

**ARCHAEOMAGNETIC RESULTS FROM  
THE PARK, GUITING POWER**

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## Introduction

Sampling was undertaken at 4 features at The Park, near Guiting Power village (51.9°N, 2.9°W - grid ref. SP 0832 2587) in an area that appears to have been occupied during the Middle Iron Age. Sampling was by the disk method (see Appendix) in which plastic discs were glued to the sampled materials, with a non-magnetic epoxy glue, and the surface of the disc oriented using a sun-compass. A burnt stone on the site, thought to be a hearthstone, was subsequently oriented by A. Marshall and sent to Plymouth Palaeomagnetic laboratory for sub-sampling and magnetic analysis. All samples were measured using Digico magnetometers with a noise-level of  $\pm 0.01$  A/m/kg and all samples were subjected to partial demagnetisation in alternating magnetic fields (AF) with the remanence measured after each successive increment in the peak applied field up to a maximum of 100 mT (See Appendix for explanation and references).

## Site GP1 (Context number 46)

This stone hearth feature was originally excavated in 1989 and is currently in a re-opened trench away from the main 1994 excavation area. This feature consisted of an approximately rectangular patch of stones, covering an area of approximate  $1\text{m}^2$ , comprising 4 larger stones (<20 cm across) and a number of smaller stones. The stones and surrounding gravel showed signs of reddening which was attributed to heating and the archaeological interpretation of the feature was that it represented a hearth. Seven samples were taken from the larger stones and from the apparently fired smaller stones that appeared to be still *in situ*.

No.	Initial		Consistency				Linearity				
	Int.	DCI	N	Range	Decl.	Incl.	Range	N	da	Decl.	Incl.
1	2.4	1.4	3	20 to 50	40.8	65.8	0 to 5	3	5.0	331.0	-46.1
2	0.6	0.9	6	5 to 50	83.5	44.0	15 to zero	5	1.2	59.1	5.6
3	3.9	3.4	6	5 to 50	346.8	62.0	5 to 30	4	2.0	354.7	71.3
4	4.7	8.3	7	3 to 50	23.2	66.2	5 to zero	7	2.8	23.8	65.3
5	15.8	4.4	3	5 to 15	337.1	72.8	0 to 5	3	3.9	329.0	48.7
6	113.5	1.3	3	20 to 50	20.2	80.2	10 to 30	4	0.8	342.2	-7.8
7	7.2	5.7	4	3 to 10	353.5	67.5	20 to zero	4	3.2	349.9	65.7

Table 1 Sample Initial Intensity and Directional Components - Site GP1

N is the number of samples. Initial Int. is the intensity (A/m/kg) before demagnetisation. The Range is the range of demagnetisation over which the vector is defined (zero corresponds to the theoretical completely demagnetised value). The directional consistency is defined by the DCI and the linearity precision by the diagonal angle da. The precision of the mean direction is  $k$  and the radius of 95% confidence is  $\alpha_{95}$ . (See Appendix for explanation and references.)

The initial intensities are variable (Table 1), mostly being weak with the notable exception of sample 6. However, all intensities were above the noise-level of the magnetometer. Four samples (3, 4, 5 & 7) showed reasonably consistent directions during demagnetisation, and three sample (2, 3 & 6) showed well defined linear vectors - in each case, these were only defined after the initial one or two demagnetisation steps. There is thus only one component of remanence after the removal of recently acquired low coercivity components. However, there is little agreement between most of the directions isolated by either analysis. The 4 consistent sample directions have a mean direction  $355.9^\circ$ ,  $+68.0^\circ$  ( $k = 87$ ,  $\alpha_{95} = 9.9^\circ$ ) but the 3 linear vectors are randomly oriented ( $k = 2$ ,  $\alpha_{95} > 90^\circ$ ). Even sample 3, which had both quite well defined directional consistency and linearity has directions  $10^\circ$  apart for the two forms of analysis. It is concluded that no meaningful mean direction can be calculated for this site.

#### Site GP2 (Feature No. 110)

This rectangular stone hearth, about 80 x 60 cm, was excavated in 1994 in the main trench on top of an infilled N/S oriented ditch. The hearth comprised some 20 stones, standing on edge, and enclosing 5 flat stones overly the basal slab (sampled separately). A number of stones showed signs of reddening and this factor, along with the shape of the feature, led to its archaeological interpretation as a hearth. Concern was expressed as to whether slumping of the feature may have occurred due to settling of the ditch deposits below it, although no structural movement was apparent from observation. Nine samples were taken from securely positioned edging stones and from stones in the centre of the feature.

No.	Initial		Consistency				Linearity				
	Int.	DCI	N	Range	Decl.	Incl.	Range	N	da	Decl.	Incl.
1	2.5	15.4	3	15 to 30	316.0	75.3	15 to zero	5	2.7	315.6	75.6
2	63.5	9.8	5	10 to 50	351.0	72.2	10 to zero	6	3.1	350.7	72.0
3	27.2	6.3	6	5 to 50	135.5	72.4	20 to zero	4	3.9	134.7	73.9
5	126.6	12.8	4	15 to 50	308.1	88.2	20 to zero	4	2.0	290.2	87.8
6	23.4	9.0	5	5 to 30	202.5	28.7	20 to zero	4	3.4	202.5	28.5
7	27.7	8.4	4	10 to 30	331.2	22.2	20 to zero	4	2.6	330.5	22.4
8	1306.0	10.2	5	10 to 50	302.0	35.6	10 to zero	6	2.6	302.3	36.3
9	96.0	3.3	3	20 to 50	233.1	-77.9	20 to zero	4	3.7	232.6	-78.7

Table 2. Sample Initial Intensity and Directional Components - Site GP2  
(Legend as Table 1.)

There is a wide range of initial intensities of magnetisation (Table 2), varying between 2.5 and 1306 A/m/kg although all intensity values were above the instrumental noise-level. Each sample contained a well concentrated direction during demagnetisation and this was similar to its direction for the moderately well defined linear vector. However, while there was consistency for the magnetisation within each sample, the directions of different samples were highly scattered, close to random, so that no statistically meaningful average direction could be defined. In view of the internal consistency, there can have been little or uniform site disturbance since the firing, each sample having moved individually.

#### Site GP3 (Feature No. 154)

This roughly rectangular area of burnt ground and stones, covering about 80 x 60 cm and comprising stones less than 15 cm across, was excavated in 1994 in Trench 3 and was considered to be the remains of a hearth. The stones, gravel and intervening soil appeared to be reddened in comparison with the surroundings and the feature was interpreted as the partially disturbed or poorly preserved remains of a hearth. Nine samples were taken from the larger and apparently most securely fixed stones.

No.	Initial		Consistency				Linearity				
	Int.	DCI	N	Range	Decl.	Incl.	Range	N	da	Decl.	Incl.
1	4	3.0	4	15 to 50	358.4	60.0	30 to zero	3	0.8	6.7	57.4
2	179	26.2	3	5 to 15	221.6	16.2	10 to zero	6	3.2	221.8	15.4
3	3855	10.0	3	20 to 50	117.5	52.5	10 to 30	4	2.9	121.0	55.6
4	18	13.9	3	20 to 50	20.8	-78.8	20 to zero	4	1.9	20.0	-78.7
5	65	30.7	3	20 to 50	250.2	-18.2	20 to zero	4	0.7	250.2	-18.4
6	416	32.9	3	20 to 50	40.9	-62.7	5 to zero	7	3.9	43.1	-62.1
7	9	5.7	5	10 to 50	17.7	25.2	none				
8	4218	13.7	3	20 to 50	36.2	-17.6	5 to 30	5	2.7	41.3	-8.4
9	53	16.2	7	3 to 50	339.0	-54.6	5 to zero	7	2.6	338.4	-54.5

Table 3. Sample Initial Intensity and Directional Components - Site GP3

(Legend as Table 1.)

There was a wide range of initial intensity, varying between 4 and 4218 A/m/kg, but above the noise-level of measurement (Table 3). All samples showed high consistency and most showed clear linearity of the vectors isolated during individual demagnetisation, and both forms of analysis yielded similar directions in each sample. However, there was no consistency between the different samples - neither forms of analysis providing a meaningful average direction. The high internal consistency of the remanences suggests that each sample is likely to have moved independently, relative to the others, since the area was originally fired.

#### Site GP4 (Feature No. 155)

This feature was excavated in 1994 in Trench 3 and consisted of a roughly rectangular area, about 60 x 40 cm, containing a number of closely grouped smaller stones (<30 cm across). The stones, gravel and intervening soil appeared reddened in comparison with their surroundings and the feature was interpreted as the partially disturbed or poorly preserved remains of a hearth. Ten samples were taken from the larger and apparently most securely fixed stones.

No.	Initial		Consistency				Linearity				
	Int.	DCI	N	Range	Decl.	Incl.	Range	N	da	Decl.	Incl.
1	47.8	13.5	3	20 to 50	270.9	-56.2	20 to zero	4	2.1	270.6	-56.3
2	325.9	12.5	2	20 to 50	99.5	51.0	30 to zero	3	0.3	100.5	50.5
3	148.8	8.9	3	10 to 20	344.7	64.1	10 to zero	6	2.5	345.0	63.8
4	111.9	9.1	5	0 to 15	289.3	82.1	30 to zero	3	2.6	328.0	83.9
5	80.1	9.3	3	15 to 30	17.0	21.6	20 to zero	4	3.1	17.0	20.9
6	4417.0	7.1	5	10 to 30	50.6	62.4	30 to zero	3	2.2	49.9	62.1
7	138.6	15.4	3	20 to 50	181.9	14.2	15 to 30	3	0.7	190.3	27.0
8	648.8	3.5	4	15 to 50	283.8	12.5	15 to zero	5	4.5	280.5	13.2
9	245.0	8.5	3	0 to 5	233.6	-57.9	20 to zero	3	1.4	60.7	-56.5
10	248.5	32.9	5	10 to 50	10.9	49.6	10 to zero	6	0.9	10.7	49.7

Table 4. Sample Initial Intensity and Directional Components - Site GP4  
(Legend as Table 1.)

The initial intensities of magnetisation were moderately strong (Table 4) and more uniform than in the other sites, with the notable exception of the high intensity of sample 4.6. Each vector, during demagnetisation, showed high directional consistency and the linearity in each sample was very well defined in samples 2, 7, 9 and 10, and quite well defined in all other samples. The characteristic directions for each sample were virtually identical, except for sample 4.9. However, there was no consistency between any of the sample directions of remanence, which appear to be random and therefore no site mean direction can be usefully

determined. The good definition of the remanence in each sample suggests that each sample has moved separately, relative to the others, since the site was originally fired.

### **GP Hearthstone (Feature No. 110)**

A large rectangular limestone slab, approximately 50 x 45 cm and up to 4 cm thick, was oriented by A. Marshall and sliced into a rectangular piece, c.20 cm by 40 cm which was sent to the University of Plymouth. There was a burnt area, coloured black and grey, extending over a circular area some 25 cm in diameter. The slab was horizontal and was reported to be resting on ditch-fill and appeared unlikely to have moved substantially since the firing had occurred. Eight samples were drilled perpendicular to the horizontal surface. These were then sliced so that the more intensively fired surface formed part of the samples that were measured. The intensities of remanence were somewhat low (Table 5), mostly less than 1 A/m/kg, but the main characteristic was the poor within sample agreement, the agreement between the intensity of remanence along each axis showing considerable change in different orientation. Nonetheless, the directions were consistent during successive demagnetization levels for samples 4, 5 and 6 and moderately well clustered for samples 3 and 6 (Figure 1). The remanence also showed quite good linearity during demagnetisation for samples 4 and 6, although poorer for samples 3 and 5, and no linearity could be determined in samples 1 and 2. Such behaviour suggests that the individual samples were inhomogeneously magnetised; consistent with some parts being much more strongly burnt than others. It thus seems probable that most of this inhomogeneity is drastically reduced by spinning during measurement along different axes, and that the measurements are more reliable than indicated by the associated measurement errors.

The mean directions for the consistent directions;  $3.0^\circ$ ,  $75.4^\circ$  ( $N = 6$ ,  $k = 92$ ,  $\alpha_{95} = 7.0^\circ$ ) and linearities  $3.7^\circ$ ,  $71.9^\circ$  ( $N = 4$ ,  $k = 120$ ,  $\alpha_{95} = 8.4^\circ$ ) were similar (mean value  $3.3^\circ$ ,  $74.0^\circ$   $N = 10$ ,  $k = 107$ ,  $\alpha_{95} = 4.7^\circ$ ). If only the more consistent ( $DCI > 1.0$ ) and most linear ( $da. < 5.0^\circ$ ) mean directions are more westerly and slightly shallower ( $353.0^\circ$ ,  $70.5^\circ$ ,  $N = 3$ ,  $k = 687$ ,  $\alpha_{95} = 4.7^\circ$  and  $347.9^\circ$ ,  $70.3^\circ$ ,  $N = 2$ ,  $k = 827$ ,  $\alpha_{95} = 8.7^\circ$ ). Combining the mean directions, but taking the average of the errors, the overall mean direction is  $351.0^\circ$ ,  $70.4^\circ$  ( $N = 5$ ,  $k = 858$ ,  $\alpha_{95} = 2.6^\circ$ ). However, it must be emphasised that this is based on selected data which, although objectively determined, require that it may not be a good representation of the total magnetisation of the hearthstone and therefore should be treated cautiously.

No.	Initial		Consistency				Linearity				
	Int.	DCI	N	Range	Decl.	Incl.	Range	N	da	Decl.	Incl.
1	0.31	0.9	3	3 to 10	345.8	74.3					
2	0.21	0.5	5	3 to 20	38.8	78.0					
3	0.94	0.9	6	0 to 20	59.5	80.7	3 to zero	6	7.5	36.0	72.9
4	1.34	3.3	3	3 to 10	354.3	69.9	3 to zero	6	2.4	352.1	69.4
5	0.52	1.8	5	3 to 20	1.5	71.1	3 to zero	6	6.4	8.1	70.1
6	1.07	3.7	3	5 to 15	343.5	70.1	3 to zero	5	3.8	342.3	71.0

Table 5. Sample Initial Intensity and Directional Components - Hearthstone  
(Legend as Table 1.)



Figure 1. The hearthstone directions of remanence  
The projection is an equal angle stereographic plot.

It is clear that caution is needed in any interpretation of such observations as the effects of inhomogeneity of magnetisation, although largely reduced during measurement, still results in a higher noise-level than is desirable for an age assessment. Similarly, only a few samples yielded useful results. Thus the mean directions must be used cautiously whether based on all the data or on selected sample values as the calculated error probably underestimates the real error, which is probably nearer to  $5^\circ$  (solid angle) which would correspond to an error of  $15^\circ$  in declination. Comparison with other archaeomagnetic data for Britain, after all observations have been corrected to Meriden using the inclined geocentric dipole correct (See Appendix),

gives a mean direction of  $3.0^\circ$ ,  $74.3^\circ$ , based on all linear and consistent directions, and  $350.8^\circ$ ,  $70.7^\circ$  for the more precisely defined linearities and consistencies. The overall mean direction, corrected to Meriden, is  $351.0^\circ \pm 7.8^\circ$ ,  $70.4^\circ \pm 2.6^\circ$  (errors are for 95% precision). The Fisherian statistics for the combined Consistency & Linearity are arithmetic means to avoid apparent precision increases from the increased number of observations when only the same number of samples are involved.

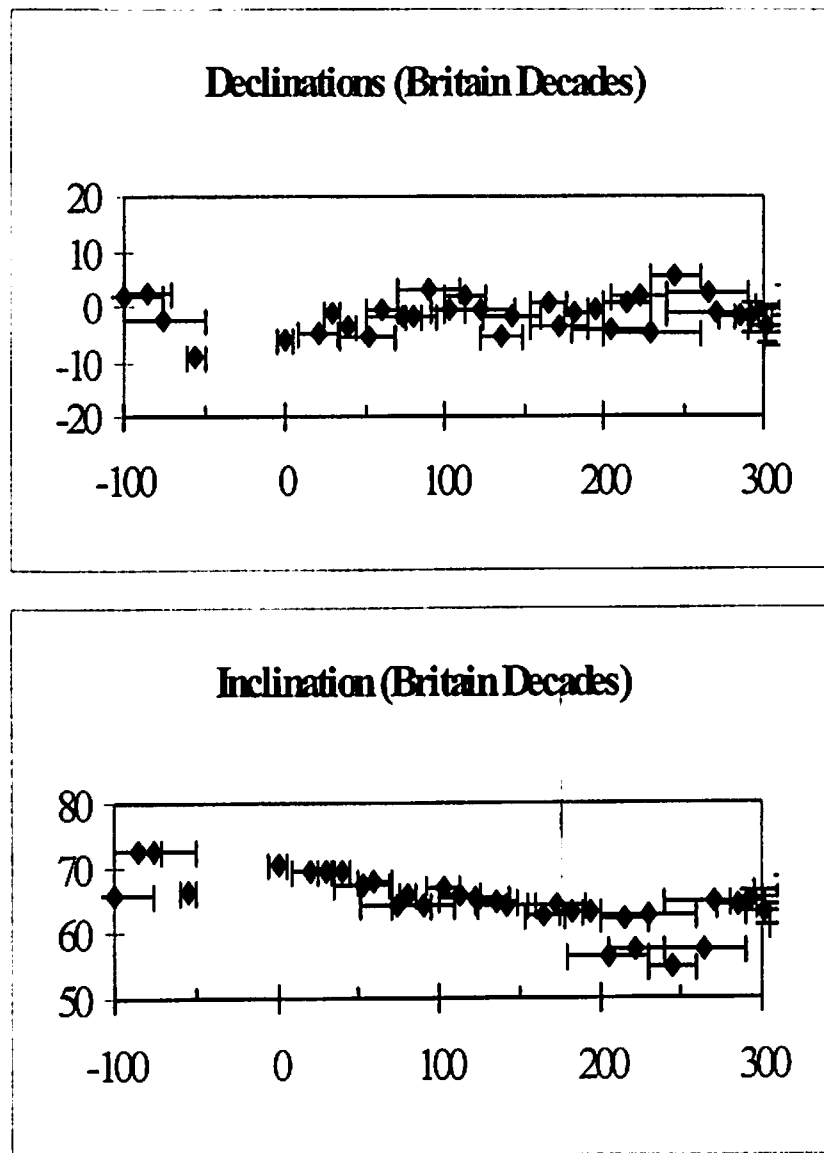


Figure 2 British data, corrected to Meriden, and the Meriden corrected hearthstone direction. (See text and Appendix for further explanation)

Comparison of this hearthstone determination with those for other British archaeomagnetic directions of well defined age ( $\pm 25$  years) and corrected to Meriden in the same way can be done in terms of the declination and the inclination. However, during Roman

times there was little change in declination (Figure 2a) making precise dating difficult on this parameter alone. Nonetheless, the hearthstone value is clearly most consistent with a slightly pre-Roman age, i.e. c. 60 BC, although the 95% probability limits do not exclude any age within the Roman period. The inclination values (Figure 2b) change throughout Roman times and the hearthstone value is clearly only consistent with somewhat pre-Roman or Early Roman times. Considering both declination and inclination, then clearly a slightly pre-Roman age seems most likely, but an early Roman age cannot be excluded. However, it must be emphasised that such age assessments are based on the mean values from selected samples from a single stone that may itself have tilted in any direction by a few degrees, which would drastically affect the age assessment provided.

### Summary and Conclusions

All of the baked clay samples were readily measurable, with intensities above the noise level of the instruments. In most cases, only one single component could be found in each sample and these were usually identical, irrespective of the analytical technique used to determine them. However, in all sites, the characteristic directions of magnetisation were extremely scattered. The precision and uniformity of the directions isolated within each sample, and the range of coercivity levels, means that the remanence can be ascribed to the time that the samples were last heated - rather than to any effects of weathering as this would have resulted in much more uniform magnetisation. The scatter observed therefore indicates major disturbances in each site, with several samples having been completely overturned and the majority of samples appearing to have been moved from their original position when originally subjected to firing. It is not possible to determine whether such disturbance was deliberate, accidental (e.g. during ploughing) or by natural processes (such as settling as a result of differential compaction of the underlying materials). However, it seems likely that deliberate or accidental human disturbance is the more likely in view of the large number of overturned samples. On this basis it is not possible to attempt any age assignment on such materials that appear no longer to be *in situ*.

The hearthstone does not provide samples of high reliability, but its magnetisation, assuming it to have remained *in situ* since its last firing, is most consistent with a slightly Pre-Roman, c. 60 BC or very early Roman age, although this age assessment must be regarded as tentative in view of the weakness and inhomogeneity of its magnetisation and the fact that only one oriented sample is involved.

### Site Contact

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