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West Denton, Newcastle-Upon-Tyne, Tyne and Wear, Archaeomagnetic Dating Report 2001

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Summary

During evaluation excavations by Tyne and Wear Museums Service on the course of Hadrian's Wall at West Denton, Newcastle-upon-Tyne a burnt clay surface was discovered. The surface appeared to be the natural Roman ground surface and it was postulated that the burning might have been the result of a brush fire intended to clear undergrowth before the construction of the wall in this area. Archaeomagnetic analysis revealed that the sample TRMs were widely scattered and that no stable magnetisation existed in high coercivity domains. It is also quite probable that the ground surface has been disturbed since it was fired and that plastic deformation of the clay has distorted the directions originally acquired. Unfortunately, owing to this wide scattering of TRM directions, it was not possible to date the firing event.

Keywords

Archaeomagnetism

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WEST DENTON, NEWCASTLE-UPON-TYNE, TYNE AND WEAR:
Archaeomagnetic Dating Report 2001

Introduction

During evaluation excavations by Tyne and Wear Museums Service on the course of Hadrian's Wall at West Denton, Newcastle-upon-Tyne (NZ 187 659, Longitude 1.7°W, Latitude 55.0°N), a burnt clay surface was discovered. The surface appeared to be the natural Roman ground surface and it was postulated that the burning might have been the result of a brush fire intended to clear undergrowth before the construction of the wall in this area. Hence, the English Heritage Ancient Monuments Laboratory (EH AML) was asked to provide archaeomagnetic analysis of the surface to test this hypothesis. Sampling was carried out on the 4th and 5th February 1988 by the author and D. Sheil of the AML; all 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. A total of 16 samples were recovered (samples WD02 and WD07 being lost due to failure of the glue during sampling). All consisted of dark brown soil containing a layer of orange clay about 5mm thick.

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 are listed in Table 1 and the distribution of their directions is depicted in Figure 1a. The magnitudes of the sample NRMs are not unduly low and in the cases of WD06, WD11-14 and WD16 quite high (remarkably so in the case of the WD16). However, their NRM directions are widely scattered and show little tendency to cluster at a particular direction.

The NRM of the samples is assumed to be caused by thermoremanent magnetisation (TRM) at the time that the feature 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 three samples, WD08, WD10 and WD17, were demagnetised incrementally to a peak alternating field of 50mT and the changes in their remanence recorded to identify the components of their magnetisation. The measurements are tabulated in Table 2 and depicted graphically in Figures 2-4. All three samples show little evidence of magnetisation in high coercivity domains, with 90% of their magnetisation being removed by partial demagnetisation to 20mT. Furthermore their directions of TRM magnetisation do not remain stable with increasing partial demagnetisation (sample WD08 being particularly wayward). This would suggest that the samples had not been subjected to a particularly intense heat. Some evidence of viscous remanent magnetisation is apparent in samples WD10 and WD13 at coercivities up to 2.5mT.

It was thus decided to partially demagnetise the remaining samples in a peak alternating field of 2.5mT in the hope that removal of this viscous component might improve the grouping of the sample TRMs. The results of this treatment are tabulated in Table 1 and depicted graphically in Figure 1b. However, it is clear from this figure that no improvement of the grouping has occurred.

Conclusions

Archaeomagnetic analysis of samples of fired soil from West Denton has revealed that they were not stably magnetised in high coercivity domains, suggesting that they were not subjected to particularly prolonged or intense heat when the firing event occurred. This finding would fit with a postulated brush fire lit to clear undergrowth from the area. The lack of a stable TRM in high coercivity domains might alone account for the widely scattered TRM directions observed. However, it is also quite probable that the ground surface has been disturbed since it was fired and that plastic deformation of the clay has distorted the directions originally acquired. Owing to this wide scattering of TRM directions, it was not possible to date the firing event at West Denton by archaeomagnetic analysis.

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Date of report: 27/04/2001

Archaeomagnetic Date Summary

Site:	**West Denton, Newcastle-upon-Tyne**
Location:	**Longitude 1.7°W, Latitude 55.0°N**
Number of Samples (taken/used in mean):	**16/-**
AF Demagnetisation Applied:	**None**
Distortion Correction Applied:	**None**
Bedding Correction Applied:	**None**
Mean Declination at Site:	-
Mean Inclination at Site:	-
Mean Declination at Meriden:	-
Mean Inclination at Meriden:	-
Alpha-95:	-
k:	-
Date range (63% confidence):	**undatable**
Date range (95% confidence):	**undatable**

	NRM Measurements				After Partial Demagnetisation			
Sample	Material	Dec°	Inc°	J (mAm⁻¹)	AF (mT)	Dec°	Inc°	J (mAm⁻¹)
WD01	Clay	0.3	18.8	37.2	2.5	-0.0	20.3	27.8
WD03	Clay	-63.5	35.7	696.3	2.5	-58.1	33.8	602.1
WD04	Clay	23.6	53.1	323.2	2.5	25.6	49.8	254.0
WD05	Clay	13.4	69.0	331.3	2.5	-5.9	71.6	236.7
WD06	Clay	-18.4	18.3	3055.6	2.5	-19.0	14.2	2882.5
WD08	Clay	0.3	22.6	672.8	2.5	5.7	9.6	498.8
WD09	Clay	9.0	6.6	678.2	2.5	10.8	4.5	605.0
WD10	Clay	12.7	53.3	874.8	2.5	16.7	49.9	715.8
WD11	Clay	7.3	60.7	1475.9	2.5	6.2	56.6	1246.8
WD12	Clay	-12.7	35.2	3340.9	2.5	-13.6	29.9	3095.7
WD13	Clay	31.4	75.3	2475.7	2.5	41.4	74.5	1980.8
WD14	Clay	74.2	78.7	1180.4	2.5	43.0	77.4	1149.0
WD15	Clay	69.5	47.9	71.2	2.5	59.0	51.8	62.2
WD16	Clay	-68.2	-33.0	12808.0	2.5	-68.4	-34.2	12762.5
WD17	Clay	-10.7	85.5	497.1	2.5	-52.0	83.5	469.1
WD18	Clay	6.7	68.1	267.1	2.5	5.3	67.7	223.3

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

	WD08			WD10			WD13		
AF (mT)	Dec°	Inc°	J (mAm⁻¹)	Dec°	Inc°	J (mAm⁻¹)	Dec°	Inc°	J (mAm⁻¹)
0.0	0.3	22.6	672.8	12.7	53.3	874.8	31.4	75.3	2475.7
2.5	5.7	9.6	498.8	16.7	49.9	715.8	41.4	74.5	1980.8
5.0	9.3	-10.1	376.3	18.7	46.0	543.5	43.4	73.2	1458.0
10.0	18.4	-31.2	232.6	21.2	37.2	298.9	51.4	77.7	753.0
15.0	28.2	-32.5	123.2	20.8	30.5	178.9	52.3	83.6	411.7
20.0	24.3	-25.9	69.5	18.7	29.5	105.3	16.6	75.8	226.7
30.0	8.3	-3.2	37.8	17.8	21.5	55.8	-3.4	57.8	107.5
50.0	7.4	6.0	25.9	8.5	19.3	31.0	7.4	28.9	85.2

Table 2: Incremental partial demagnetisation measurements for samples WD08, WD10 and WD13.

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 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.

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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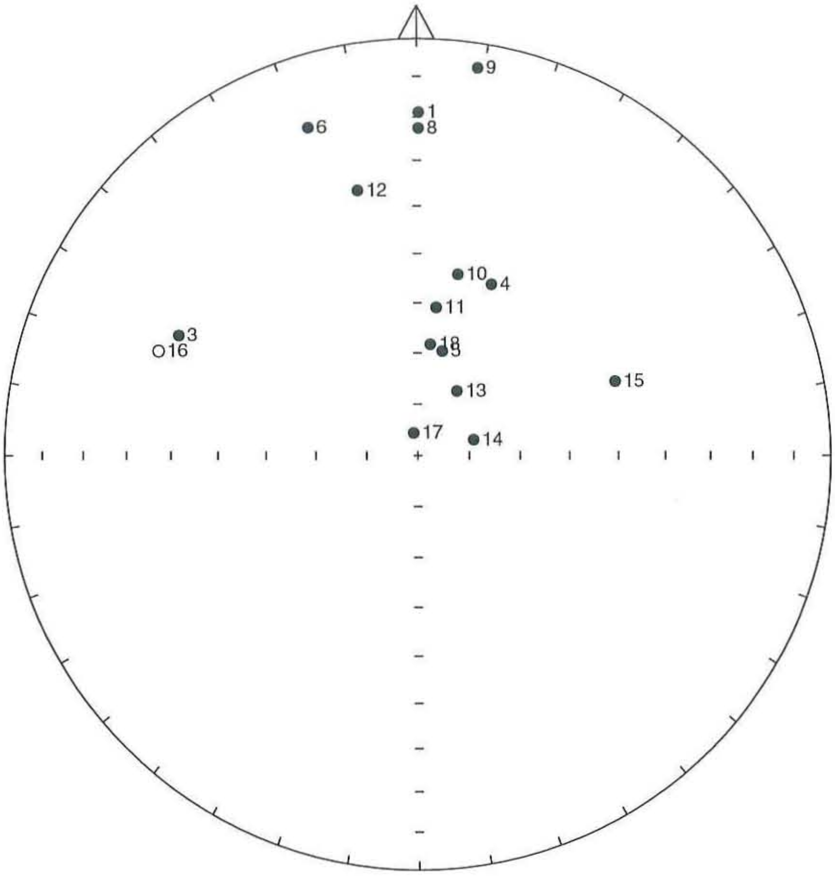
a)



b)

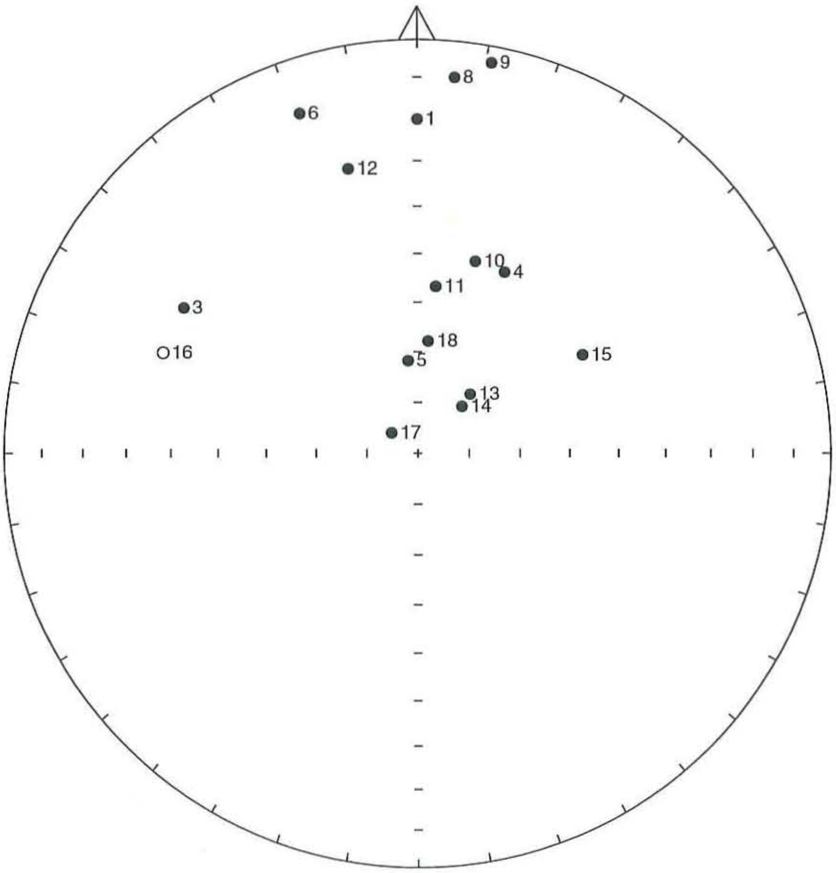


Figure 1: a) Distribution of NRM directions of samples from West Denton represented as an equal area stereogram. In this projection declination increases clockwise with zero being at 12 o'clock while inclination increases from zero at the equator to 90 degrees in the centre of the projection. b) Distribution of thermoremanent directions of magnetisation of the same samples after partial AF demagnetisation to 2.5mT.

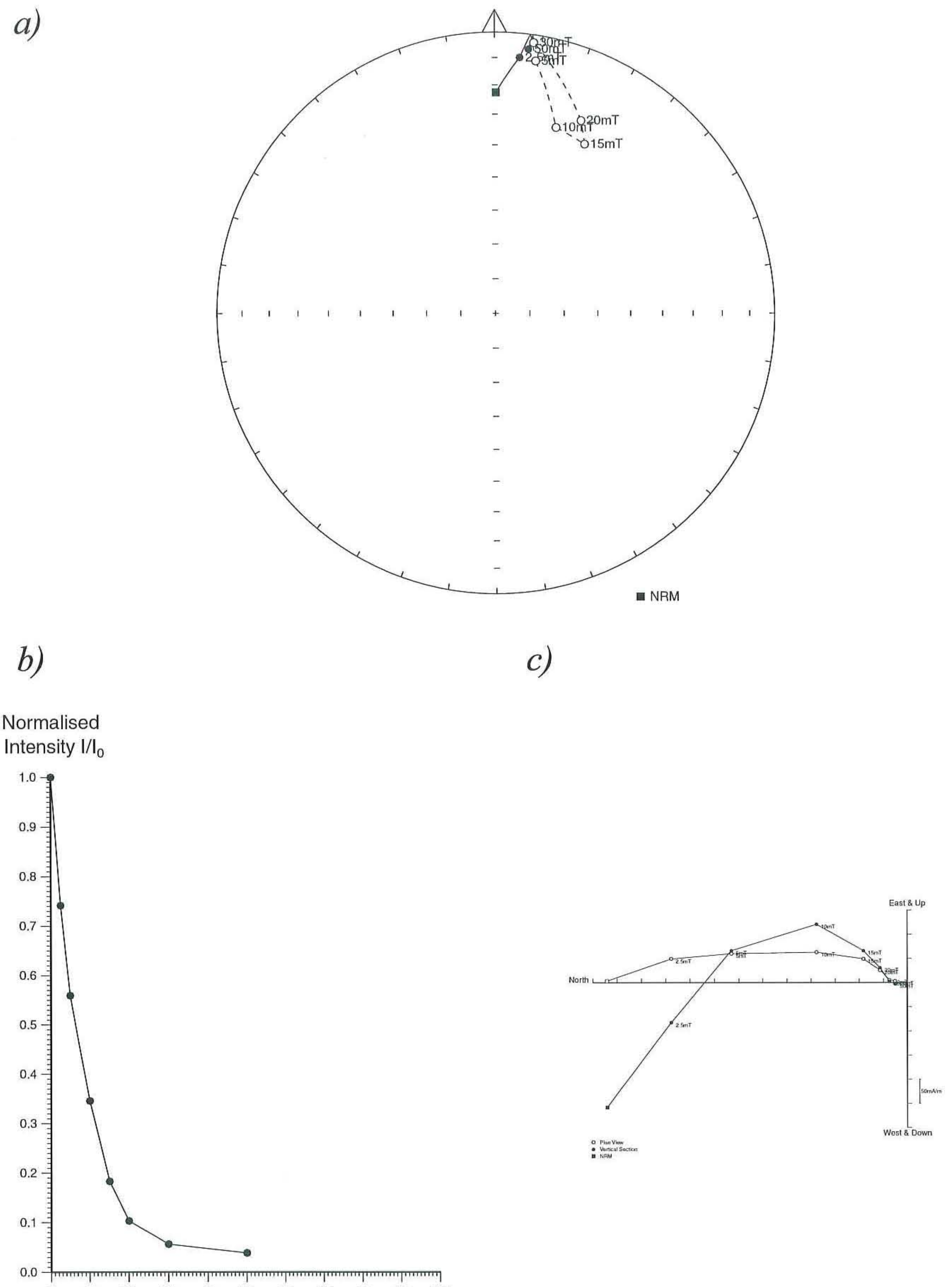


Figure 2: Stepwise AF demagnetisation of sample WD08. Diagram a) depicts the variation of the remanent direction as an equal area stereogram (declination increases clockwise, while inclination increases from zero at the equator to 90 degrees at the centre of the projection); b) shows the normalised change in remanence intensity as a function of the demagnetising field; c) shows the changes in both direction and intensity as a vector endpoint projection.

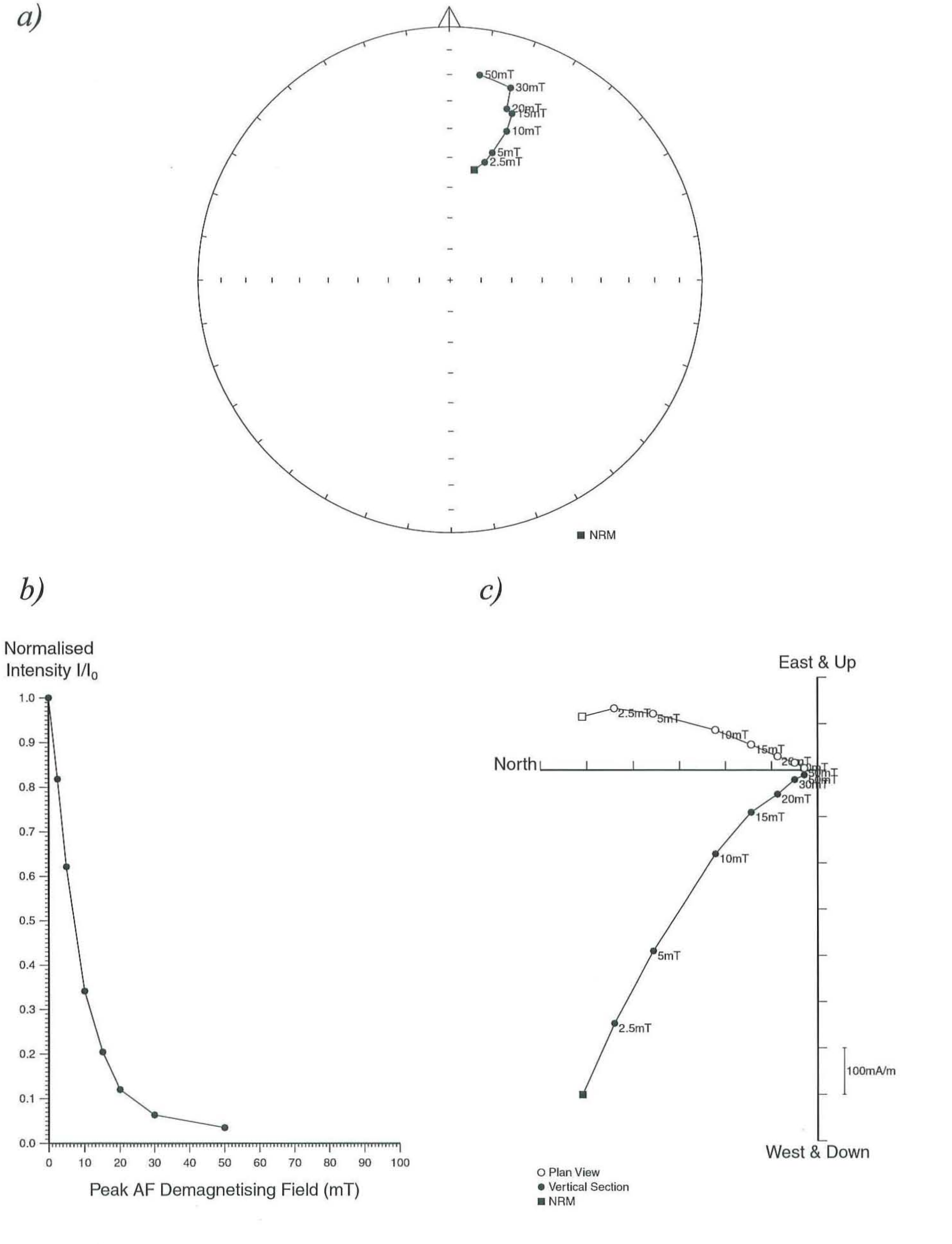


Figure 3: Stepwise AF demagnetisation of sample WD10. Diagram a) depicts the variation of the remanent direction as an equal area stereogram (declination increases clockwise, while inclination increases from zero at the equator to 90 degrees at the centre of the projection); b) shows the normalised change in remanence intensity as a function of the demagnetising field; c) shows the changes in both direction and intensity as a vector endpoint projection.

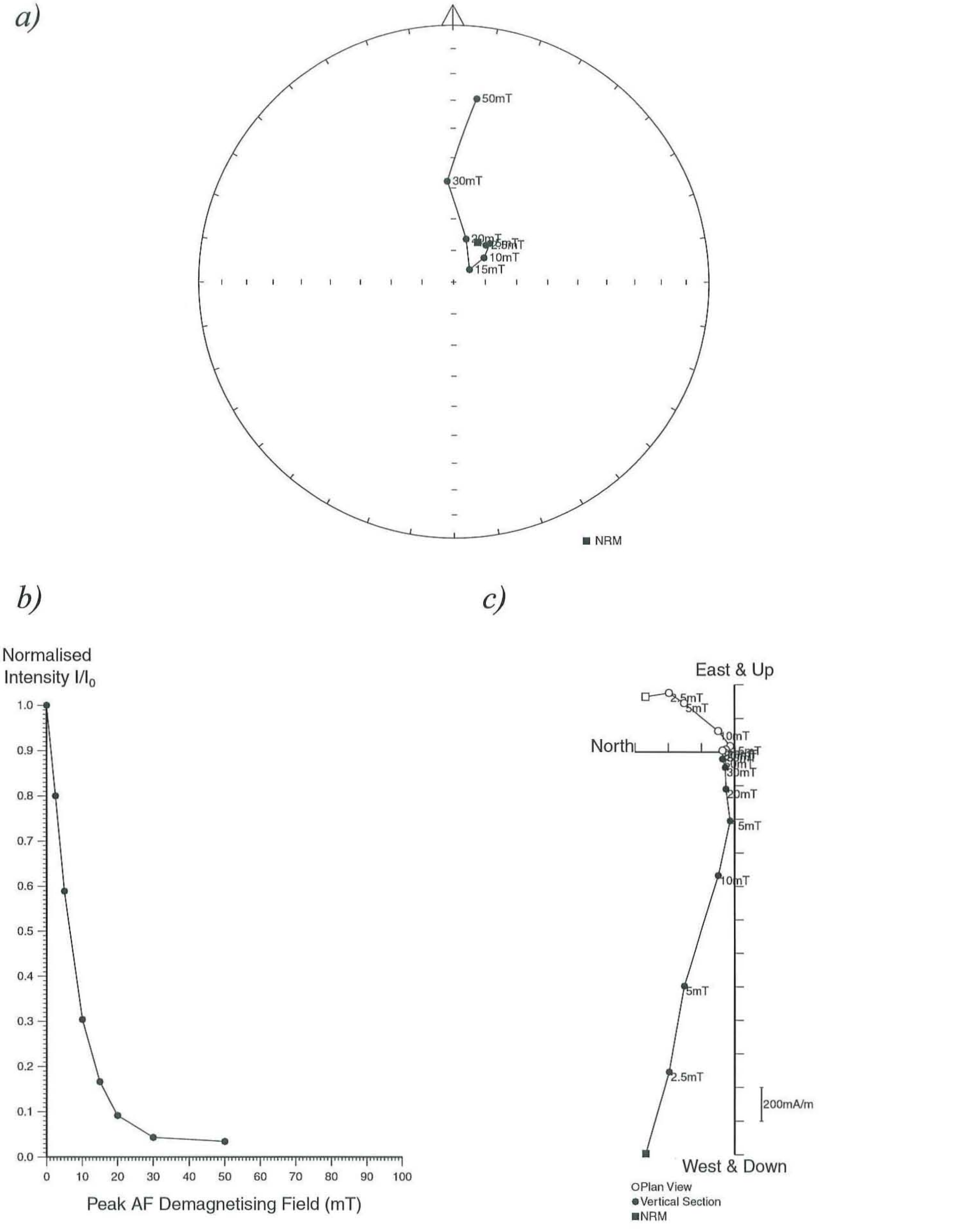


Figure 4: Stepwise AF demagnetisation of sample WD13. Diagram a) depicts the variation of the remanent direction as an equal area stereogram (declination increases clockwise, while inclination increases from zero at the equator to 90 degrees at the centre of the projection); b) shows the normalised change in remanence intensity as a function of the demagnetising field; c) shows the changes in both direction and intensity as a vector endpoint projection.