ARCHAEOMAGNITUDE DETERMINATIONS FOR BRITAIN AND SOUTH-WEST USA FROM 600 AD TO 1700 AD AND THEIR IMPLICATIONS FOR MEDIEVAL POTTERY STUDIES

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Summary

A report on the archaeomagnetic results for eighteen British and five South-West American pottery samples shows that in both areas sampled field strength fluctuations occurred over the 1100 years between 600 and 1700 years AD. The variations in Britain and South-West America are not in phase and suggest a westward drift of non-dipole features of 0.32% per year. Whilst these results offer the possibility of dating individual pottery sherds from excavations, limitations in the method, period coverage and lack of resources for further work suggest that considerable work will be needed before a service to archaeologists could be offered.

Four years ago Medieval Ceramics published an account of archaeomagnetic research using fired clay objects which appeared to have the potential for dating fragments of pottery recovered from archaeological contexts removed from the actual kiln sites (Games 1981). This led to the involvement of the Medieval Pottery Research Group in the collection of well dated material from Britain and Ireland in order to establish a usable curve for that area. This paper is divided into two parts: first, an account of the results obtained from the British samples, together with a small group from South-West USA and a discussion of their geophysical importance (KPG) and secondly, an assessment of the implications of this work for medieval pottery studies (PJD).

Introduction

This project was undertaken with the intention of obtaining curves of the magnitude of the geomagnetic field in Britain and South-West USA over approximately the same time period. The intention was (a) to see if the rapid large changes in field strength observed by many authors for other parts of the world were seen in our two locations, and (b) by comparing field strengths at two sites of similar latitudes but far apart, it was hoped that it would be possible to decide whether these fluctuations were due to dipole or non-dipole field changes. As it happens, due to lack of time available to complete this study, not enough data could be obtained to make definitive conclusions. Using other recent American results to complement the data from South-West USA, however, it seems that some conclusions can tentatively be drawn from this study.

Method and Material

All of the samples used in this study were fired ceramics, and Shaw's ARM method (Shaw 1974) was used in all cases to determine the archaeomagnitudes.

The maximum alternating field used to demagnetize the samples was 170mT, and the TRM was installed parallel to the NRM to avoid anisotropy problems (Rogers, Fox & Aitken 1979), and the TRM was imparted over a seven-hour cooling period so as to minimise any cooling rate dependence (Fox & Aitken 1979). In all cases only samples which could be accurately dated were used for this study. Samples of the British pottery were kindly supplied by members of the Medieval Pottery Research Group, and those from USA were provided by Dr R. Sternberg of the University of Arizona.

Results

Sample	Source*	Date	Field Strength
B105AP4	Hen Domen	c.1150	31 ± 2
B107AP1	Hen Domen	c.1150	40 ± 2
B110AP1	Hen Domen	c.1150	26 ± 3
B111AP1	Hen Domen	1200 - 1250	48 ± 2
BO14AP3	Carrickfergus, Ulster	1200 - 1250	49 ± 3
BO14AP1	Carrickfergus, Ulster	1200 - 1250	40 ± 1
B705AP1	Okehampton Castle, Devon	1220 - 1260	42 ± 6
B704AP1	Newenham Abbey, Devon	1285 - 1320	53 ± 2
B124AP1	Hen Domen	1325 - 1375	48 ± 2
B125AP2	Hen Domen	1375 - 1425	53 ± 3
B005AP1	St Andrew's Church, Gt Linford	1473	55 ± 3
B009AP4	Farnborough Hill, Hampshire	1560 - 1575	51 ± 5
B025AP4	Bristol	1581 - 1596	37 ± 3
B025AP5	Bristol	1581 - 1596	48 ± 4
B703AP1	Queen St., Exeter	1590 - 1610	50 ± 2
B000AP1	Rainford, Merseyside	1635 - 1655	53 ± 2
B706AP2	Holloway St., Exeter	1643 - 1660	50 ± 2
B024AP1	South Castle St., Liverpool	1729 - 1734	40 ± 1
MO3CCO2AP1	Chaco Canyon, New Mexico	c. 625	32 ± 2
MO3EAN1CAP2	Canyon de Chelly, Arizona	700 - 750	43 ± 2
MO3WAP1CAP1	Green Bear Site, Lupton, Arizona	790 - 810	43 ± 4
MO3ECA1CAP1	Pueblo del Encierro, New Mexico	1479 - 1520	49 ± 2
MO3EWA2AP1	Walpi, Arizona	1700 - 1800	58 ± 3

(* for more complete information on these samples see the appendix)

(a) British Archaeomagnitudes

In all, 97 samples of British pottery were studied and 18 successful archaeomagnitude determinations were made. Fortunately, these covered a fairly short time period from 1150 to 1730 AD. As a result, a convincing curve of field strength against time can be drawn for this period (Fig. 1). This curve shows a maximum of the field occurring at c. 1450 AD, with the field being about 55% of the maximum at 1150 AD.

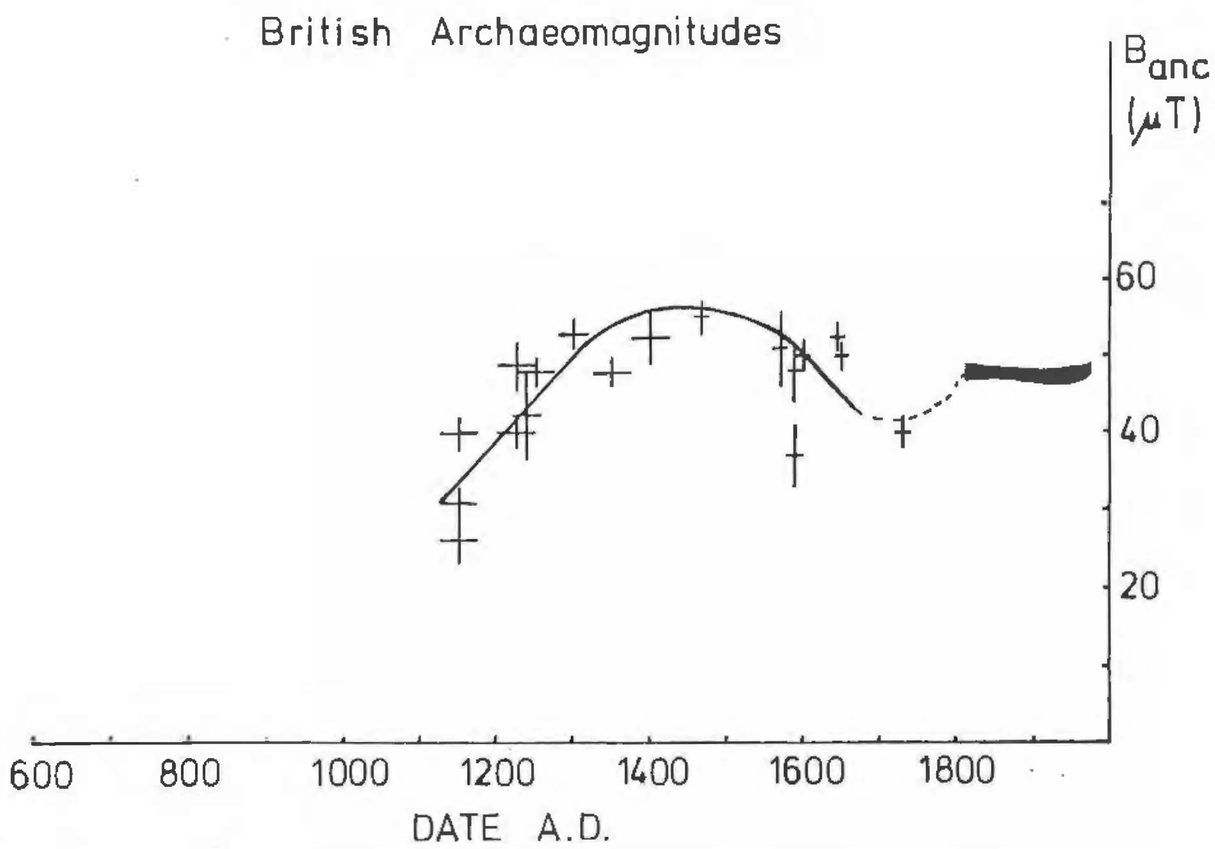

Fig.1

(b) South-West USA Archaeomagnitudes

For this study, 19 samples were processed from the American material, out of which five reliable archaeomagnitude determinations were produced. These have been plotted in Fig. 2 together with results obtained by Sternberg and Butler (1978), who used the Thellier method on ceramics from Snaketown, Arizona, and results obtained by Champion (1980) who also used the Thellier method on recent lava flows. The first thing of interest is that where these results overlap in time they show good agreement with each other. In all there are 14 results covering the

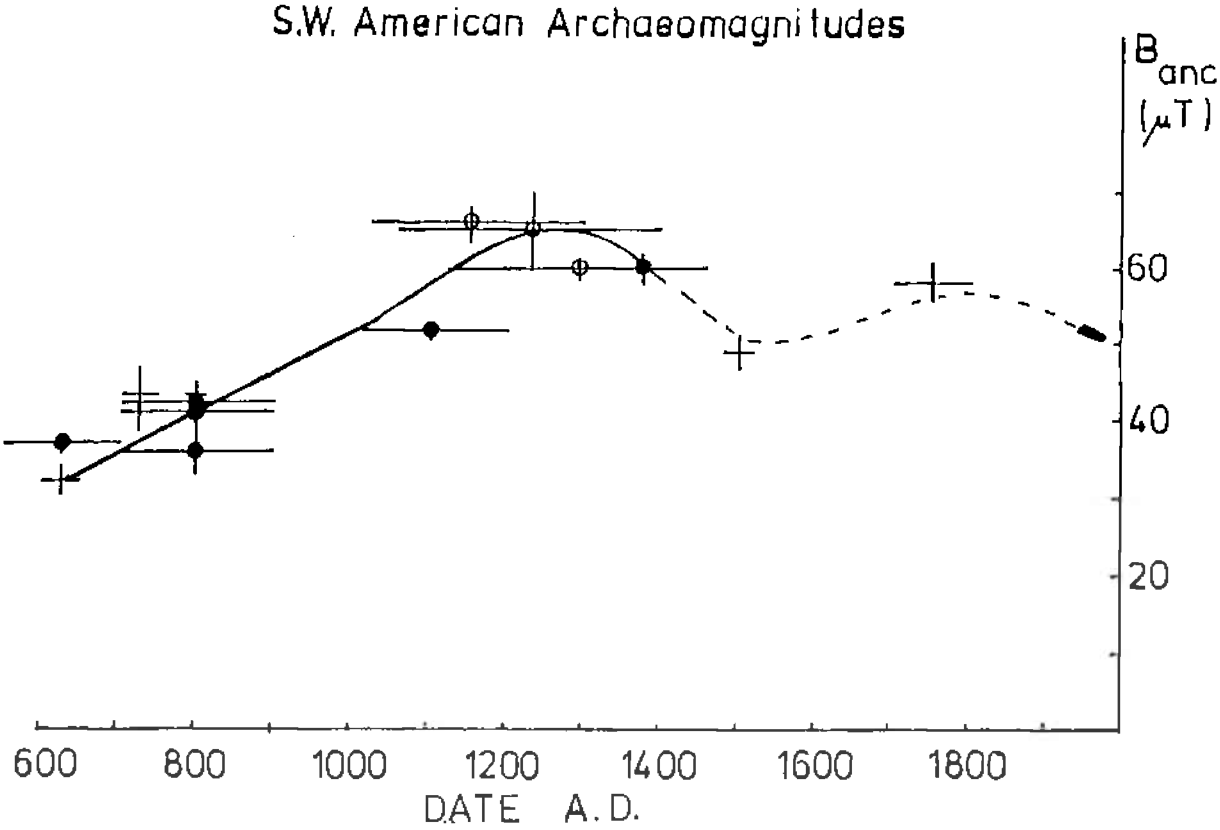

Fig.2

period 600-1750 AD. These results enable us to define a portion of the curve between 600 and 1400 AD. During this period there is a maximum at c. 1250 AD, and the field is about 50% of this value at c. 600 AD.

Discussion of results

It can be seen from Figs. 1 and 2 that these results do confirm the large rapid fluctuations in field strength already referred to. Moreover, it would seem that the variations in Britain and South-West USA are either not in phase, which would point to drifting non-dipole sources as the cause of these fluctuations, or they are not correlated at all. It was hoped that it would be possible to detect these non-dipole features drifting from Britain to South-West USA. Estimates for the rate of westward drift vary from 0.2% / year (Yukutake 1967) to 0.4% / year (Creer 1981), and using these values, a non-dipole source in Britain would take between 560 and 280 years respectively to reach South-West USA. It is unfortunate that when we compare the data in Figs. 1 and 2 we see that the well-defined part of the South-West USA curve is older than the well-defined part of the British curve, and hence the existence of a westward-drifting feature cannot be checked. If, however, the dotted portion of the curve of the South-West USA data is real, then the tentative maximum at c. 1800 AD may correspond to the maximum at 1450 AD on the British curve. This would indicate a westward drift rate of 0.32% / year. This, of course, is a very tentative comparison, and until more data are obtained between 1400 and 1900 AD for South-West USA and between 600 and 100 AD for Britain, no more meaningful comparisons can be made from these results.

The Archaeological Implications

It is clear from these results that during the medieval period the values obtained for variations in the residual strength of the earth's magnetic field fluctuate by large amounts as in other areas and periods (e.g. Peru - Gunn & Murray 1980, for the period 0-1400 AD; Egypt - Games 1980, for the period 0-3000 BC) and that, therefore, the dating of British archaeological material by this method is a possibility. It has the enormous advantage for archaeologists of being applicable to fragments of fired clay such as occur in quantity on most excavations and not being dependent on the recovery of a hearth or kiln structure in situ. In order to apply this technique to medieval pottery from Britain and Ireland two groups of problems need to be considered. The first centres on limitations in the method itself and the second on specific difficulties with the results obtained so far for our region.

As the variations in the earth's magnetic field strength are cyclic, with a periodicity of around 400 years between maximum and minimum values (e.g. the Peruvian results - Games 1981, 23, Fig. 5) any results obtained cannot be translated directly into absolute date ranges. For example, Peruvian pottery produced around 1500 AD and between 300-500 AD will give the same range of archaeomagnitude values. Unless there is independent evidence for the rough dating of a particular sherd, the results will remain ambiguous, with the added difficulty that similar values occur around 700 AD and again around 900 AD. Even where the approximate date range of a sherd is known, the method can only discriminate between points on the steep upward and downward slopes of the curve. At its peaks and troughs field strength changes only slowly. Thus similar results would be obtained from pottery made in Peru from between 200 and 500 AD. On the British curve (Fig. 1) a Civil War vessel should not be distinguishable from one produced around 1250 AD. In addition, it must be remembered both that a laboratory error of up to $\pm$ 5% may mean a date variation of as much as $\pm$ 40 years at higher points on the side of the curve, and that local non-dipole variations can be as much as 18T (Games 1981, 21). Variations in pottery fabric may also provide another area of difficulty. Work on pipe clay artifacts from Rainford suggested that, whilst satisfactory results were obtained from objects made in locally derived Coal Measure Clays during the 17th century, the much purer and almost totally iron free clays imported from the south-west peninsula during the 18th century could not be used (Games 1981). This suggests that there might be problems with the fine products of the Saintonge or Surrey white-ware industries. A further practical problem is the number of sherds which may need to be submitted for satisfactory results to be obtained. In the present study only 18 out of 97 British and 5 out of 19 American samples produced usable data. This implies that future work should concentrate on common fabrics rather than rarities or exotics. Finally, any results obtained will probably be meaningless if iron was used in the kiln structure. This will probably rule out many later post-medieval production centres.

The second group of difficulties lies with the particular nature of the British results themselves. The first point is that the date range covered only includes the high medieval and post-medieval periods. If the Peruvian and Egyptian results are any guide, archaeomagnitudes should start to increase again before around 1000 AD. If this should turn out to be the case, a reliable curve will be needed in order to date Saxon and Saxo-Norman ceramics. A priority for future research should be the study of Roman and early medieval pottery in order to extend the curve backwards. This would have the effect of making the comparison with the USA curve more viable. The British peak at 1450 AD means that the method is not likely to be able to separate material produced between 1350 and 1550 AD, but, provided it is already known that a particular sherd is pre-1450 and post-1100, reasonable discrimination should be possible.

Postscript

This project is not being pursued at Liverpool at the moment due to lack of funding. In order to progress further on the geophysical or archaeological front, renewed grant aid will be needed.

APPENDIX

Further details of samples used in this study

B105AP4	Pottery from Hen Domen, Britain, Middle Period; Fabric type 5; site code: HD80, F1177. Donor: DOE, via P.A. Barker.
B017AP1	As B105AP4; Fabric type 8; site code: HD71.
B110AP1	As B105AP4; Fabric type 9, Group 3; site code: HD, Pit 1/27, 13.
B111AP1	As B105AP4; Fabric type 19; site code: HD 70, 46b, 1 I-II.
B014AP3	Carrickfergus, Ulster, Ireland; coin-dated kiln group. Donor: Department of Antiquities, Ulster Museum, Belfast.
B014AP1	As B014AP3.
B705AP1	Okehampton Castle, Devon, Britain, found 1829. Donor: Royal Albert Memorial Museum, Exeter.
B704AP1	Newenham Abbey, Devon, Britain; fragments of tile dated by heraldry and context. Donor: as B705AP1.
B124AP1	As B105AP4; Latest fabric types, type 9, Group 1; site code: HD70, 46c, 1 1-2.
B125AP2	As B105AP4; Fabric type 12; site code: HD71, 1 II.
B005AP1	St Andrew's Church, Gr. Linford (NGR SP/85064232); medieval floor tile from the Little Brickhill Kilns. Donor: Archaeology Unit, Milton Keynes.

B009AP4	Farnborough Hill, Hampshire, Britain; kiln tile from 16th century kiln. Donor: Guildhall Museum, via F.W. Holling.
B025AP4	Bristol, Avon, Britain; pottery from a 'pit group', dated on documentary and circumstantial evidence. Donor: City of Bristol Museum and Art Gallery.
B025AP5	As B025AP4.
B703AP1	Queen St., Exeter, Britain; pottery from a cess pit dated by pipes, porcelain and imports; site code: QS 314-2. Donor: as B705AP1.
B000AP1	Rainford, Merseyside, Britain; fragments of clay pipe from a pipe kiln site; site code: R,78/1. Donor: University of Liverpool, via P.J. Davey.
B706AP2	Holloway St., Exeter 1974; sherds from a Civil War ditch, cut in 1643 and back-filled in 1660; feature 7. Donor: As B705AP1.
B024AP1	Liverpool, South Castle St., Merseyside, Britain; pottery from a demolition deposit closely dated by pipes, tokens and documentary evidence; site code: SCS 1(78). Donor: Merseyside County Museums, via P.J.Davey.
M03CC02AP1	Chaco Canyon National Monument, New Mexico, 36.03° N, 252.10° E; Lino Gray pottery, dated by dendrochronology; sample: CC002.
M03EAN1CAP2	Antelope House Site, Canyon de Chelly National Monument, Arizona, 36.16° N, 250.56° E; Lino Plain pottery dated by dendrochronology; sample: AN001.
M03WAP1CAP1	Green Bear Site, just east of Lupton, Arizona, 35.33° N, 251.00° E; Alma Plain pottery, dated by associated and intrusive ceramics; sample: AP001.
M03ECA1CAP1	Pueblo del Encierro Site, 2 miles north-east of Cochiti Pueblo, New Mexico, 35.64° N, 253.67° E; dated by dendrochronology; sample: LA001.
M03EWA2AP1	Walpi, on the Hopi Indian Reservation, Arizona, 35.83° N, 249.60° E; an orange utility ware, dated by ceramic seriation and historic events.

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