Ancient Monuments Laboratory
Report 14/91

ARCHAEOMAGNETIC STUDY OF HEARTH 1627, ST GILES HOSPITAL, CATTERICK BRIDGE, YORKSHIRE

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Summary

A total of 13 oriented stone blocks were removed for archaeomagnetic study from a rectangular hearth, feature 1627, in Area 4 of the Saint Giles Hospital excavations, near Catterick Bridge. Three samples were too weakly magnetised for analysis but the remainder were found to contain a strong, stable and well defined remanence due to firing in the ancient field. After partial demagnetisation and correction to Meriden, the mean remanence vector (D=5.6, I=63.0) was compared to the UK master curve to yield magnetic dates of either 1260-1280 or 1395-1445 A.D.. The ambiguity arises from the positioning of the mean vector close to an intersection in the archaeomagnetic curve.

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INTRODUCTION

Excavations at St Giles Hospital, Brompton Bridge have exposed a Mediaeval hospital complex and associated features. In a previous archaeomagnetic study we investigated the directions of magnetisation in a large millstone hearth, no. 2034, and suggested that this structure was last fired between 1490 and 1530 A.D. (Archaeometrics, 1990). Continued work in Area 4 has since revealed a second hearth built of substantial stone blocks, up to 40cm long, with little evidence for later disturbance (feature 1627; Figure 1). Colour changes within and beneath this hearth provided good evidence that the structure had been thoroughly heated during use. It was therefore decided to obtain a set of archaeomagnetic specimens with the following objectives in mind:

1 Investigate whether the hearth had acquired a stable, uniform thermoremanent magnetisation as a result of being heated in the ancient geomagnetic field.

2 Obtain an absolute archaeomagnetic date for the feature by comparing the mean remanence direction with the British master curve.

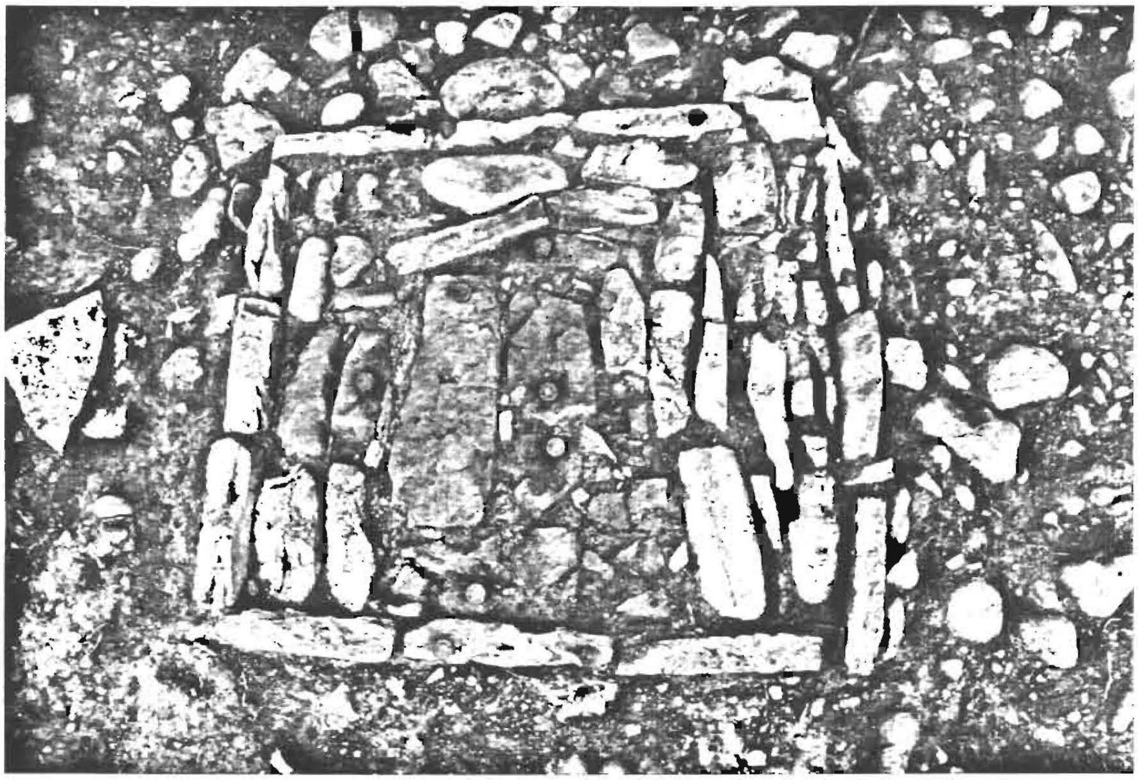
3 Compare archaeomagnetic dates for hearths 1627 and 2034.

A brief introduction to the principles and methods of directional archaeomagnetic dating was given in our previous report. For more detailed information consult Clark, Tarling and Noel, (1988).

SAMPLING AND MEASUREMENT

Hearth 1627 was an approximately 80cm square feature constructed of tightly packed stone blocks set on edge within a frame made up of thinner vertical flags. Because there were no plans to conserve the hearth it was possible to choose optimum positions for the archaeomagnetic specimens and also to remove the largest block for controlled subsampling in the laboratory.

The button method and a sun compass were used to record the orientation of a total of 13 stone blocks at the locations shown in Figure 1. Using a clinometer, the upper surface of the hearth was found to be horizontal and it was therefore assumed that little, if any, overall rotation had occurred. Furthermore, by selecting the largest and most tightly wedged blocks, the possibility of internal rotation introducing error into the mean archaeomagnetic direction was also minimised.



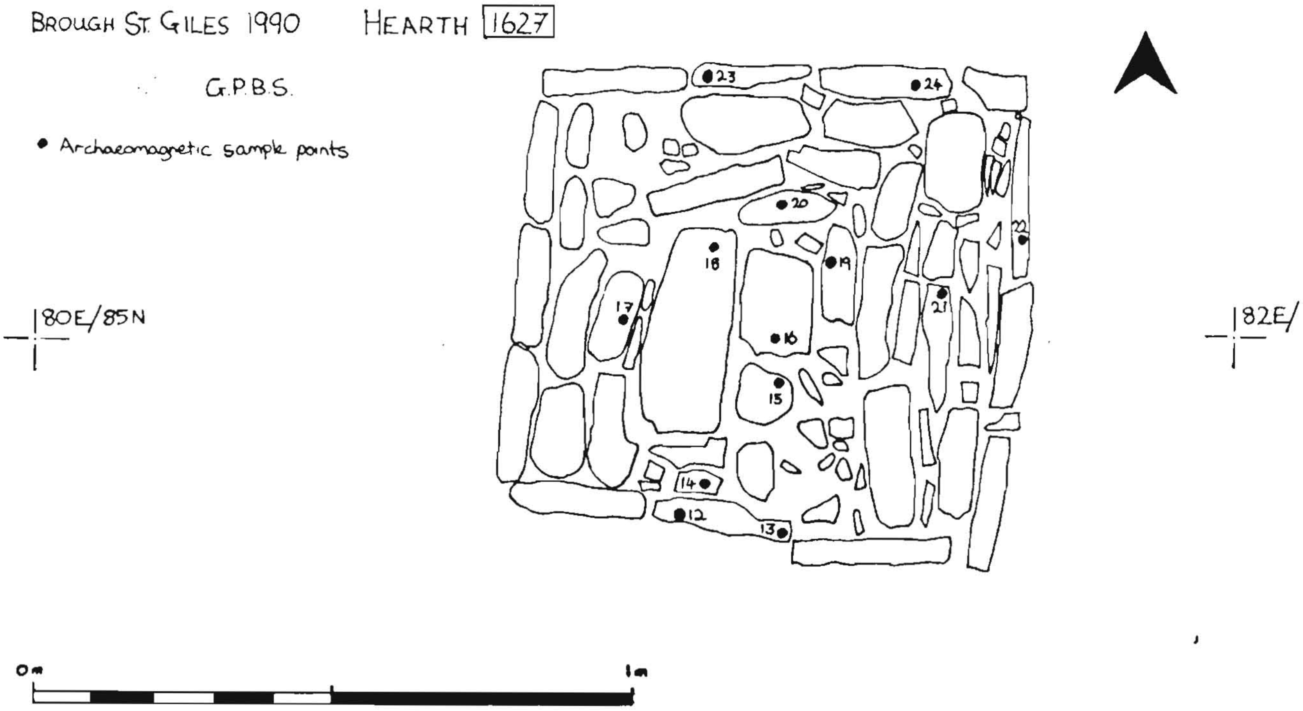


Figure 1. Hearth 1627 at Saint Giles Hospital and the positions of the archaeomagnetic samples as shown by the numbered circles.

The largest block (No. 18) was reoriented in the laboratory and a further two buttons fixed to the upper surface. These are identified as specimens 18a and 18b in Table I. Using a diamond impregnated saw, the blocks were then cut until each button retained a small fragment which could be mounted inside a standard 25x25mm specimen holder for inserting into the magnetometer. Finally, the specimens were briefly etched in dilute hydrochloric acid to remove any ferrous surface contamination that might have been introduced by the sawing.

The petrology of the 13 hearth stones was examined in hand and sawn section and is summarised below:

BSG 12, 13 and 21-24:
Bioclastic wackestone (=BW)

Apparently recrystallised bioclastic debris (mainly crinoid ossicles but with bivalve fragments) 'float' in what was probably originally a clayey-carbonate mud matrix. Both comminuted and fairly fresh crinoidal clasts are seen and are typically 1-1.5mm across. The matrix shows varying degrees of thermal alteration, ranging in colour from strong brown (Munsell dry colour 7.5YR 5/6) to dark red (10YR 3/6).

BSG 14:
Thermally metamorphosed impure bioclastic limestone (=BL)

This specimen was difficult to identify. Mottled weak-red (2.5YR 4/2) and dark reddish grey (10R 3/1), its 'vesicular' texture is suggestive of a lava. Some vesicles are elongate and are reminiscent of a bioclastic limestone following dissolution of its framework clasts. No reaction with dilute HCL. One crinoid ossicle seen.

BSG 15-17, 18, 18a, 18b and 20:
Very fine grained quartz arenite (=QA)

Predominantly composed of angular to subangular quartz grains. Colour ranges from light grey to dark reddish brown (5YR 2.5/2) when thermally altered. A faint sub-millimetre lamination is seen in some of these samples.

BSG 19:
Bioclastic packstone (=BP)

Apparently un-recrystallised comminuted bioclastic debris (predominantly bivalve and a little crinoid material), clasts typically 0.25-3mm in diameter although some fragments are up to 8mm long, surrounded by a grey/dark grey (5YR 5-4/1) mud matrix.

From a preliminary reconnaisance it would appear that all of these lithologies are represented in the boulder clay and flood deposits exposed below the river bank.

MEASUREMENT

The natural remanent magnetisation of all the samples was first measured in a Molspin fluxgate spinner magnetometer (Molyneux, 1971) with a minimum sensitivity of around $5x10^{-9} Am^2$. Remanence directions were corrected for the solar orientation using the Air Almanac and the procedure described by Creer and Sanver (1967). These are shown as equal area vector plots in Figure 2 and the complete data are summarised in Table 1. As in our previous study, the remanence stability of pilot specimens was examined using the technique of stepwise demagnetisation in alternating magnetic fields to a peak intensity of 40mT. From a study of the pilot sample demagnetisation behaviour (Figure 3), it was decided to partially demagnetise the remaining samples in an alternating field of 2.5mT in order to remove any secondary components of remanence. The remaining primary magnetisation was then remeasured in the spinner magnetometer. These data are plotted in Figure 2 and listed in Table 1.

RESULTS AND DISCUSSION

Intensities of the natural remanent magnetisation varied over four orders of magnitude ($496.65-0.04x10^{-5}Am^2kg^{-1}$) with both the most intense and the weakest magnetisation occuring in samples of bioclastic wackestone. This could reflect either a primary inhomogeneity of magnetic minerals in this lithology or, more likely, a varying degree of thermal alteration. Specimens BSG 21, 22 and 24 were too weakly magnetised to measure reliably in the magnetometer and were therefore excluded from further analysis. These samples are responsible for the three misfit vectors seen in the natural remanence plot of Figure 2. Directions of magnetisation in the remaining 12 specimens are very tightly clustered about a mean direction which has clearly been geomagnetically controlled.

The results of the demagnetisation tests carried out on pilot specimens BSG 15 and BSG 18b indicated that the archaeomagnetism comprises a single component of excellent stability. The remaining samples were partially demagnetised in the weak alternating field of 2.5mT simply to ensure the removal of any weak viscous components that might have been acquired during transport and storage. Comparison of results shows that this treatment caused a slight improvement in the clustering of vectors (Figure 2; Table I). Finally, a correction was made to adjust the mean archaeomagnetic direction to Meriden, the reference locality for the British master curve (Clark, Tarling & Noel, 1988). This has the main effect of slightly reducing the inclination. The mean direction falls close to a crossover point in the reference curve and hence two possible dates for final use of this structure can be inferred. These are 1260-1280 A.D. or 1395-1445 A.D. (Figure 4).

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Hearth 1627 Area 4

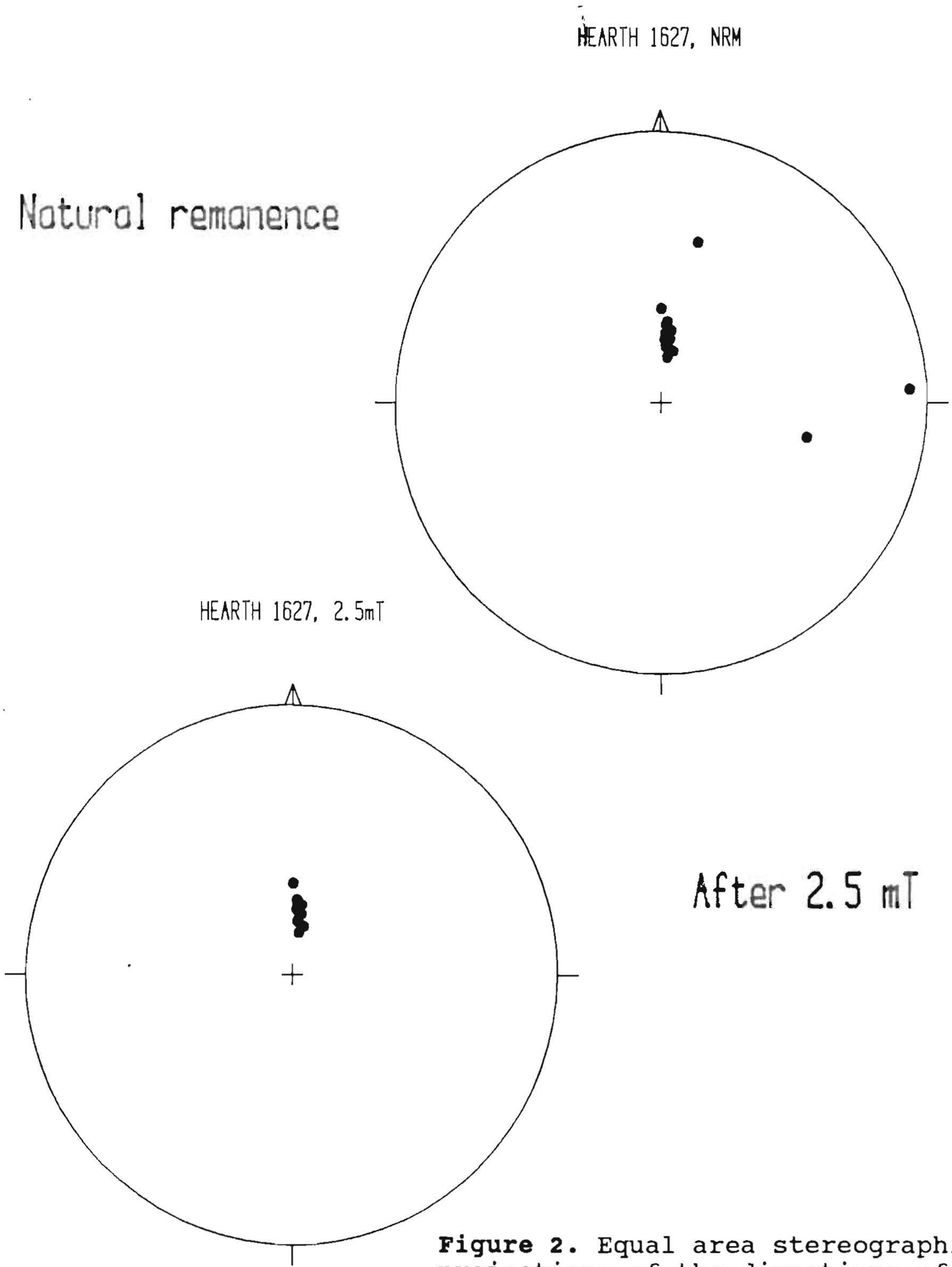

Figure 2. Equal area stereographic projections of the directions of archaeomagnetism before and after partial demagnetisation. Three weakly magnetised specimens have been excluded from the second set of data.

St. GILES HOSPITAL

Hearth 1627 Area 4

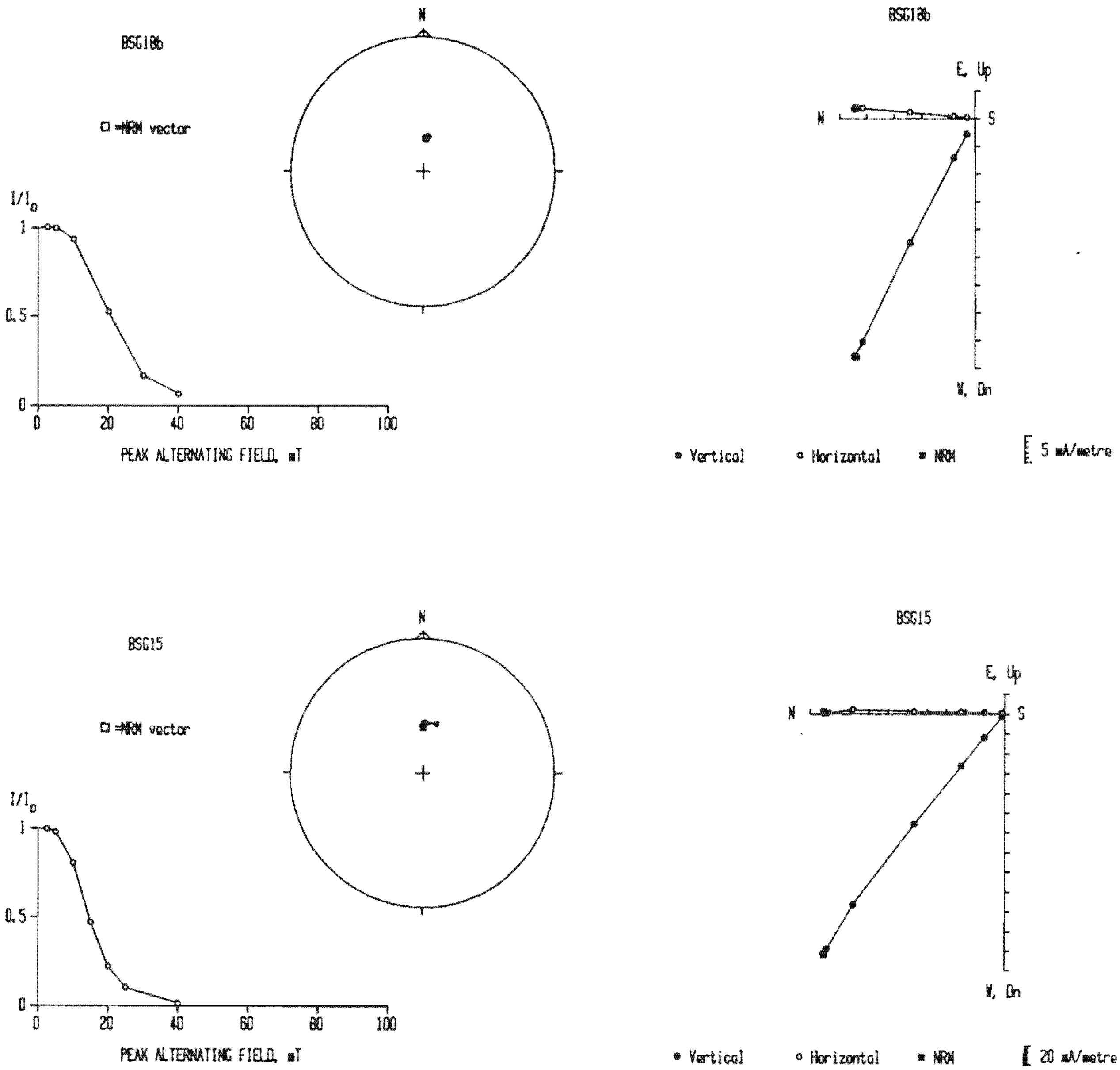

Figure 3. Demagnetisation of samples BSG 15 and BSG 18b shown as graphs of change in the intensity with increasing field along with a stereographic projection of associated directions. Results are also portrayed as a vector endpoint plot in three dimensions.

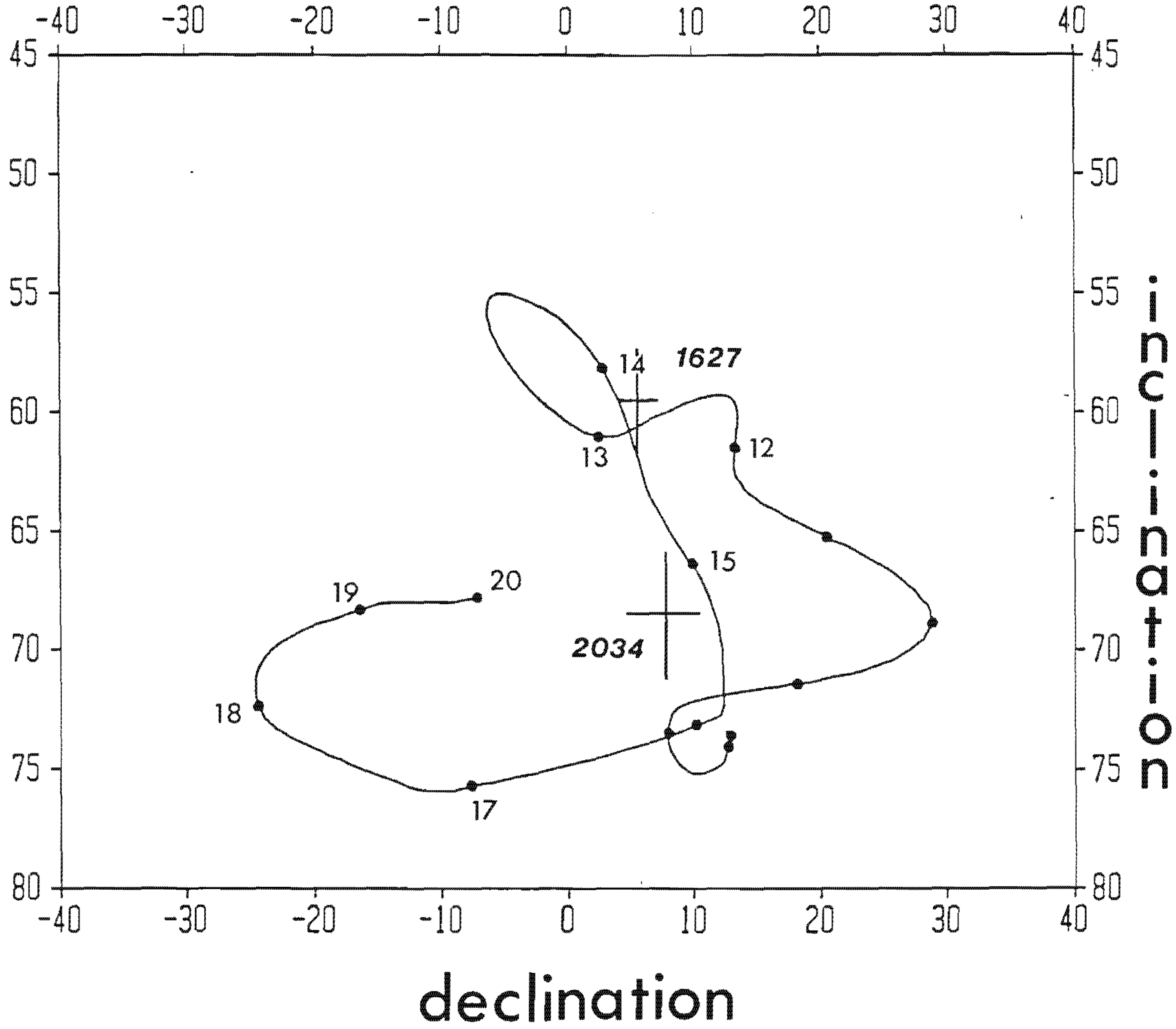

Figure 4. The mean archaeomagnetic direction for hearth 1627 restored to Meriden and compared to the UK master curve and the earlier result from hearth 2034. The archaeomagnetic result suggests two possible dates, viz.: 1260-1280 or 1395-1445 A.D..

CONCLUSIONS

Referring to the statement of objectives in the **Introduction**, we can summarise the results of this study as follows:

1 Hearth 1627 has acquired a stable remanent magnetisation as a result of being heated in the ancient geomagnetic field.

2 Comparison of the mean archaeomagnetic direction with the UK master curve suggests that this hearth was last used 1260-1280 A.D. or 1395-1445 A.D..

2 If the youngest archaeomagnetic date is favoured, then the evidence suggests that hearth 1627 was last used about 90 years before hearth 2034 was abandoned.

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Report compiled by: ....[signature]....

Date: 23/11/90

Table 1
Archaeomagnetic results from Hearth 1627

Sample	LITH	J	D	I	A.F.	D	I
BSG12	BW	496.65	8.8	59.6	2.5	7.9	60.6
BSG13	BW	69.61	7.2	62.4	2.5	6.4	63.4
BSG14	BL	1.33	5.0	56.3	2.5	4.0	59.7
BSG15	QA	158.12	0.4	51.7	2.5	0.3	52.4
BSG16	QA	18.50	4.4	61.9	2.5	4.7	63.1
BSG17	QA	42.58	14.3	67.7	2.5	13.5	69.0
BSG18	QA	8.05	4.1	61.2	2.5	4.3	62.4
BSG18a	QA	26.74	8.4	63.2	2.5	8.6	64.3
BSG18b	QA	10.24	4.1	63.5	2.5	4.5	62.5
BSG19	BP	29.61	4.3	57.7	2.5	3.5	58.8
BSG20	QA	49.88	6.3	66.6	2.5	5.7	67.6
BSG21	BW	0.04	13.5	27.3	-.-	-.-	-.-
BSG22	BW	0.06	103.0	31.1	-.-	-.-	-.-
BSG23	BW	73.38	8.5	70.6	2.5	8.5	72.1
BSG24	BW	0.04	86.9	3.8	-.-	-.-	-.-
MEAN		65.66	5.9	61.9		5.6	63.0
AT MERIDEN						**5.6**	**59.4**

circular standard error=1.6°
circular standard deviation=5.4°
$alpha_{95}$ =2.9°

NOTES:

LITH=Lithology: BW: Bioclastic wackestone, BL: Thermally metamorphosed impure bioclastic limestone, QA: Very fine grained quartz arenite, BP: Bioclastic packstone.

D=declination, I=inclination, J=intensity $Am^2kg^{-1} x10^{-5}$
A.F.=demagnetising peak alternating field, mT. Figure for D and I in the right hand columns are after partial demagnetisation.

Blank entries in the table represent magnetisations too weak to measure accurately.

Results for samples 21, 22 and 24 have been omitted from the calculations of mean values.