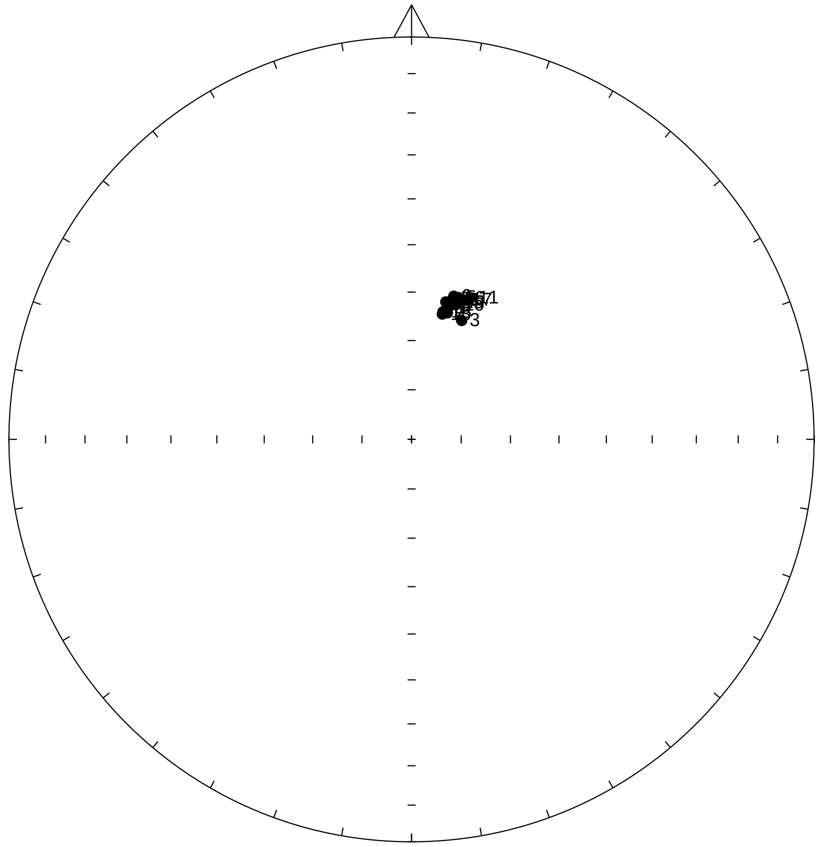


Figure 3: Stepwise AF demagnetisation of sample ICK03. Diagram a) depicts the variation of the remanent direction as an equal area stereogram (declination increases clockwise, while inclination increases from zero at the equator to 90 degrees at the centre of the projection); b) shows the normalised 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.

a)



b)

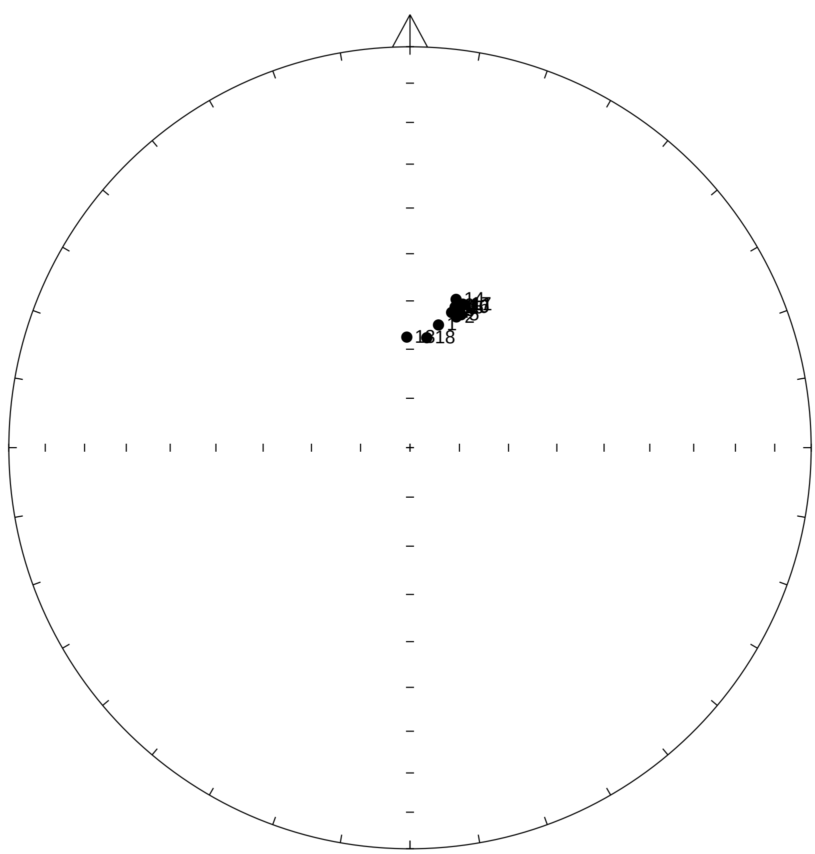


Figure 2: a) Distribution of NRM directions of samples from feature ICK represented as an equal area stereogram. In this projection declination increases clockwise with zero being at 12 o'clock while inclination increases from zero at the equator to 90 degrees in the centre of the projection. Open circles represent negative inclinations. b) Distribution of thermoremanent directions of magnetisation of the same samples after partial AF demagnetisation to 7.5mT.

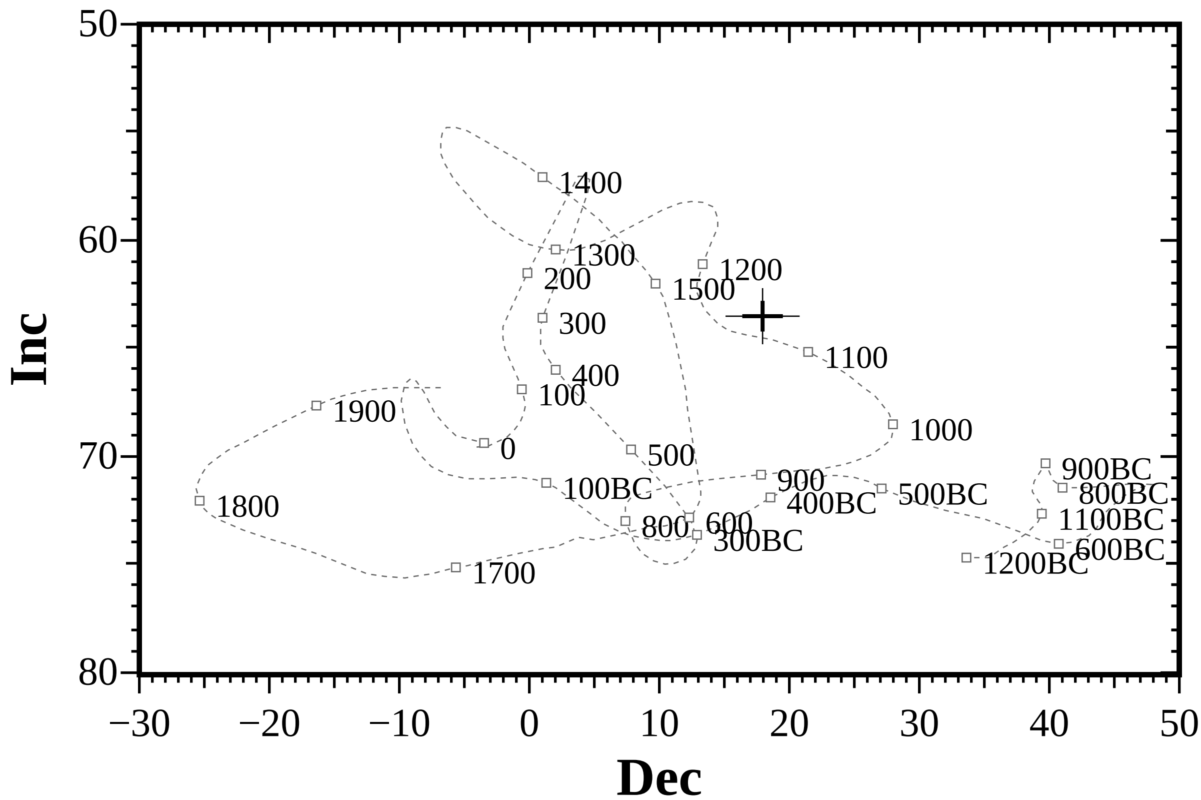


Figure 5: Comparison of the mean thermoremanent vector calculated from samples 01-07, 09-11 and 14-18 from feature ICK after 7.5mT partial demagnetisation with the UK master calibration curve. Thick error bar lines represent 63% confidence limits and narrow lines 95% confidence limits.