ARCHAEOMAGNETIC RESULTS FROM CASTELL HENLLYS, PEMBROKESHIRE

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Introduction

This site (52.00 N 4.75 W; grid ref. @@?@@) is part of the Pembroke National Park and covers approximately one acre enclosed by steep banks to the West, South and East, with defence work on the Northern side. The name Castell Hen Llys (Castle of the Old King) is thought to derive from the name of a nearby farm. The site was probably established around 350 BC and may have been largely abandoned in the 1st Century BC when farmland was occupied around it. There are signs of occupation during Roman times, with pottery links to northern England. The final phases are thought to have been Late and/or Post Roman. It can be considered a predominantly Iron Age site. Modern excavation commenced in 1981 and sampling for archaeomagnetic purposes was undertaken on Sunday August 8th 1994. A total of 4 separate features were sampled. In all cases, the sampling was by the disk method in which plastic disks are glued to the feature, the disk surface oriented using a sun compass, whenever possible, or a magnetic compass where the samples were in shadow. The samples were then removed, with the disk attached, and consolidated using polyurethane varnish. All measurements were made using a Digico magnetometer with a noise-level of ±0.01 mA/m (±0.01 A/m/kg). Each specimen was subjected to partial demagnetisation in a series of incremented peak fields (0, 3, 5, 10, 15, 20, 30 & 50 mT), with their remanence measured after each increment. Each magnetic vector was then examined visually, and by computer, to determine the most consistent direction of the magnetisation during demagnetisation, irrespective of its intensity, and the linearity of any components of remanence that could be detected for each individual sample. These directions were then compared with other directions from within the site and then with other sites within the immediate area and with those directions expected at this site location from previous studies within Britain.

Site CH1 Hearth (Context number 1293)

This feature was a hearth, attributed to Iron Age times, edged by flat stones placed on their edges and oriented approximately N/S and E/W. These stones showed clear evidence of having been heated. The positions of the samples were:

Sample 1.1 from the central West side

Samples 1.2-1.4 from the NE corner

Sample 1.5 from the central E side

Sample 1.6 from the southern end of the East side.

In addition, three samples (1.7 - 1.9) were taken from burnt clays and ashes immediately north of the hearth and apparently relating directly to it. (See below).

The intensity of magnetisation of all samples were readily measurable but much weaker than expected for such well fired stones. It is assumed that this low intensity reflects a low content of magnetic minerals within the stones themselves. After partial demagnetisation, the intensity decreased to 6 to 60% of the initial value by 15 mT treatment and the measurement error remained similar, between 10 and 20°. In all cases, the sample directions showed high consistency (DCI. greater than 7.0) and their magnetic vectors were well defined (diagonal angle less than 3.3°). Only one vector was isolated for each sample after removal of weak viscous components at 3 to 5 mT applied fields. This suggests that the magnetisation only represented the final heating. There is, however, only moderate consistency between the directions isolated for different samples whether defined on internal sample consistency or linearity (Table 1), although there was high consistency between these two analytical techniques for the same sample. The mean directions, obtained by either method, were therefore statistically identical but the precision was lower than expected for such a feature.

As the stones were flat, and oriented almost vertically, the most probable explanation for the scatter is that there has been some tilting of these stones by a few degrees (probably less than 10°). It would be expected that such a motion would have rotated the stones along the northern edge of the hearth so that they would now have directions which were shallower (if tilting into the hearth) or steeper (tilting away from the hearth), with little change in declination, than the original field direction when they were last heated. The directions of these three samples are steeper than those for the samples from the east and west sides, but the main scatter seems to be in the declinations. Nonetheless, it is suspected that the stones from the northern edge have tilted by a few degrees, probably 1-3°, away from the hearth. The tilt in or out of the stones on the eastern and western sides would move the magnetic vector in both declination and inclination. Assuming the mean direction to be approximately correct, then the direction

determined for the western sample (1) would be consistent with a small tilt away from the hearth, but the two easterly samples suggest only small and opposite directions of motion, i.e. sample 5 titling slightly into the hearth and sample 6 tilting slightly away. However, it must also be stated that such motions are very small and are only indicated, not proved. On this basis, it is safest to assume that the mean direction is a reasonable representation of the true mean direction for this feature and that the possibility of small motions are allowed for within the error in its determination. The overall mean direction is thus calculated as 353.1, 67.9 and the error is estimated as the mean of those determined for each of the two forms of analysis, i.e. $k = 24$, $\alpha_{95} = 13.9°$.

Figure 1. Sample Direction for site CH1

(The projection is stereographic, equal angle. The local geomagnetic field direction is shown as X)

Site CH1 Ashes Context number 1293

Three samples of reddened ashes were collected. These had much stronger magnetisation than the samples from the hearth stones (discussed above) and the measurement error remain extremely small, c.5°, throughout treatment even though the intensity had dropped to 10-20% of its original value after 15 mT. The directional consistency and linearity within each sample were somewhat better defined and more mutually consistent than for the stone samples,

Initial Consistency Linearity

No.	Int.	DCI.	N	Range	Decl.	Incl.	Range	N	d.a.	Decl.	Incl.
CH1 tiled hearth											
1	10	7.3	4	0 to 10	46.2	60.2	5 to zero	7	2.8	44.2	61.1
2	66	10.6	3	10 to 20	353.7	69.2	15 to zero	5	3.0	353.4	67.9
3	138	7.0	6	5 to 50	320.3	69.1	5 to zero	7	1.8	316.6	68.9
4	133	10.8	4	10 to 30	324.2	67.7	10 to zero	6	1.8	324.3	68.0
5	91	10.5	5	0 to 15	316.5	63.1	0 to 20	6	3.3	322.0	60.7
6	69	7.5	3	3 to 10	20.2	55.1	3 to 20	5	1.4	21.1	55.9
		Mean Values			353.5	68.1				352.9	67.7
					(N= 6	k = 24	α_{95} = 14.0°)	(N = 6	k = 25	α_{95} = 13.7°)	
CH1 ashes											
7	774	13.2	3	3 to 10	8.3	58.2	3 to zero	8	1.0	8.2	58.4
8	507	15.3	5	5 to 30	304.8	67.0	5 to 20	5	1.1	304.8	67.0
9	972	10.1	3	3 to 10	19.5	71.6	5 to 30	5	0.8	22.4	71.2
					352.4	68.9				353.2	68.9
				(N = 3	k = 24	α_{95} = 26.0°)		(N = 3	k = 23	α_{95} = 26.3°)	

Table 1. Sample intensity and directions for CH1 hearth and ashes

N is the number of samples. Initial Int. is the intensity of remanence (A/m/kg) measured 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. (>2.5 = consistent) and the linearity precision is defined by the diagonal angle (d.a. <2.5 = high linearity). The measurement of precision is k and the corresponding radius of 95% confidence is α_{95}. (See Appendix for references and explanation.)

although the reliability is similar for both the hearth and ash samples as there are fewer ash samples. However, the three samples had directions that were somewhat scattered and there was little individual agreement between them and the sample directions for the hearth (CH1) with which they were thought to be associated. However, they are broadly similar and the mean directions are statistically identical. As the precisions of both sets of observations are low, it can only be stated that the archaeomagnetic properties are consistent, but do not prove, that both the hearth and ashes are of the same age.

Site CH2 Context number 1382

This site comprised five samples from an area of burnt ashes attributed to a probable Roman age extending over an area of approximately 20 x 20 cm. All samples were quite strongly magnetised and readily measured. During demagnetisation, the measurement errors remained small, 5-10°, and the intensity had fallen to 50% of its original value after 5 mT treatment. There was high consistency in the individual sample directions of remanence and near perfect linearity, indicating that these samples only carried remanence from a single heating. Analyses based on either the consistency or linearity of the sample vectors showed a close identity in direction, with only sample 5 showing a slightly lower inclination than the

other four samples, but the angular difference is not considered significant. This feature is thus characterised by a very well defined direction;

Decl. 355.3, Incl. 60.3, $k = 770$, $\alpha 95 = 2.8°$

This direction similar but shallower than the present geomagnetic field direction at the site (Decl. 6.1°W, Incl. 66.9°),) and is considered to be representative of the Earth's magnetic field direction at the time that the burnt clays last cooled. The consistency also suggests that there has been no site disturbance since that time.

Figure 2. Sample direction for site CH2
(Legend as Fig. 1)

	Initial		Consistency				Linearity				
No.	Int.	DCI.	N	Range	Decl.	Incl.	Range	N	d.a.	Decl.	Incl.
1	2523	16.8	3	20 to 50	353.8	62.6	5 to zero	7	1.0	357.3	60.6
2	1223	24.8	4	10 to 30	356.8	62.7	10 to zero	6	1.2	356.8	62.7
3	4274	26.4	7	0 to 30	352.3	56.1	15 to zero	5	0.9	351.6	56.1
4	2414	23.5	4	10 to 30	355.8	61.7	3 to zero	8	1.6	354.0	61.4
5	3666	45.3	5	3 to 20	357.8	59.6	5 to zero	7	0.7	357.9	59.5
	Mean Directions				355.2	60.6				355.4	60.1
					(N = 5 $k = 731$ $\alpha_{95} = 2.8°$)					(N = 5 $k = 809$ $\alpha_{95} = 2.7°$)	

Table 2. Sample intensity and directions for CH2 ashes
Legend as for Table 1.

Site CH3 Context number 3509

This site comprised loose, unconsolidated burnt clays and ashes attributed to burning activity during the Iron Age, probably in Roman times. The intensity of magnetisation was variable, being strong in samples 4 and 7, but weak in other samples, although well above the measurement noise level in all cases. The individual measurement errors were similarly variable, being consistently very large, > 30° for sample 3 and it is not considered that a reliable determination of the remanence can be made for this sample. The remanence in sample 4 was also poorly definable, although the directions were consistent for different levels of treatment and the directions isolated for this sample were not dissimilar to those of the other samples. In general, the initial intensity dropped to 6 to 40% of its original value after 15 mT demagnetisation. The observations clearly suggest that several of the samples were inhomogeneously magnetised, which may be due to a variety of factors, such as differing quantities of magnetic material within each sample, but sample 3, in particular, has probably been disturbed or partially reworked since it accumulated. Sample 6 has a highly deviant direction to all other samples, although its suggest that this sample had moved, relative to the others, since they acquired their magnetisation. On this basis, two samples (3 & 6) were excluded from the calculation of the mean direction for this site.

Figure 3. Sample direction for site CH3
(Legend as Fig. 1)

	Initial		Consistency				Linearity				
No.	Int.	DCI	N	Range	Decl.	Incl.	Range	N	d.a.	Decl.	Incl.

1	18	5.9	4	3 to 15	358.5	58.2	3 to 15	4	4.8	355.7	59.6
2	30	8.0	6	0 to 20	1.0	63.8	5 to 20	4	1.9	357.8	64.9
3	18	0.9		inhomogeneity errors >30°					None		
4	330	3.8	4	0 to 10	0.4	58.4	5 to 50	6	4.5	358.3	58.1
5	40	4.8	8	0 to 50	358.9	70.6	3 to zero	8	4.1	0.7	70.9
6	41	6.3	4	5 to 20	253.1	54.2	3 to 20	5	3.3	247.9	57.1
7	487	5.8	4	0 to 10	4.1	52.6	0 to 20	6	1.6	1.7	52.4
Mean Direction (Exc. 3 & 6)					0.8	60.7				358.9	61.2
					(N = 5 k = 138 α_{95} = 6.5°)					(N = 5 k = 130 α_{95} = 6.7°)	

Table 3. Sample intensity and directions for CH3 hearth and ashes
Legend as Table 1.

Site CH4 Context number @@@

This was a compacted area of red burnt ashes, lying on flat stones, thought to be of Iron Age, possibly pre-Roman age. Only four samples were taken from a square shaped area cut into the ashes which were some 5 cm thick, as it was considered possible that the area had suffered compaction since the ashes were emplaced..

Figure 4. Sample direction for site CH4
(Legend as Fig. 1)

Initial Consistency Linearity

No.	Int.	DCI	N	Range	Decl.	Incl.	Range	N	d.a.	Decl.	Incl.
1	1086	5.6	4	0 to 10	34.4	76.7	5 to 20	4	0.5	30.2	78.2
82	1095	3.9	5	0 to 15	9.8	63.3	0 to 20	6	3.3	13.0	65.5
3	1468	3.8	4	3 to 15	338.4	67.3	3 to 50	7	3.4	337.8	67.1
4	1311	5.1	4	0 to 10	5.3	62.8	0 to 30	7	2.2	15.7	64.3
	Mean Directions				7.4	68.6				7.0	69.8
					(N = 4 k = 62 α_{95} = 11.7°)					(N = 4 k = 67 α_{95} = 11.3°)	

Table 4. Sample intensity and directions for CH4 ashes
Legend as for Table 1.

All samples were very strongly and uniformly magnetised. The directions isolated within each sample showed high consistency and well defined linearities, with similar directions isolated by both analytical methods. The directions isolated in different samples were similar to each other, with samples 2 and 4 almost identical, but sample 1 had a steeper, more easterly direction and sample 3 direction was slightly steeper and more westerly. The scatter about the mean direction was therefore greater than would have been expected for materials that had been fired at the same time and remained exactly in the same relationship to each other. It seems possible, but not established, that samples 2, 3 & 4 had been somewhat more compacted than sample 1, resulting in a somewhat shallower direction and that such motion also somewhat scattered the declination values. Clearly, the results from this site must be treated cautiously in any age assessment.

SUMMARY and Assessment

In all cases, the scatter was greater than would be expected for completely undisturbed sites, although site CH2 showed least disturbance. However, the disturbances seems to be relatively small for any individual sample, with a few notable exception that have been excluded from the calculation of the mean direction. On this basis, the mean directions can be used for an

		Decl.	Incl.	N	α_{95}°	(Meriden)
CH1 Feature Ref 1293	Roman? hearth	353.1	67.9	6	13.9	(353.2 68.0)
	Roman? burnt clays	352.8	68.9	3	26.2	(352.7 69.0)
Combined		353.1	68.2	9	13.4	(353.1 68.3)
CH2 Feature Ref 1382	Roman? burnt clays	355.3	60.3	5	2.8	(356.1 60.5)
←CH3 Feature	Iron Age? burnt clays	0.4	61.0	5	6.6	(1.1 61.4)
⇐CH4 Feature	Iron Age? burnt clays	7.2	69.2	4	11.5	(7.2 69.7)

Table 5. Castell Henllys Site Mean Directions after Correction to Meriden.
This correction is to give the expected direction at Meriden (52.4°N 1.6°W) assuming a geocentric dipole geomagnetic field. This enables direect comparison with other U.K. data (See Appendix).

Figure 5. The British Archaeomagnetic Curve, corrected to Meriden
The declination & inclination for the Castell Henllys sites are shown as 1, 2, 3 and 4.

rather than definitive. After corrected to a central location (Meriden), the mean directions (Table 5) can then be compared directly to other British data corrected to the same location (Figure 5). age assessment, although it must be emphasised that the errors in each determination precludes ANY reliance on such assessment and, as such, then can only be taken as indicative of the age

The inclination values, which are the most diagnostic for this period as the declination only changes slightly, appears to indicate that sites 1 and 4 could be of Pre-Roman or early

Roman (100 BC to 50 AD) while those of sites 2 and 3 are most consistent with a late Roman age (160 AD to 270 AD). However, the declinations for sites 1 and 2 are most consistent with a Pre-Roman age (80 BC to 20 BC) while sites 3 and 4 declinations are most consistent with ae even earlier or much later age. There is thus a conflict in the age assessments, although all the differences are within the error limits. Such a conclusion is disappointing and entirely reflects motions of individul samples within the site prior to collection and subsequent to firing.

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Travel estimated at £82.00

Location

Castell Henllys Iron Age Site, Pembroke National Park

IGRF -6.1 66.9

Orientations

1	43	37	81	Stone rim E
2	158	152	9	NE
3	119	113	79	NE
4	106	100	28	NE
5	223	117	111	WNW (overtilt correct)
6	215	209	28	WS corner
7	93	87	10	burnt area on N
8	183	177	12	
9	233	227	4	

CH2	Magn	CorrMag		Site Ref 1382 Roman?
1	218	212	2	
2	193	187	3	
3	182	176	7	
4	171	165	12	
5	251	245	4	

CH3		BST	Site ref. 3509	Iron Age	SunOut	
1	156	09.36	13	Sun compass	82	13
2	58	09.37	12		344.5	12
3	171	09.36	9		33	9
4	358	11.34	4		316	4
5	167	11.35	20		125	20
6	216	11.38	8		49	8
7	187	11.37	3		146	3

CH4	Magn	CorrMag		Site ref to be sent Iron Age
1	43	37	4	5 cm thick red burnt area - square cut out and sampled edges
2	77	71	2	
3	135	129	8	
4	192	186	2	

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