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SIMPSON'S MALT, PONTEFRACT, WEST YORKSHIRE
SCIENTIFIC DATING OF A POTTERY KILN

SCIENTIFIC DATING REPORT

David Greenwood, Cathy Batt, Chris Bronk Ramsey, Gordon Cook, John Meadows and Ian Roberts

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SUMMARY

A pottery kiln was excavated at Simpson's Malt, Pontefract, by Archaeological Services WYAS, in February 2008. The pottery kiln was well-preserved and showed no obvious signs of post-firing disturbance, making it an ideal candidate for archaeomagnetic investigation. Forty oriented archaeomagnetic samples were taken from two areas of the kiln and analysed at the University of Bradford. Samples from the kiln wall lining were magnetically poorly stable and could not be dated with confidence. The most likely cause of this is insufficient heating when the kiln was fired. Samples from the base of the pottery kiln had been heated to a sufficient temperature to produce a record of magnetic direction, and that magnetisation had remained stable and was consistent with last firing in AD 538–1014. Radiocarbon dating of six short-lived charcoal samples from three contexts associated with the use of the kiln indicated a final firing in *cal AD 990–1050 (95% probability)*. Both techniques produced dates earlier than those expected on archaeological grounds.

CONTRIBUTORS

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ARCHIVE LOCATION

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DATE OF INVESTIGATION

2008–10

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CONTENTS

INTRODUCTION

Simpson's Malt, Pontefract (SE 4622 2284) was excavated in 2008 in advance of a housing development. The site of the former malt house lies on the north side of Ferrybridge Road, just north of the Scheduled Area of Pontefract Priory (Fig 1). Whilst the site does not cover any part of the monastic precinct, the western part does cover the eastern extremity of what was the separate township of Monkhill, a small detached hamlet established by the monks. Excavations in the eastern part of the site identified a number of medieval rock-cut features, mainly pits and ditches, which may be equated with the medieval township.

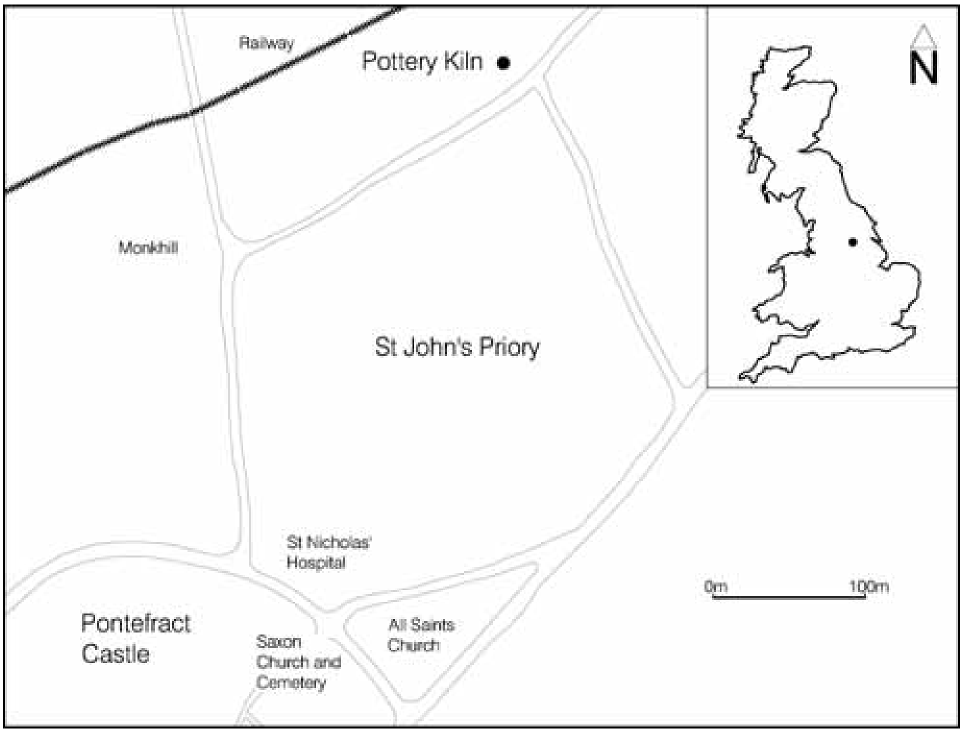

Figure 1. Location of the Simpson's Malt kiln, Pontefract, West Yorkshire (Archaeological Services WYAS)

In the western part of the site, beyond the supposed area of Monkhill, a well-preserved pottery kiln was found, in which Stamford-type pottery was produced (Figs 2–4). It was previously thought that Stamford-type pottery was only made in Stamford itself, where Stamford wares were manufactured between *c* AD 850–1250. From associations with other pottery in features at the Simpson's Malt site, and material from the priory site, it was supposed that the kiln was in operation in the twelfth century AD (Roberts and Cumberpatch 2009).

Figure 2. The kiln under excavation

Figure 3. Charcoal and pottery found in-situ on the heat-affected kiln base

Figure 4. Detail of the kiln wall, showing the secondary lining

Two sets of oriented archaeomagnetic samples were taken from this well-preserved fired feature during excavations. This report archives technical details of their measurements (Appendices 1 and 2). The objectives of the archaeomagnetic investigation were:

- to determine whether the material had been heated *in situ* to a high enough temperature to record the geomagnetic field.
- to provide a date of last use of the feature.

Concurrently, six radiocarbon samples of charcoal from the fills of the kiln were dated by Accelerator Mass Spectrometry (AMS), to refine the archaeomagnetic date and provide additional archaeomagnetic calibration data. Wood identification was carried out by Diane Alldritt on five samples recovered from the kiln floor and from soil samples from the stoking pit deposits (Alldritt 2009 unpubl). These produced a good range of generally well-preserved wood charcoal, but no other types of carbonised plant material were recovered and it is concluded that wood charcoal, of various types, was the main source of fuel for the pottery kiln. The number of different wood types found suggests exploitation of local woodland and scrub environments, without discrimination towards a particular type, indicating the use of whatever was available in the immediate vicinity of the site. In particular, the finding of alder charcoal with bark still attached strongly suggested a wood charcoal fuel resource being manufactured very close to the kiln site.

ARCHAEOMAGNETIC SAMPLING

Forty *in-situ* samples were taken from cleaned horizontal surfaces within the kiln structure, as follows:

- Kiln base (Fig 5): 20 samples (SML07-01 to SML07-20) from a freshly exposed section of firm, but moist, heat-affected clay with no evidence for bioturbation, using the tube method (English Heritage 2006).
- Kiln wall (Fig 6): 20 samples (SML07-21 to SML07-40) from a freshly exposed section of extremely hard heat-affected blackened clay, approximately 50mm thick, using the button method (English Heritage 2006).

All of the samples were north-oriented using a magnetic compass, and there appeared to be no local disturbances to the geomagnetic field caused by the feature itself or other factors.

Figure 5. Cleaned heat-affected basal layer of kiln

Figure 6. Archaeomagnetic sampling of the kiln wall lining

ARCHAEOMAGNETIC MEASUREMENTS

The direction of natural remanent magnetisation (NRM) of all samples was measured using a Molspin fluxgate spinner magnetometer at the University of Bradford. The results are presented below (Table 1)and further details of the methodology can be found in Appendix 1. The stability of the magnetisation was investigated by the stepwise demagnetisation of four pilot samples from each of the two groups (base and wall), in fields of 2.5, 5, 7.5, 10, 12.5, 15, 20, 30, 40, 50, 60, 80, and 100mT (peak applied field), with the magnetisation being measured after each step. These pilot samples were chosen for three reasons:

- their declination and inclination values represented a spread of magnetic directions exhibited by all the samples in that particular set.
- their initial magnetic strengths were sufficiently high to obtain meaningful results.
- the pilot samples were spread physically over each of the areas under investigation.

ARCHAEOMAGNETIC RESULTS

The detailed results of the analyses of these two sample sets are given in Appendix 1 (wall lining) and Appendix 2 (basal layer). A summary is given in Table 1.

Table 1: summarising the results from the direction of remanent magnetisation (NRM) and the characteristic remanent magnetisation (ChRM) after removal of the less stable component. These values have been corrected to Meriden

Sample	Number of samples	Mean Declination	Mean Inclination	α_{95}	Mean Intensity	Stability Index
Units		degrees	degrees		$\times 10^{-6}$ Am^2kg^{-1}	
Kiln base						
NRM	20	25.8	63.5	7.7	15.3	n/a
ChRM	15	11.4	71.5	4.8	10.6	9.47
Kiln wall						
NRM	19	16.8	68.0	12.7	1.5	n/a
ChRM	-	-	-	-	-	-

Basal samples (SML07-01 to SML07-20)

Twenty samples were analysed from this part of the feature. The intensity of NRM varied between 0.5 and 57 $\times 10^{-6}$ Am^2kg^{-1}, which is sufficiently strong to be measurable. For fired clay from domestic hearths values typically range between 10 and 200 $\times 10^{-6}$ Am^2kg^{-1} so the strength of the magnetisation is consistent with this surface being exposed to heat in the past. There were no systematic differences observed between the intensities of the materials within the feature.

The initial directions of magnetisation were fairly scattered, providing an alpha-95 of 7.7°, which is outside the limit of 5° defined by Clark *et al* (1988, 606) as being appropriate for dating. Four representative samples were selected for pilot stepwise demagnetisation, as detailed above.

The samples showed consistent behaviour on demagnetisation, with a median destructive field of 10 to 15mT. This indicates that the main magnetic mineral is likely to be magnetite and shows no variation in mineralogy across the feature. The assessment of the pilot samples indicated that each sample had two magnetic components, and the unstable component was removed at 10mT, leaving a component classed as 'stable' using the criteria set by Tarling and Symons (1967). Therefore any unstable component could be removed from the other samples using a field of 10mT. Once this magnetic cleaning has been performed the characteristic remanence (ChRM) had an alpha-95 of 9.4°. The samples were then assessed to determine if they were all recording the same heating event (Appendix 2).

Five samples were identified as deviating significantly from the rest of the samples using the statistical procedures recommended by McFadden and McElhinny (2000, 92). An alpha-95 of 4.8° was obtained from the remaining group, within the limit for dating.

Wall lining (SML07-21 to SML07-40)

Nineteen samples were analysed from this part of the feature; one sample became detached from its button (SML07-33). The intensity of NRM was low (0.3–8.8 $\times 10^{-6}$ Am^2kg^{-1}), but measurable. The direction of NRM varied considerably across the area, with an alpha-95 of 12.7°; possibly reflecting inhomogeneous firing or cooling cycles and/or varying concentrations of remanence-carrying minerals.

Study of the demagnetisation behaviour of the pilot samples showed that the samples removed from the section of kiln wall had stability indices below 2.5, indicative of poorly stable magnetic remanence (Tarling and Symons 1967, 446). This suggested that they did not retain a stable record of the geomagnetic field, and were therefore not suitable for archaeomagnetic dating (Appendix 1). The intensity spectra varied in shape, suggesting a variety of magnetic minerals were present. These samples were not analysed further.

DATING OF MAGNETIC DIRECTION

The mean declination and inclination of the basal layer samples after demagnetisation were corrected to Meriden, the reference locality for the British calibration curve using the standard method (Noel and Batt 1990). The corrected mean direction was then compared to calibration dataset for Britain using the RenDate calibration programme (Lanos *et al* 2005). The RenDate software is an improvement on the previous British calibration curve (Clark *et al* 1988; Zananiri *et al* 2007) because it takes into account the errors associated both with the magnetic direction of the samples being calibrated and the magnetic directions that make up the reference data, whereas the Clark curve only considered the errors associated with the samples being dated and required a visual interpretation of the direction against the calibration curve. Therefore, calibration using the RenDate software provides a larger but more realistic date range.

Calibration with RenDate provides a best estimate age of last heating with a 95% confidence interval (Fig 7). The magnetic field obtained from the samples was consistent with the magnetic field between 1000–303 BC; AD 538–1014; and AD 1613–1834. In archaeomagnetic dating it is often necessary to give multiple probable date ranges, as the earth's magnetic field has had the same direction at different times in the past. However, the available archaeological evidence is usually sufficient to select the most probable range. In this case, the archaeological evidence suggests that the most likely date range is AD 538–1014 (Table 2). The compacted layer of pottery wasters sealing the basal layer indicates that there has been no redeposition or disturbance since the last heating event and the magnetic analysis of the material suggests that it was heated to sufficient temperature to reset the magnetisation associated with its geological origin.

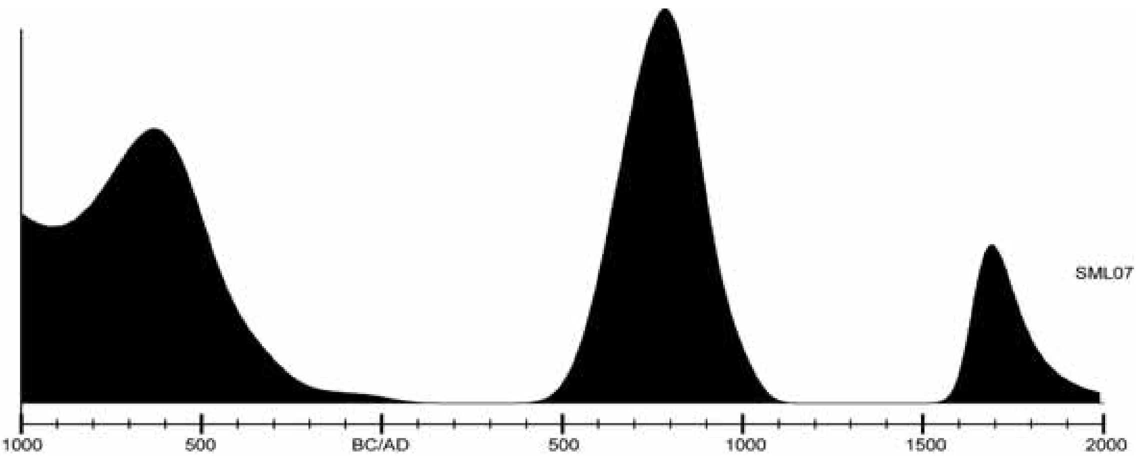

Figure 7. Probability distribution for the archaeomagnetic date of last firing, SML07 produced using RenDate v1.0.0.4b (Lanos et al *2005) and the Zananiri* et al *(2007) calibration data, which cover the period between 1000 BC and AD 2000*

Table 2: Archaeomagnetic dating summary

Archaeomagnetic ID:	SML07: 1–20	SML07: 21–40
Feature:	Pottery kiln base: Context 4232	Pottery kiln wall lining: Context 4243
Location – latitude:	53.70	53.70
Location – longitude;	-1.29	-1.29
Magnetic deviation:	-2.78	-2.78
Number of samples (taken/used in mean):	20/15	20/19
AF demagnetisation applied:	Yes	Yes
Distortion correction applied:	No	No
Declination (at Meriden):	11.4	16.8
Inclination (at Meriden):	71.5	68.0
Alpha-95:	4.8	12.7
Date range (95% confidence):	AD 538–1014	Undatable
Archaeological date range:	Early Medieval	Early Medieval

RADIOCARBON DATING

Charcoal from four contexts appeared to be functionally associated with the use of the kiln. These included Context 4038, a primary deposit in the stoking pit, and Contexts 4232 and 4239, primary deposits within the kiln itself (west and east, respectively, of the central partition). These three deposits were stratigraphically contemporary. It is assumed that this charcoal was spent fuel, left *in situ* after the last firing of the kiln, and freshly-felled wood fragments with negligible intrinsic age should therefore be very close in date to the last firing. A fourth context, 4244, was a charcoal deposit sealed within unfired clay between the vitrified primary and secondary surfaces, and was thus thought to represent an earlier rake-out of spent fuel (Fig 8).

Two identified charcoal fragments from each context were submitted for dating by Accelerator Mass Spectrometry (AMS). Two samples, both from Context 4244, were too small to date. The results for the other six samples are given in Table 3.

Table 3: radiocarbon results from the Simpson's Malt Kiln

Laboratory number	Sample	Material dated	$\delta^{13}C$ (‰)	Radiocarbon age (BP)	Calendar date (95% confidence)
SUERC-22828	4038A	charcoal, *Corylus*	-27.6	1020 ±30	cal AD 970–1040
OxA-20352	4038B	charcoal, *Betula*	-25.0	1006 ±24	cal AD 990–1030
OxA-20353			-25.0	1027 ±24	
4038B mean				1017 ±17	
SUERC-22829	4232A	charcoal, *Corylus*	-27.7	1035 ±30	cal AD 900–1030
OxA-20354	4232B	charcoal, *Alnus*	-26.9	1067 ±24	cal AD 895–1020
SUERC-22830	4239A	charcoal, *Salix/Populus*	-28.5	1010 ±30	cal AD 980–1120
OxA-20355	4239B	charcoal, *Corylus*	-27.3	997 ±23	cal AD 990–1120

The samples were dated at the Scottish Universities Environmental Research Centre in East Kilbride (SUERC; technical procedures are described by Vandenputte *et al* (1996), Slota *et al* (1987), and Xu *et al* (2004)), or at the Oxford Radiocarbon Accelerator Unit at Oxford University (OxA; laboratory methods are given by Brock *et al* (2010) and Bronk Ramsey *et al* (2004)). Internal quality assurance procedures at both laboratories and international inter-comparisons (Scott 2003) indicate no laboratory offsets, and validate the measurement precision quoted. OxA-20352 and OxA-20353 are independent replicate measurements of the same charcoal fragment. The results are statistically consistent, following the method of Ward and Wilson (1978; $T'=0.4$, $T'(5\%)=3.8$, $\nu = 1$), and their weighted mean, 1017 ±17BP, is therefore the best estimate of this sample's radiocarbon age. This value has been used in calibration and subsequent discussion, rather than the individual measurements.

The results reported are conventional radiocarbon ages (Stuiver and Polach 1977). The calibrated date ranges given in Table 3 have been calculated by the maximum intercept method (Stuiver and Reimer 1986), using the program OxCal v4.1 (Bronk Ramsey 1995; 1998; 2001; 2009) and the IntCal09 data set (Reimer *et al* 2009), and are quoted in the form recommended by Mook (1986), with date ranges rounded outwards to decadal endpoints, or to 5 years where the radiocarbon error is less than ±25. The probability distributions of the calibrated dates (Fig 9) have been calculated using the probability method (Stuiver and Reimer 1993), and the same calibration data.

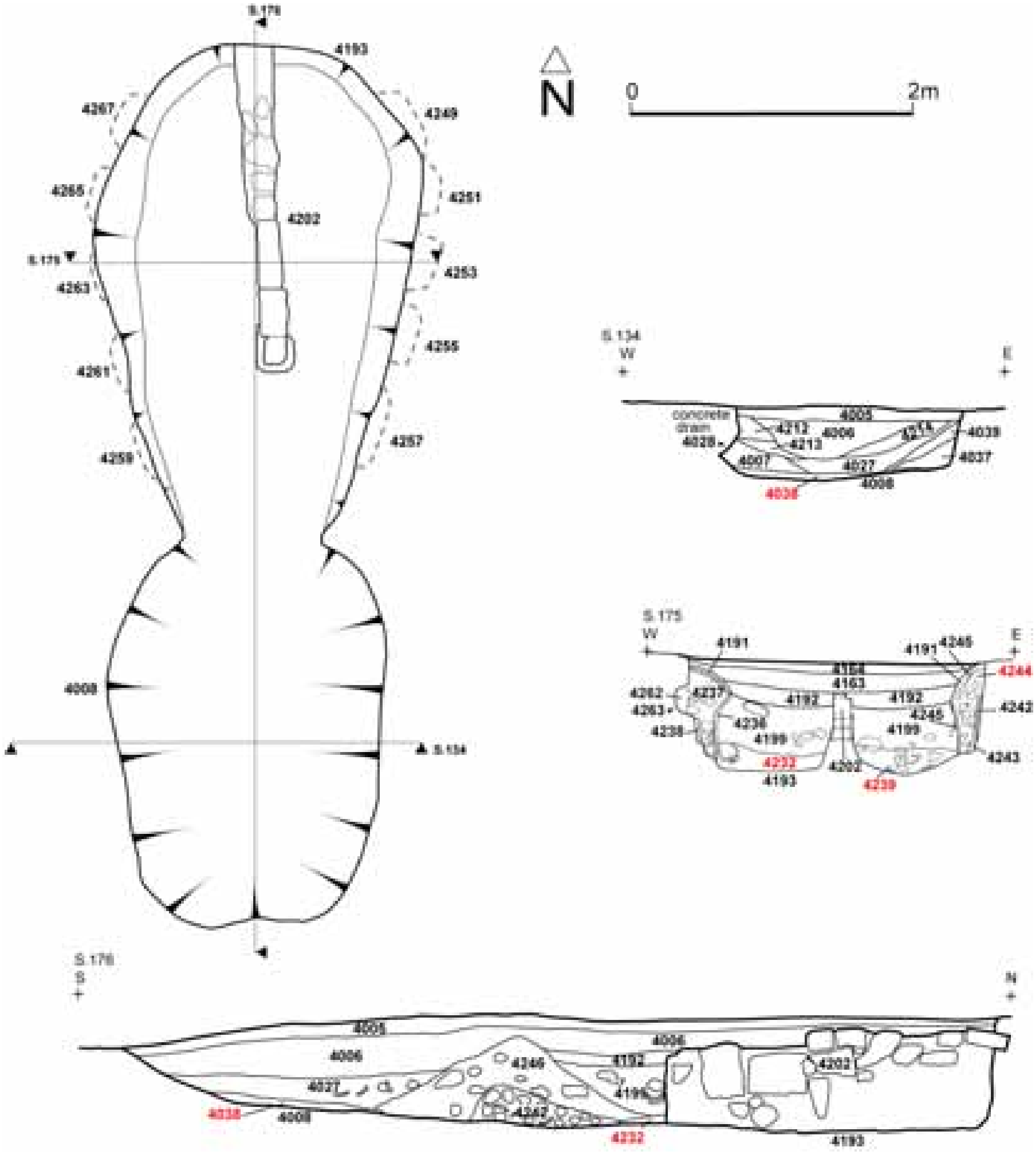

Figure 8. Plan and sections of the kiln, Simpson's Malt, Pontefract (Archaeological Services WYAS). Contexts from which radiocarbon samples were selected are indicated in red

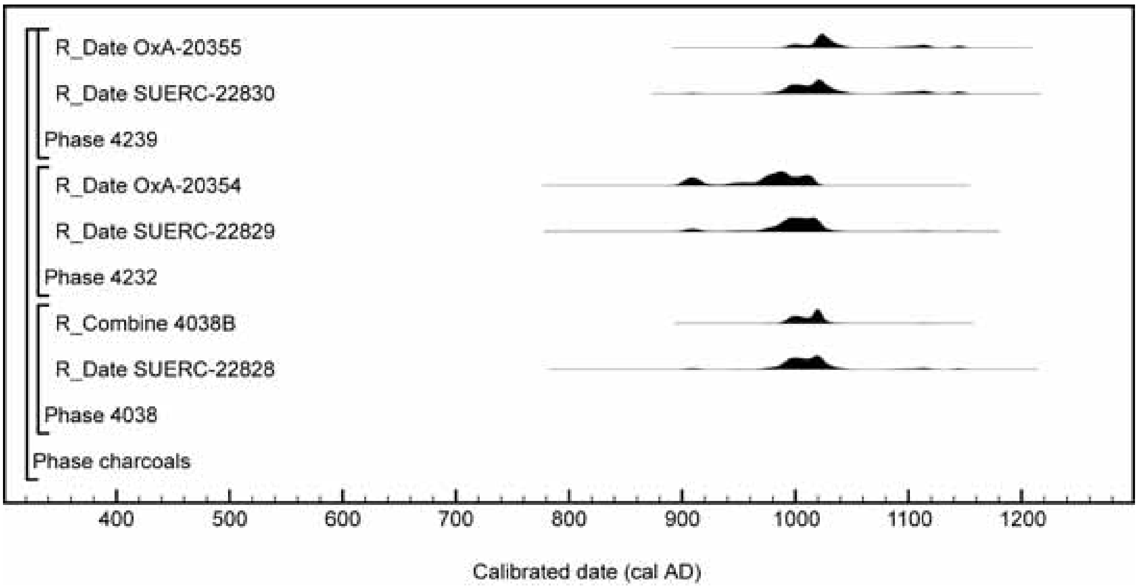

Figure 9: calibration of radiocarbon results by the probability method (Stuiver and Reimer 1993)

There is no indication in the radiocarbon results that any sample must be residual or intrusive. In each instance, the pairs of samples from individual contexts gave results that are statistically consistent with a single radiocarbon age (T' <3.8, ν=1; Ward and Wilson 1978). The value of T', the test statistic, is

Context	Sample	Radiocarbon age (BP)	T'
4038	SUERC-22828	1020 ±30	0.0
	4038B mean	1017 ±17	
4232	SUERC-22829	1035 ±30	0.7
	OxA-20354	1067 ±24	
4239	SUERC-22830	1010 ±30	0.1
	OxA-20355	997 ±23	

It is even possible that all six dated samples are of the same date (T'=5.1, T'(5%)=11.1, ν=5; Ward and Wilson 1978). The consistency of the radiocarbon results supports the archaeological interpretation that these charcoal fragments are derived from the last firing of the kiln.

DISCUSSION

In order to compare the radiocarbon results to the archaeomagnetic date, we need to estimate the date of the final firing from the radiocarbon results, using Bayesian chronological modelling (Buck *et al* 1996). The model shown in Figure 10, implemented in OxCal v4.1, groups all the radiocarbon results into a single phase, and calculates a firing date, based on the scatter of the calibrated dates. The bounded phase model used here assumes that the radiocarbon samples represent calendar dates evenly scattered over a single, continuous period of time (Bronk Ramsey 2000), which could, nevertheless, have been very brief; it is more conservative (and realistic) than an assumption that all six samples must be of the *same* calendar date.

The spread of the calibrated dates allows the model to calculate probability distributions for the dates of the start and end of this phase, which are shown as 'boundaries' in Figure 10, and *posterior density estimates* of the dates of the individual radiocarbon samples. One other distribution, *kiln firing*, has been calculated. This is a posterior density estimate of the date of an event later than all the radiocarbon samples (which must predate their burning in the kiln) and before the boundary *after kiln abandonment*. The posterior density estimate for *kiln firing* is *cal AD 990–1050 (95% probability)* or *cal AD 1000–1040 (68% probability)*, after rounding outwards to decadal endpoints. The italics are used to emphasise that a posterior density estimate is a modelled date, which will change if components of the model (eg the number of radiocarbon results or the relative dates of the samples) are altered. This estimate overlaps with the archaeomagnetic date range for the final firing (AD 538–1014).

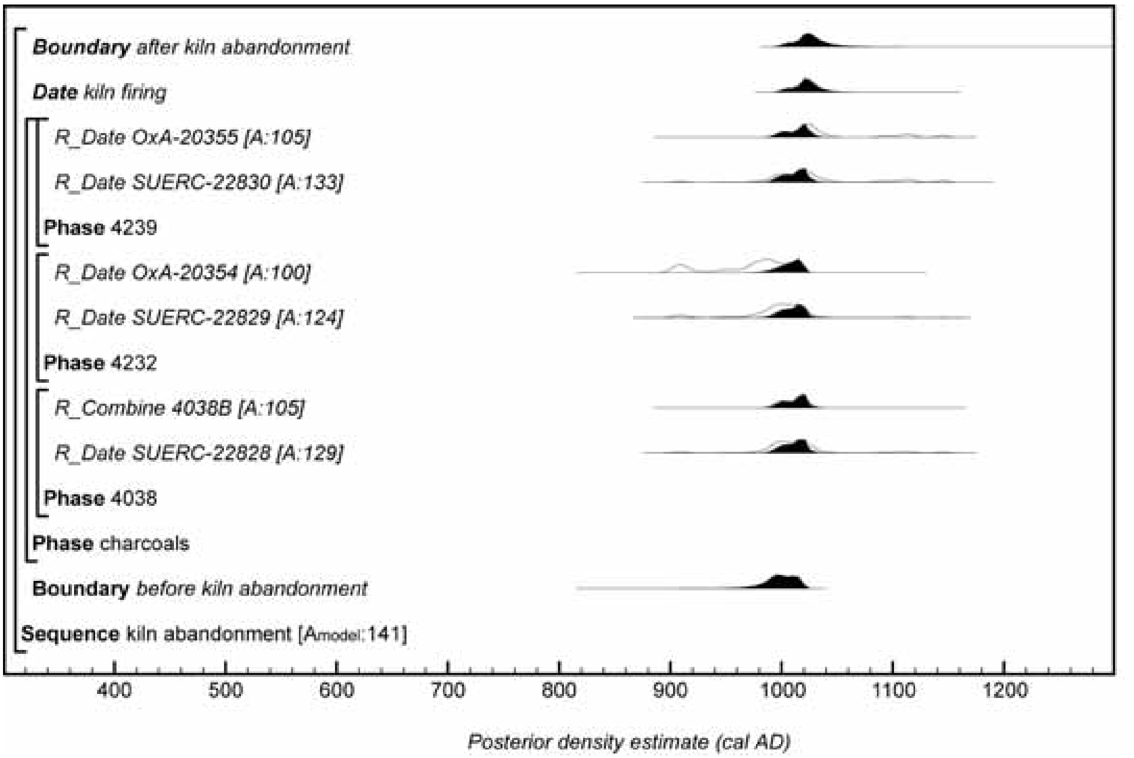

*Figure 10: a Bayesian model of the Simpson's Malt radiocarbon results, implemented using OxCal v4.1 (Bronk Ramsey 2009). Distributions in outline are simple calibrations of radiocarbon results by the probability method, as shown in Figure 9. The solid distributions are posterior density estimates of the dates of samples and events. The square brackets and OxCal keywords (in **bold**) define the model structure precisely. The satisfactory index of agreement (A_{model} >60) indicates that the results are consistent with the relative dating implicit in the model structure*

An alternative approach is to include both the calibrated radiocarbon results and the archaeomagnetic date distribution in a Bayesian model, as the two methods are complementary and independent sources of information about the final firing date. This can be done by importing the probability distribution of the archaeomagnetic date generated in RenDate (Fig 7) into an OxCal model (*Prior last firing*, Fig 11), instead of calculating the final firing date from the scatter of radiocarbon dates alone (*Date kiln firing*, Fig 10). Although the overall index of agreement remains satisfactory (A_{model}=70.5, Fig 11), the individual index for the archaeomagnetic date distribution (*Prior last firing*) is relatively poor (A=18.4), suggesting a small discrepancy between the archaeomagnetic date distribution and its position in this model (in which it is required to be more recent than all the radiocarbon samples). The posterior density estimate for the archaeomagnetic date (*last firing*, Fig 11) is *cal AD 990–1040 (95% probability)* or *cal AD 1000–1030 (68% probability)*, after rounding outwards to decadal endpoints.

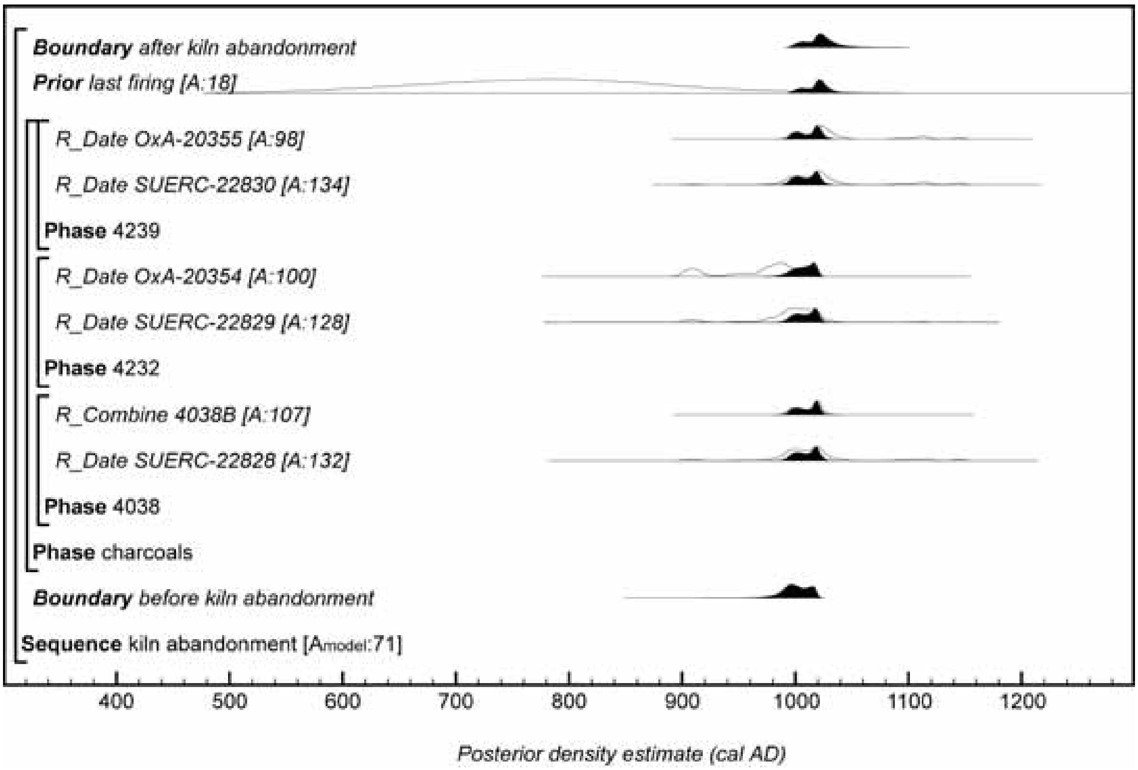

Figure 11. A Bayesian model of all the Simpson's Malt scientific dating results, implemented in OxCal v4.1 (Bronk Ramsey 2009). The format is the same as that used in Figure 10. The outline distribution for Prior last firing *is identical to the archaeomagnetic date distribution calculated in RenDate and shown in Fig 7, but for clarity only the early medieval region of the distribution is shown here*

The charcoal samples must predate their inclusion in the burnt layers sealed by the collapsed kiln fabric (front cover; Figs 4, 8), and it is unlikely that they would have given such consistent radiocarbon results, had the charcoal deposits included intrusive material, so the date of *kiln firing* (Fig 10) based on radiocarbon evidence is credible. On the other hand, although the archaeomagnetic calibration curve is poorly defined between AD 300 and AD 900, due to a lack of data from well-dated material and (probably) to very slow movement of the geomagnetic field in this period, it is well-defined and distinctive from AD 1000 onwards, and the Simpson's Malt data do not match the curve after AD 1014. As both techniques appear to date the final firing, it seems that this must have occurred at the very beginning of the eleventh century cal AD.

CONCLUSIONS

Two sets of oriented archaeomagnetic samples were recovered from the pottery kiln at Simpson's Malt, Pontefract. The samples from the wall lining were discovered to be poorly magnetically stable and therefore could not be archaeomagnetically dated, but the sample set from the basal lining of the kiln showed evidence of having been heated above the Curie temperature and remaining *in situ* since the last firing event. Although the appearance of the basal layer showed some colour changes in the heat-affected material, the directions recorded were reasonably well-grouped, suggesting that all parts of the basal layer sampled recorded the same event and provided a record of the earth's geomagnetic field at the time of last cooling. The magnetic direction of this sample set is consistent with last cooling in AD 538–1014. The broad date range at 95% confidence is a reflection of the slow movement of the geomagnetic field for this period and large uncertainties in the calibration dataset, arising from a lack of well-dated reference points.

Even the later part of the date range is earlier than that indicated by the pottery assemblage, but the magnetic field is very distinctive after AD 1000 and is not consistent with the magnetic results obtained. The archaeomagnetic results therefore indicate an earlier date than that suggested by the pottery assemblage. The radiocarbon results point to an early eleventh-century cal AD date for the last firing, still significantly earlier than expected on archaeological grounds, but perhaps slightly later than the archaeomagnetic results would imply.

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APPENDIX 1: DETAILED MEASUREMENTS AND STATISTICAL ANALYSES OF THE WALL LINING

Site information

Site name:	Simpson's Malt, Pontefract
Feature:	Pottery kiln wall lining
Context number:	4243
Description:	Freshly exposed heat-affected wall lining
Latitude (+ve N):	53.70
Longitude (+ve E):	-1.29
Date Sampled:	5 Feb 2008
Magnetic Variation on date sampled (+ve E):	-2.78

Magnetic measurements of NRM

Sample no.	Dec	Inc	x	y	z
SML07-21	14.3	58.9	0.5005	0.1276	0.8563
SML07-22	343.3	36.6	0.7690	-0.2307	0.5962
SML07-23	180.8	67.1	-0.3891	-0.0054	0.9212
SML07-24	56.5	79.4	0.1015	0.1534	0.9829
SML07-25	32.0	35.3	0.6921	0.4325	0.5779
SML07-26	29.2	33.5	0.7279	0.4068	0.5519
SML07-27	101.7	67.8	-0.0766	0.3700	0.9259
SML07-28	103.6	53.4	-0.1402	0.5795	0.8028
SML07-29	29.3	51.4	0.5441	0.3053	0.7815
SML07-30	24.7	36.4	0.7313	0.3363	0.5934
SML07-31	359.2	63.9	0.4399	-0.0061	0.8980
SML07-32	228.4	58.7	-0.3449	-0.3885	0.8545
SML07-34	9.4	71.0	0.3212	0.0532	0.9455
SML07-35	5.8	56.8	0.5448	0.0553	0.8368
SML07-36	210.7	65.5	-0.3566	-0.2117	0.9100
SML07-37	25.9	77.9	0.1886	0.0916	0.9778
SML07-38	13.7	56.3	0.5391	0.1314	0.8320
SML07-39	358.0	74.1	0.2738	-0.0096	0.9617
SML07-40	347.6	53.5	0.5809	-0.1277	0.8039

Number	19
Sum x	5.65
Sum y	2.06
Sum z	15.61
R	16.73
x bar	0.34
y bar	0.12
z bar	0.93
Mean Dec	20.07
Mean Inc	68.94
Alpha95	12.73

Corrections

Mean Dec	20.07
Mean Inc	68.94

Correction for magnetic variation

Mean Dec	17.29
Mean Inc	68.94

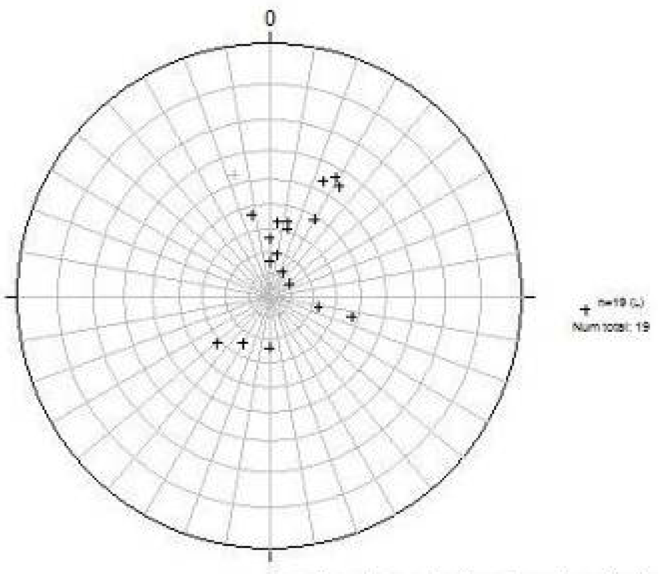
Correction to Meriden (CVP)

Uncorrected Dec	17.29
Uncorrected Inc	68.94
Latitude	53.70
Longitude	-1.29
Kai	37.61
Latitude of pole	79.55
Beta1	89.81
Longitude of pole	88.90
Geomag colat	38.88
Corrected Inc	68.04
Beta 2	89.48
Corrected Dec	16.79

Final Result

Corrected Dec	16.79
Corrected Inc	68.04
Alpha95	12.73

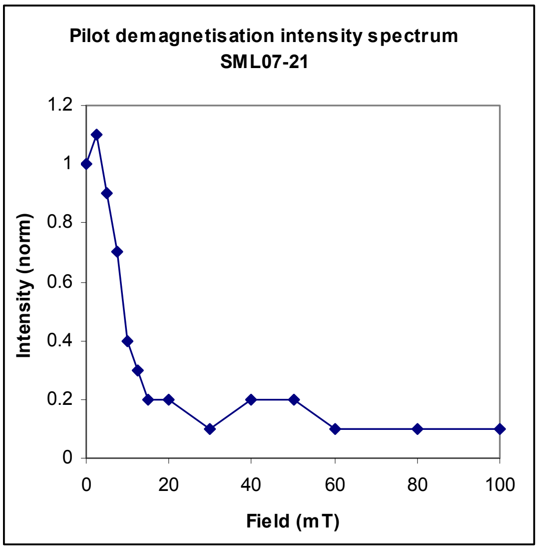
Stereoplot of NRM directions

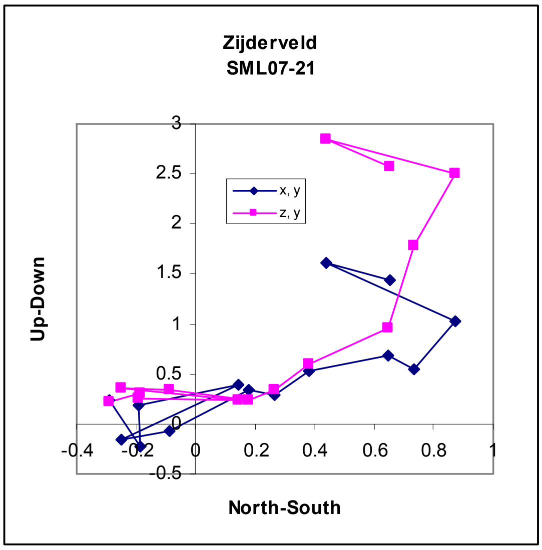


Pilot demagnetisation measurements, intensity spectra, and Zijderveld plots

Pilot demagnetisation sample number SML07-21

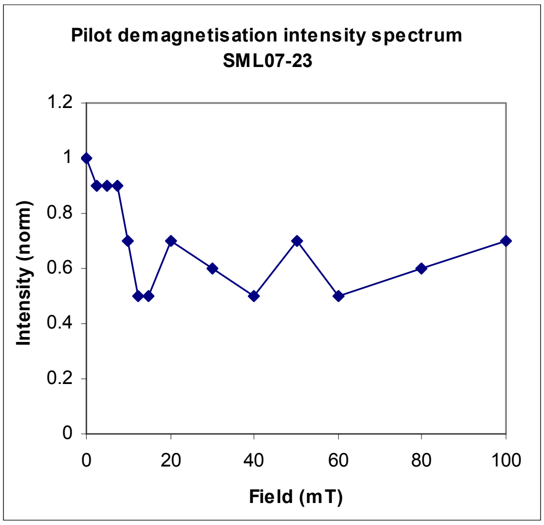
Demag Step	D	I	Int	Int	x	y	z
mT	degs.	degs.	arb	norm			
0	24.4	58.4	3.0227	1.0	1.4423	0.6554	2.5743
2.5	15.1	59.5	3.3009	1.1	1.6161	0.4369	2.8449
5	40.1	61.7	2.8501	0.9	1.0352	0.8713	2.5085
7.5	53.5	62.8	1.9976	0.7	0.5437	0.7348	1.7762
10	43.4	45.5	1.3410	0.4	0.6827	0.6454	0.9570
12.5	35.7	42.2	0.8834	0.3	0.5312	0.3823	0.5933
15	42.7	41.3	0.5212	0.2	0.2880	0.2656	0.3438
20	26.9	31.7	0.4581	0.2	0.3475	0.1763	0.2408
30	228.4	70.8	0.3640	0.1	-0.0794	-0.0894	0.3438
40	237.4	51.2	0.4700	0.2	-0.1589	-0.2482	0.3662
50	20.0	29.6	0.4830	0.2	0.3947	0.1440	0.2383
60	313.5	44.1	0.3671	0.1	0.1812	-0.1911	0.2557
80	219.0	46.0	0.4317	0.1	-0.2333	-0.1887	0.3103
100	308.5	29.9	0.4281	0.1	0.2309	-0.2904	0.2135

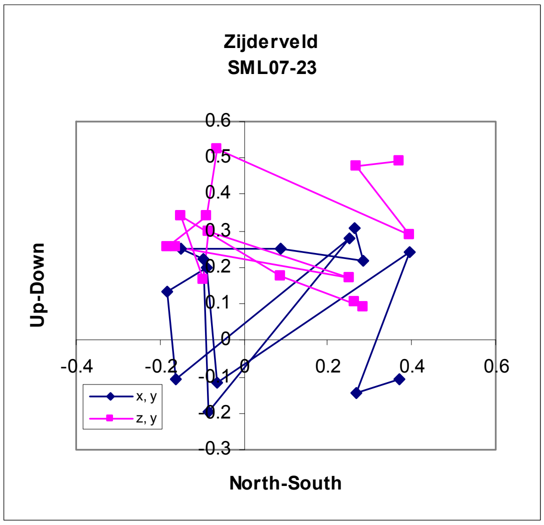




Pilot demagnetisation sample number SML07-23

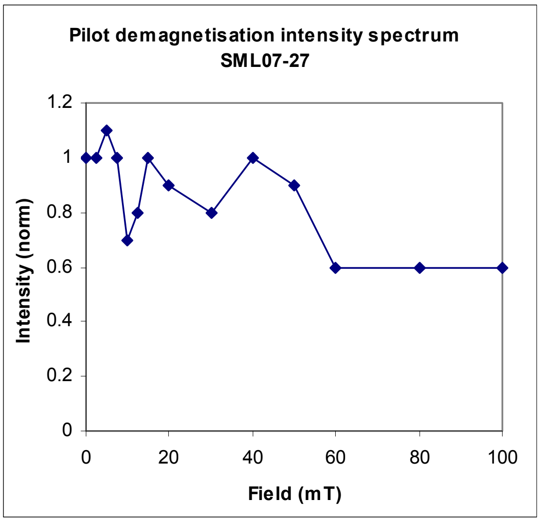
Demag Step mT	D degs.	I degs.	Int arb	Int norm	x	y	z
0	106.1	51.9	0.6222	1.0	-0.1065	0.3692	0.4894
2.5	118.2	57.4	0.5644	0.9	-0.1437	0.2676	0.4757
5	58.4	32.0	0.5454	0.9	0.2428	0.3940	0.2887
7.5	208.5	76.1	0.5399	0.9	-0.1140	-0.0619	0.5240
10	336.6	57.3	0.4048	0.7	0.2007	-0.0867	0.3407
12.5	306.5	48.7	0.3412	0.5	0.1338	-0.1809	0.2564
15	236.5	52.8	0.3190	0.5	-0.1065	-0.1611	0.2540
20	42.3	24.8	0.4135	0.7	0.2775	0.2527	0.1734
30	203.0	54.3	0.3692	0.6	-0.1982	-0.0842	0.2998
40	336.6	34.3	0.2943	0.5	0.2230	-0.0966	0.1660
50	329.3	49.4	0.4472	0.7	0.2503	-0.1487	0.3395
60	19.1	33.6	0.3180	0.5	0.2503	0.0867	0.1759
80	52.3	14.3	0.3718	0.6	0.2205	0.2849	0.0917
100	40.8	14.4	0.4189	0.7	0.3072	0.2651	0.1041

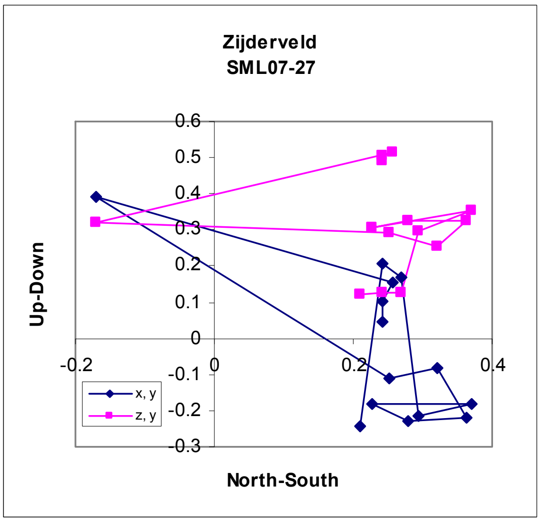




Pilot demagnetisation sample number SML07-27

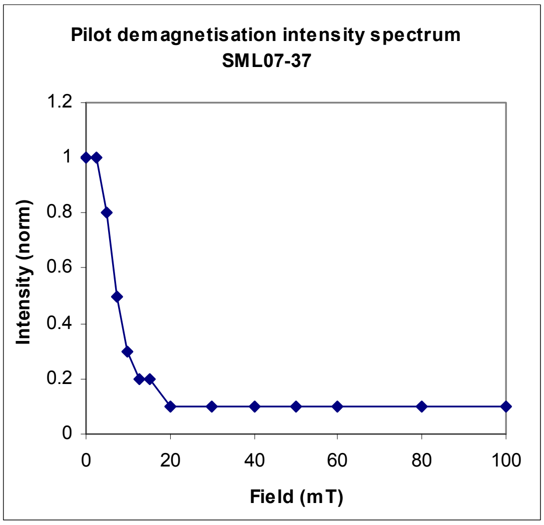
Demag Step mT	D degs.	I degs.	Int arb	Int norm	x	y	z
0	79.0	63.2	0.5492	1.0	0.0472	0.2432	0.4902
2.5	67.1	62.6	0.5687	1.0	0.1018	0.2408	0.5051
5	59.0	60.0	0.5963	1.1	0.1539	0.2556	0.5163
7.5	336.3	37.1	0.5334	1.0	0.3897	-0.1713	0.3214
10	113.5	47.0	0.4007	0.7	-0.1092	0.2507	0.2929
12.5	104.3	37.6	0.4171	0.8	-0.0819	0.3202	0.2544
15	121.1	37.5	0.5336	1.0	-0.2184	0.3624	0.3251
20	129.4	42.0	0.4841	0.9	-0.2283	0.2780	0.3239
30	128.8	46.1	0.4223	0.8	-0.1837	0.2283	0.3040
40	116.1	40.7	0.5482	1.0	-0.1812	0.3698	0.3537
50	126.4	39.3	0.4702	0.9	-0.2159	0.2929	0.2978
60	57.4	21.3	0.3414	0.6	0.1713	0.2681	0.1241
80	49.7	21.7	0.3430	0.6	0.2060	0.2432	0.1266
100	139.1	20.5	0.3437	0.6	-0.2432	0.2110	0.1204

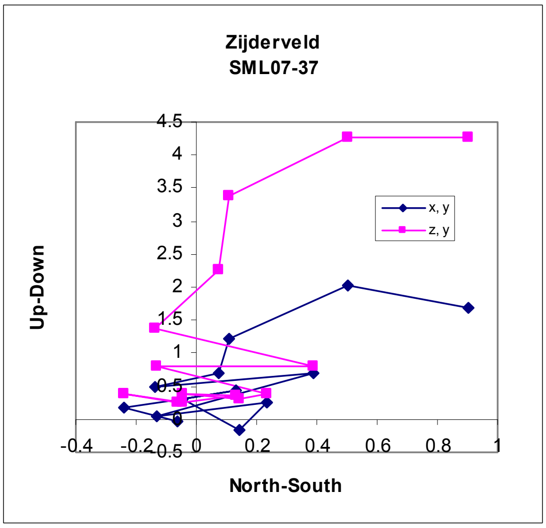




Pilot demagnetisation sample number SML07-37

Demag Step mT	D degs.	I degs.	Int arb	Int norm	x	y	z
0	28.1	65.7	4.6675	1.0	1.6942	0.9041	4.2542
2.5	13.9	64.0	4.7542	1.0	2.0212	0.5003	4.2740
5	5.1	70.3	3.6013	0.8	1.2112	0.1090	3.3897
7.5	6.0	72.6	2.3719	0.5	0.7035	0.0743	2.2639
10	343.8	70.2	1.4702	0.3	0.4781	-0.1387	1.3834
12.5	29.1	45.2	1.1337	0.2	0.6985	0.3889	0.8038
15	291.6	79.9	0.8063	0.2	0.0520	-0.1313	0.7939
20	43.0	48.9	0.5256	0.1	0.2526	0.2353	0.3963
30	136.9	56.1	0.3774	0.1	-0.1536	0.1437	0.3133
40	352.1	49.5	0.4968	0.1	0.3195	-0.0446	0.3777
50	16.6	38.4	0.5867	0.1	0.4409	0.1313	0.3641
60	351.7	39.7	0.4033	0.1	0.3071	-0.0446	0.2576
80	306.5	52.5	0.4856	0.1	0.1759	-0.2378	0.3852
100	243.4	74.9	0.2758	0.1	-0.0322	-0.0644	0.2663





APPENDIX 2: DETAILED MEASUREMENTS AND STATISTICAL ANALYSES OF THE BASAL LAYER

Site information

Site name:	Simpson's Malt, Pontefract
Feature: Pottery	kiln basal layer
Context number:	4232
Description:	Freshly exposed heat-affected basal layer
Latitude (+ve N):	53.70
Longitude (+ve E):	-1.29
Date Sampled:	5 Feb 2008
Magnetic Variation on date sampled (+ve E):	-2.78

Magnetic measurements of NRM and partial demagnetisation

Sample no.	NRM			Field	After partial demag			Pilot?
	D	I	Int		D	I	Int	
	degs.	degs.	arb	mT	degs.	degs.	arb	Y/N
SML07-01	50.7	68.1	11.1741	10	53.6	83.4	3.9550	N
SML07-02	318.0	28.8	57.1447	10	311.5	20.3	59.7569	N
SML07-03	24.6	58.1	14.2169	10	359.7	61.8	9.9364	N
SML07-04	14.6	67.1	14.8468	10	344.2	74.2	7.8387	N
SML07-05	55.0	41.2	9.1302	10	53.3	21.2	4.1286	N
SML07-06	315.4	73.0	38.0700	10	269.6	68.4	25.4020	Y
SML07-07	32.3	52.8	12.9023	10	13.5	58.9	7.8060	N
SML07-08	39.3	63.2	15.9903	10	350.3	75.0	10.9410	N
SML07-09	3.5	74.9	23.9115	10	300.7	78.1	17.3107	N
SML07-10	25.3	57.4	14.0515	10	16.8	69.5	8.6676	Y
SML07-11	44.6	59.3	10.7434	10	51.2	70.6	5.6855	N
SML07-12	32.1	61.3	19.4427	10	16.7	71.4	11.9586	Y
SML07-13	43.3	67.5	15.8845	10	20.7	76.2	10.0630	N
SML07-14	9.6	62.8	19.0836	10	342.5	72.2	11.6916	N
SML07-15	39.8	53.6	9.2388	10	355.8	70.1	4.3981	N
SML07-16	79.9	65.8	10.6380	10	104.3	76.5	6.8124	N
SML07-17	44.4	48.9	5.6524	10	36.6	56.8	3.1595	N
SML07-18	50.4	83.4	1.2873	10	44.0	81.9	0.7381	Y
SML07-19	34.1	79.1	3.0999	10	16.7	79.3	2.0034	N
SML07-20	37.1	58.2	0.4614	10	21.0	67.3	0.3250	N

Statistics for NRM and partial demagnetisation measurements

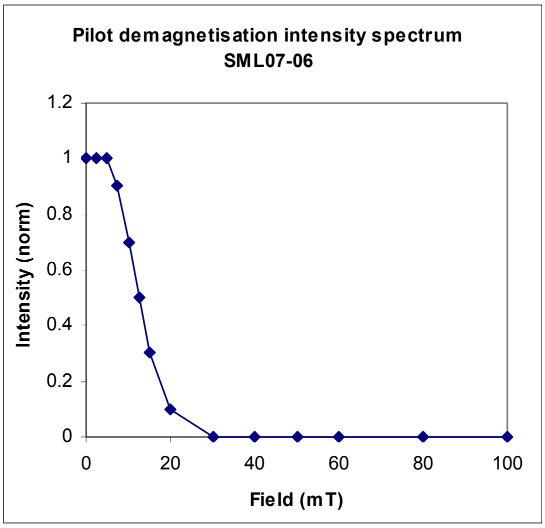
Statistics for NRM data			Statistics for demag data		
Sample no.	Dec	Inc	Sample no.	Dec	Inc
SML07-01	50.7	68.1	SML07-01	53.6	83.4
SML07-02	318.0	28.8	SML07-02	311.5	20.3
SML07-03	24.6	58.1	SML07-03	359.7	61.8
SML07-04	14.6	67.1	SML07-04	344.2	74.2
SML07-05	55.0	41.2	SML07-05	53.3	21.2
SML07-06	315.4	73.0	SML07-06	269.6	68.4
SML07-07	32.3	52.8	SML07-07	13.5	58.9
SML07-08	39.3	63.2	SML07-08	350.3	75.0
SML07-09	3.5	74.9	SML07-09	300.7	78.1
SML07-10	25.3	57.4	SML07-10	16.8	69.5
SML07-11	44.6	59.3	SML07-11	51.2	70.6
SML07-12	32.1	61.3	SML07-12	16.7	71.4
SML07-13	43.3	67.5	SML07-13	20.7	76.2
SML07-14	9.6	62.8	SML07-14	342.5	72.2
SML07-15	39.8	53.6	SML07-15	355.8	70.1
SML07-16	79.9	65.8	SML07-16	104.3	76.5
SML07-17	44.4	48.9	SML07-17	36.6	56.8
SML07-18	50.4	83.4	SML07-18	44.0	81.9
SML07-19	34.1	79.1	SML07-19	16.7	79.3
SML07-20	37.1	58.2	SML07-20	21.0	67.3

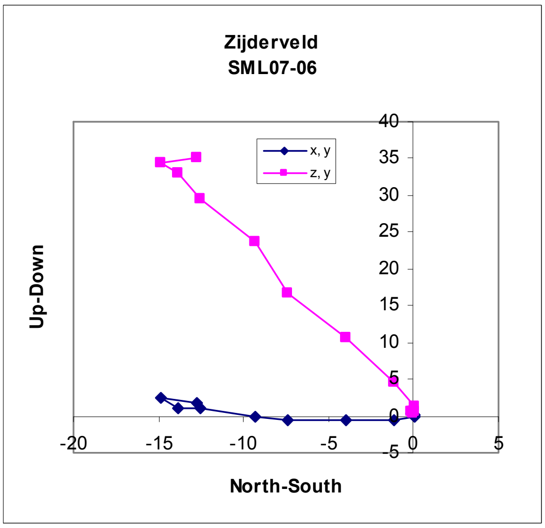
Pilot demagnetisation measurements, intensity spectra and Zijderveld plots

NRM		Partial Demag	
Number =	20	Number =	20
Sum x =	7.14	Sum x =	5.57
Sum y =	3.99	Sum y =	0.85
Sum z =	17.14	Sum z =	17.67
R =	18.99	R =	18.55
x bar =	0.38	x bar =	0.30
y bar =	0.21	y bar =	0.05
z bar =	0.90	z bar =	0.95
Mean Dec =	29.23	Mean Dec =	8.72
Mean Inc =	64.48	Mean Inc =	72.33
Alpha95 =	7.73	Alpha95 =	9.38
		Beck 2-Delta Test	
		2-delta =	44.80
Corrections		Corrections	
Mean Dec =	29.23	Mean Dec =	8.72
Mean Inc =	64.48	Mean Inc =	72.33
Correction for magnetic variation		Correction for magnetic variation	
Mean Dec =	26.41	Mean Dec =	5.91
Mean Inc =	64.48	Mean Inc =	72.33
Correction to Meriden (CVP)		Correction to Meriden (CVP)	
Uncorrected Dec =	26.41	Uncorrected Dec =	5.91
Uncorrected Inc =	64.48	Uncorrected Inc =	72.33
Latitude =	53.70	Latitude =	53.70
Longitude =	-1.30	Longitude =	-1.30
Kai =	43.67	Kai =	32.51
Latitude of pole=	71.63	Latitude of pole=	84.95
Beta1 =	77.13	Beta1 =	38.95
Longitude of pole =	101.57	Longitude of pole =	37.65
Geomag colat =	44.89	Geomag colat =	33.79
Corrected Inc=	63.52	Corrected Inc=	71.50
Beta 2 =	76.81	Beta 2 =	140.73
Corrected Dec=	25.76	Corrected Dec=	5.75
Final Result		Final Result	
Corrected Dec=	25.76	Corrected Dec=	5.75
Corrected Inc =	63.52	Corrected Inc =	71.50
Alpha95 =	7.73	Alpha95 =	9.38

Pilot demagnetisation sample number SML07-06

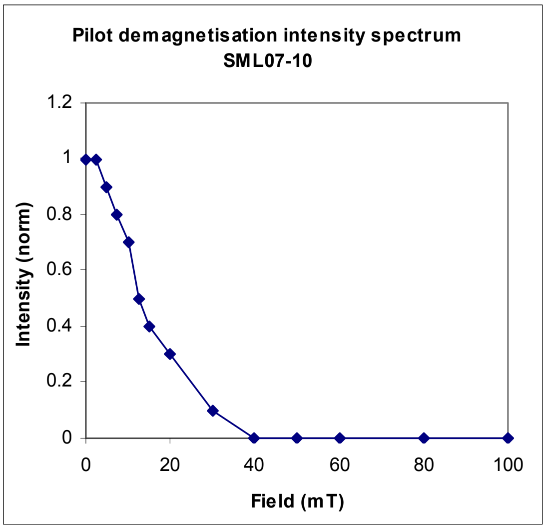
Demag Step mT	D degs.	I degs.	Int arb	Int norm	x	y	z
0	277.9	69.9	37.4982	1.0	1.7601	-12.7552	35.2182
2.5	279.2	66.4	37.6308	1.0	2.4130	-14.9000	34.4709
5	274.7	67.1	35.7164	1.0	1.1295	-13.8450	32.9045
7.5	274.9	66.8	32.0919	0.9	1.0700	-12.5814	29.5034
10	269.6	68.4	25.4020	0.7	-0.0621	-9.3467	23.6199
12.5	264.8	65.8	18.2276	0.5	-0.6728	-7.4451	16.6242
15	261.6	69.1	11.3902	0.3	-0.5933	-4.0117	10.6438
20	242.8	74.3	4.8123	0.1	-0.5958	-1.1593	4.6324
30	136.5	87.0	1.3237	0.0	-0.0497	0.0472	1.3219
40	348.1	82.2	0.7116	0.0	0.0943	-0.0199	0.7050
50	49.3	75.2	0.5496	0.0	0.0919	0.1067	0.5313
60	345.9	56.5	0.7370	0.0	0.3947	-0.0993	0.6144
80	351.6	62.6	0.7422	0.0	0.3376	-0.0497	0.6591
100	348.7	70.8	0.4614	0.0	0.1490	-0.0298	0.4357

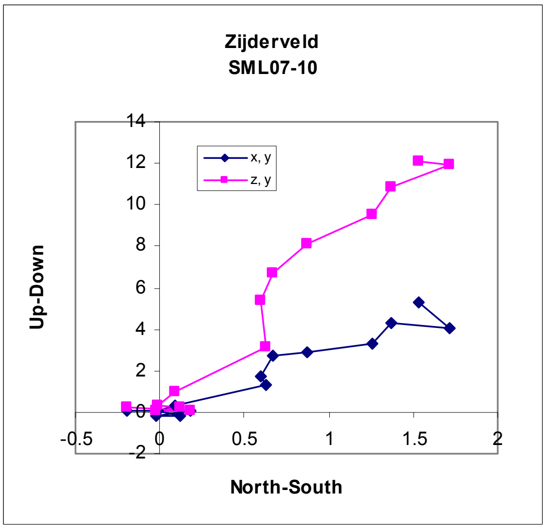




Pilot demagnetisation sample number SML07-10

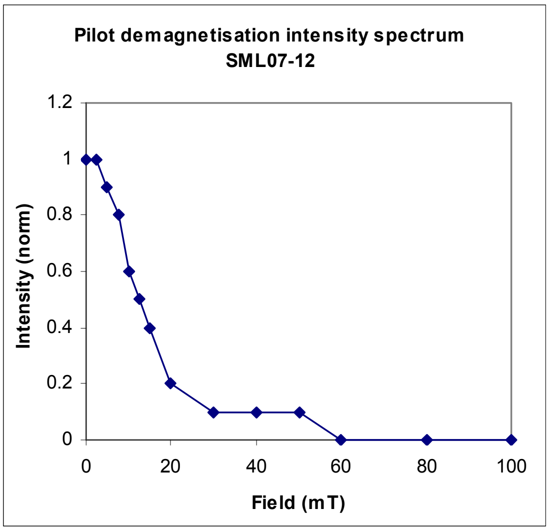
Demag Step mT	D degs.	I degs.	Int arb	Int norm	x	y	z
0	16.2	65.5	13.2450	1.0	5.2667	1.5290	12.0562
2.5	22.8	69.6	12.6816	1.0	4.0739	1.7108	11.8869
5	17.6	67.4	11.7556	0.9	4.3130	1.3696	10.8497
7.5	21.0	69.6	10.1173	0.8	3.2870	1.2600	9.4851
10	16.8	69.5	8.6676	0.7	2.9011	0.8765	8.1205
12.5	14.0	67.4	7.2215	0.5	2.6944	0.6723	6.6662
15	19.2	71.2	5.6520	0.4	1.7207	0.6001	5.3502
20	25.1	65.0	3.4791	0.3	1.3322	0.6250	3.1526
30	15.0	71.0	1.0353	0.1	0.3262	0.0872	0.9786
40	354.3	73.1	0.3448	0.0	0.0996	-0.0100	0.3299
50	147.9	45.6	0.3152	0.0	-0.1868	0.1170	0.2254
60	190.3	36.9	0.1741	0.0	-0.1370	-0.0249	0.1046
80	67.0	25.6	0.2190	0.0	0.0772	0.1818	0.0946
100	299.7	46.4	0.3200	0.0	0.1096	-0.1917	0.2316

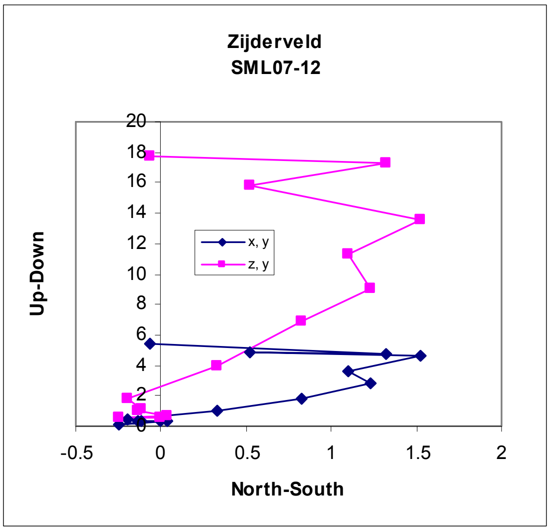




Pilot demagnetisation sample number SML07-12

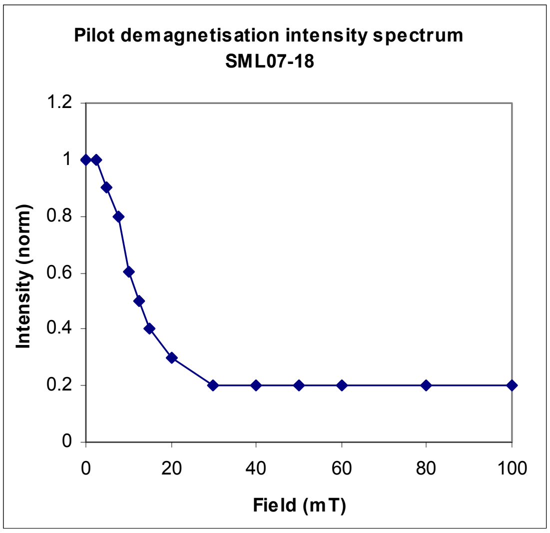
Demag Step mT	D degs.	I degs.	Int arb	Int norm	x	y	z
0	359.3	72.9	18.5780	1.0	5.4560	-0.0648	17.7587
2.5	15.5	74.1	18.0088	1.0	4.7656	1.3235	17.3163
5	6.2	72.9	16.5078	0.9	4.8204	0.5209	15.7797
7.5	18.1	70.1	14.3631	0.8	4.6459	1.5229	13.5053
10	16.7	71.4	11.9586	0.6	3.6564	1.0942	11.3332
12.5	23.1	70.8	9.5267	0.5	2.8763	1.2263	8.9990
15	24.3	73.7	7.1830	0.4	1.8344	0.8275	6.8954
20	17.5	74.7	4.1214	0.2	1.0369	0.3265	3.9755
30	334.7	76.0	1.8548	0.1	0.4063	-0.1919	1.7995
40	339.5	74.0	1.2125	0.1	0.3140	-0.1171	1.1652
50	339.5	68.7	1.0768	0.1	0.3664	-0.1371	1.0032
60	5.8	64.4	0.8012	0.0	0.3440	0.0349	0.7228
80	302.2	64.5	0.6836	0.0	0.1570	-0.2492	0.6169
100	0.0	56.1	0.6170	0.0	0.3440	0.0000	0.5122

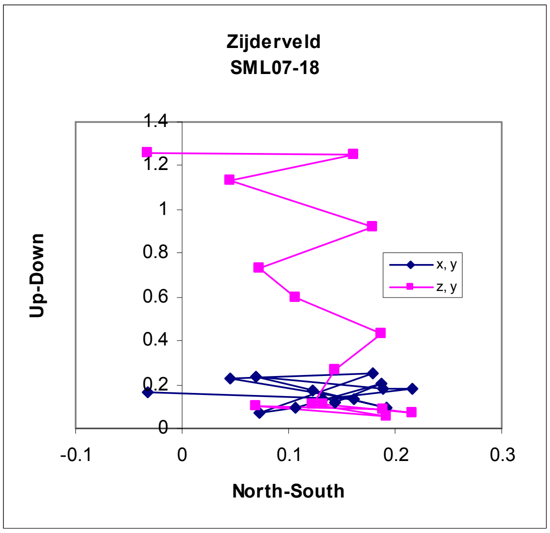




Pilot demagnetisation sample number SML07-18

Demag Step mT	D degs.	I degs.	Int arb	Int norm	x	y	z
0	349.2	82.2	1.2702	1.0	0.1690	-0.0323	1.2589
2.5	50.3	80.5	1.2714	1.0	0.1342	0.1616	1.2540
5	11.0	78.3	1.1564	0.9	0.2312	0.0447	1.1322
7.5	35.5	71.5	0.9711	0.8	0.2510	0.1790	0.9209
10	44.0	81.9	0.7381	0.6	0.0746	0.0721	0.7308
12.5	47.8	76.4	0.6149	0.5	0.0969	0.1069	0.5978
15	42.4	57.6	0.5153	0.4	0.2038	0.1864	0.4350
20	49.8	54.5	0.3251	0.3	0.1218	0.1442	0.2647
30	34.6	26.8	0.2401	0.2	0.1765	0.1218	0.1081
40	64.3	15.4	0.2202	0.2	0.0920	0.1914	0.0584
50	16.6	22.7	0.2642	0.2	0.2336	0.0696	0.1019
60	46.2	17.9	0.2752	0.2	0.1814	0.1889	0.0845
80	50.0	14.8	0.2920	0.2	0.1814	0.2162	0.0746
100	43.9	29.9	0.2191	0.2	0.1367	0.1317	0.1094





Outlier test results

McElhinny and McFadden (2000) discordancy test (demag data, omitting sample SML07-06)

Statistics for demag data	(N-1)	SML07-06			
Sample no.	Dec	Inc	x	y	z
SML07-01	53.6	83.4	0.0682	0.0925	0.9934
SML07-02	311.5	20.3	0.6215	-0.7024	0.3469
SML07-03	359.7	61.8	0.4725	-0.0025	0.8813
SML07-04	344.2	74.2	0.2620	-0.0741	0.9622
SML07-05	53.3	21.2	0.5572	0.7475	0.3616
SML07-07	13.5	58.9	0.5023	0.1206	0.8563
SML07-08	350.3	75.0	0.2551	-0.0436	0.9659
SML07-09	300.7	78.1	0.1053	-0.1773	0.9785
SML07-10	16.8	69.5	0.3353	0.1012	0.9367
SML07-11	51.2	70.6	0.2081	0.2589	0.9432
SML07-12	16.7	71.4	0.3055	0.0917	0.9478
SML07-13	20.7	76.2	0.2231	0.0843	0.9711
SML07-14	342.5	72.2	0.2915	-0.0919	0.9521
SML07-15	355.8	70.1	0.3395	-0.0249	0.9403
SML07-16	104.3	76.5	-0.0577	0.2262	0.9724
SML07-17	36.6	56.8	0.4396	0.3265	0.8368
SML07-18	44.0	81.9	0.1014	0.0979	0.9900
SML07-19	16.7	79.3	0.1778	0.0534	0.9826
SML07-20	21.0	67.3	0.3603	0.1383	0.9225

Number =	19
Sum x =	5.57
Sum y =	1.22
Sum z =	16.74
R =	17.69
x bar =	0.31
y bar =	0.07
z bar =	0.95
Mean Dec =	12.4
Mean Inc =	71.2
Alpha95 =	9.4
COS gamma(1-P)	44.36

McElhinny and McFadden 2000 discordancy test

Statistics for demag data			(N-2)	Sml07-02	
Sample no.	Dec	Inc	x	y	z
SML07-01	53.6	83.4	0.0682	0.0925	0.9934
SML07-03	359.7	61.8	0.4725	-0.0025	0.8813
SML07-04	344.2	74.2	0.2620	-0.0741	0.9622
SML07-05	53.3	21.2	0.5572	0.7475	0.3616
SML07-07	13.5	58.9	0.5023	0.1206	0.8563
SML07-08	350.3	75.0	0.2551	-0.0436	0.9659
SML07-09	300.7	78.1	0.1053	-0.1773	0.9785
SML07-10	16.8	69.5	0.3353	0.1012	0.9367
SML07-11	51.2	70.6	0.2081	0.2589	0.9432
SML07-12	16.7	71.4	0.3055	0.0917	0.9478
SML07-13	20.7	76.2	0.2231	0.0843	0.9711
SML07-14	342.5	72.2	0.2915	-0.0919	0.9521
SML07-15	355.8	70.1	0.3395	-0.0249	0.9403
SML07-16	104.3	76.5	-0.0577	0.2262	0.9724
SML07-17	36.6	56.8	0.4396	0.3265	0.8368
SML07-18	44.0	81.9	0.1014	0.0979	0.9900
SML07-19	16.7	79.3	0.1778	0.0534	0.9826
SML07-20	21.0	67.3	0.3603	0.1383	0.9225

Number =	18
Sum x =	4.95
Sum y =	1.92
Sum z =	16.39
R =	17.23
x bar =	0.29
y bar =	0.11
z bar =	0.95
Mean Dec =	21.3
Mean Inc =	72.1
Alpha95 =	7.5
COS gamma(1-P)	32.95

McElhinny and McFadden 2000 discordancy test

Statistics for demag data			(N-3)	Sml07-09	
Sample no.	Dec	Inc	x	y	z
SML07-01	53.6	83.4	0.0682	0.0925	0.9934
SML07-03	359.7	61.8	0.4725	-0.0025	0.8813
SML07-04	344.2	74.2	0.2620	-0.0741	0.9622
SML07-05	53.3	21.2	0.5572	0.7475	0.3616
SML07-07	13.5	58.9	0.5023	0.1206	0.8563
SML07-08	350.3	75.0	0.2551	-0.0436	0.9659
SML07-10	16.8	69.5	0.3353	0.1012	0.9367
SML07-11	51.2	70.6	0.2081	0.2589	0.9432
SML07-12	16.7	71.4	0.3055	0.0917	0.9478
SML07-13	20.7	76.2	0.2231	0.0843	0.9711
SML07-14	342.5	72.2	0.2915	-0.0919	0.9521
SML07-15	355.8	70.1	0.3395	-0.0249	0.9403
SML07-16	104.3	76.5	-0.0577	0.2262	0.9724
SML07-17	36.6	56.8	0.4396	0.3265	0.8368
SML07-18	44.0	81.9	0.1014	0.0979	0.9900
SML07-19	16.7	79.3	0.1778	0.0534	0.9826
SML07-20	21.0	67.3	0.3603	0.1383	0.9225

Number =	17
Sum x =	4.84
Sum y =	2.10
Sum z =	15.42
R =	16.29
x bar =	0.30
y bar =	0.13
z bar =	0.95
Mean Dec =	23.5
Mean Inc =	71.1
Alpha95 =	7.7
COS gamma(1-P)	33.38

McElhinny and McFadden 2000 discordancy test

Statistics for demag data			(N-4)	Sml07-16	
Sample no.	Dec	Inc	x	y	z
SML07-01	53.6	83.4	0.0682	0.0925	0.9934
SML07-03	359.7	61.8	0.4725	-0.0025	0.8813
SML07-04	344.2	74.2	0.2620	-0.0741	0.9622
SML07-05	53.3	21.2	0.5572	0.7475	0.3616
SML07-07	13.5	58.9	0.5023	0.1206	0.8563
SML07-08	350.3	75.0	0.2551	-0.0436	0.9659
SML07-10	16.8	69.5	0.3353	0.1012	0.9367
SML07-11	51.2	70.6	0.2081	0.2589	0.9432
SML07-12	16.7	71.4	0.3055	0.0917	0.9478
SML07-13	20.7	76.2	0.2231	0.0843	0.9711
SML07-14	342.5	72.2	0.2915	-0.0919	0.9521
SML07-15	355.8	70.1	0.3395	-0.0249	0.9403
SML07-17	36.6	56.8	0.4396	0.3265	0.8368
SML07-18	44.0	81.9	0.1014	0.0979	0.9900
SML07-19	16.7	79.3	0.1778	0.0534	0.9826
SML07-20	21.0	67.3	0.3603	0.1383	0.9225

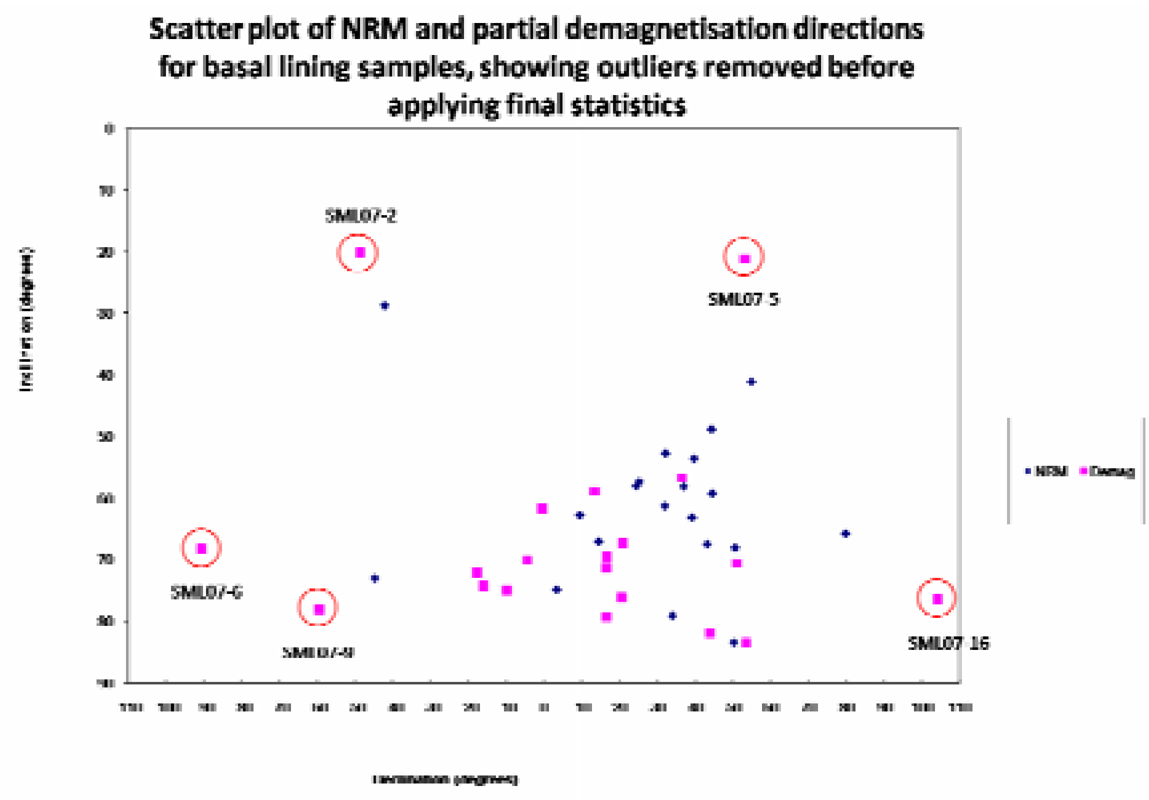
Number =	16
Sum x =	4.90
Sum y =	1.88
Sum z =	14.44
R =	15.37
x bar =	0.32
y bar =	0.12
z bar =	0.94
Mean Dec =	20.9
Mean Inc =	70.0
Alpha95 =	7.7
COS gamma(1-P)	33.54

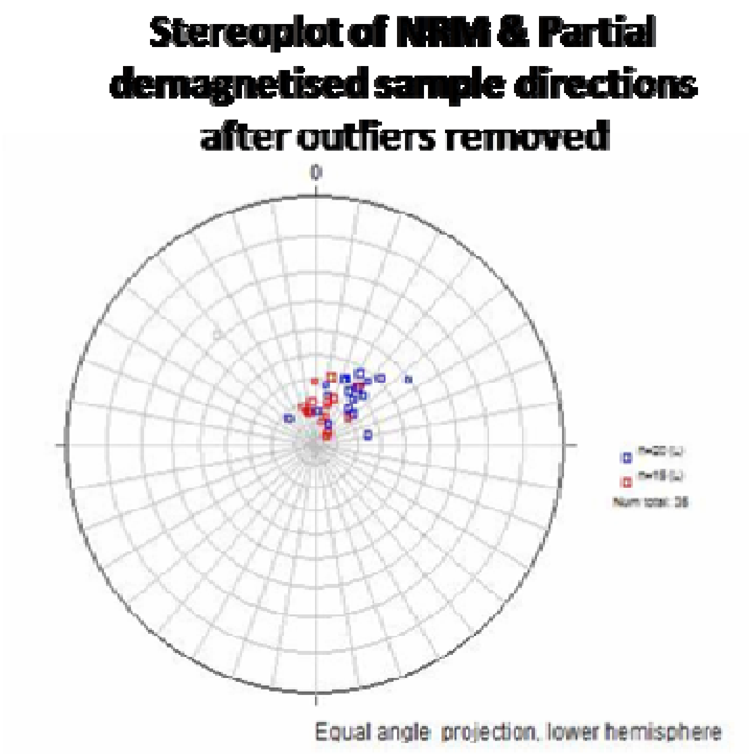
McElhinny and McFadden 2000 discordancy test

Statistics for demag data			(N-5)	Sml07-05	
Sample no.	Dec	Inc	x	y	z
SML07-01	53.6	83.4	0.0682	0.0925	0.9934
SML07-03	359.7	61.8	0.4725	-0.0025	0.8813
SML07-04	344.2	74.2	0.2620	-0.0741	0.9622
SML07-07	13.5	58.9	0.5023	0.1206	0.8563
SML07-08	350.3	75.0	0.2551	-0.0436	0.9659
SML07-10	16.8	69.5	0.3353	0.1012	0.9367
SML07-11	51.2	70.6	0.2081	0.2589	0.9432
SML07-12	16.7	71.4	0.3055	0.0917	0.9478
SML07-13	20.7	76.2	0.2231	0.0843	0.9711
SML07-14	342.5	72.2	0.2915	-0.0919	0.9521
SML07-15	355.8	70.1	0.3395	-0.0249	0.9403
SML07-17	36.6	56.8	0.4396	0.3265	0.8368
SML07-18	44.0	81.9	0.1014	0.0979	0.9900
SML07-19	16.7	79.3	0.1778	0.0534	0.9826
SML07-20	21.0	67.3	0.3603	0.1383	0.9225

Number =	15
Sum x =	4.34
Sum y =	1.13
Sum z =	14.08
R =	14.78
x bar =	0.29
y bar =	0.08
z bar =	0.95
Mean Dec =	14.6
Mean Inc =	72.3
Alpha95 =	4.8
COS gamma(1-P)	20.35

NRM and partial demagnetisation directions after outliers removed





Final statistics used to calculate age

Sample no.	Dec	Inc	x	y	z
SML07-01	53.6	83.4	0.0682	0.0925	0.9934
SML07-03	359.7	61.8	0.4725	-0.0025	0.8813
SML07-04	344.2	74.2	0.2620	-0.0741	0.9622
SML07-07	13.5	58.9	0.5023	0.1206	0.8563
SML07-08	350.3	75.0	0.2551	-0.0436	0.9659
SML07-10	16.8	69.5	0.3353	0.1012	0.9367
SML07-11	51.2	70.6	0.2081	0.2589	0.9432
SML07-12	16.7	71.4	0.3055	0.0917	0.9478
SML07-13	20.7	76.2	0.2231	0.0843	0.9711
SML07-14	342.5	72.2	0.2915	-0.0919	0.9521
SML07-15	355.8	70.1	0.3395	-0.0249	0.9403
SML07-17	36.6	56.8	0.4396	0.3265	0.8368
SML07-18	44.0	81.9	0.1014	0.0979	0.9900
SML07-19	16.7	79.3	0.1778	0.0534	0.9826
SML07-20	21.0	67.3	0.3603	0.1383	0.9225

Number	15
Sum x	4.34
Sum y	1.13
Sum z	14.08
R	14.78
x bar	0.29
y bar	0.08
z bar	0.95
Mean Dec	14.6
Mean Inc	72.3
Alpha95	4.8
Alpha68	2.9

Corrections

Mean Dec	14.6
Mean Inc	72.3

Correction for magnetic variation

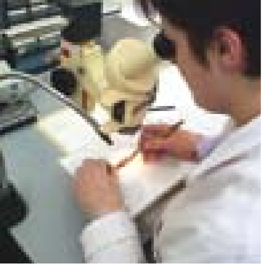
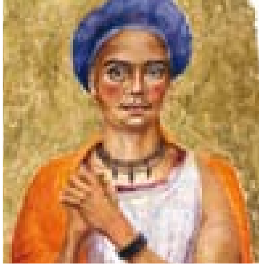
Mean Dec	11.7
Mean Inc	72.3

Correction to Meriden (CVP)

Uncorrected Dec	11.7
Uncorrected Inc	72.3
Latitude	53.70
Longitude	-1.30
Kai	32.50
Latitude of pole	82.37
Beta1	55.47
Longitude of pole	54.16
Geomag colat	33.79
Corrected Inc	71.50
Beta 2	124.22
Corrected Dec	11.39

Final Result

Corrected Dec	11.4
Corrected Inc	71.5
Alpha95	4.8
Alpha68	2.9

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