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ASHTEAD ROMAN VILLA, ASHTEAD COMMON, SURREY ARCHAEOMAGNETIC ANALYSIS OF A ROMAN TILE KILN

SCIENTIFIC DATING REPORT

Mark Noel

ARCHAEOLOGICAL SCIENCE

ENGLISH HERITAGE

Research Department Report Series 80-2011

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ARCHAEOMAGNETIC ANALYSIS OF A ROMAN TILE KILN

Prof M J Noel

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SUMMARY
A total of 16 samples of fired clay tile were removed from Context 908 for the purpose of archaeomagnetic analysis and dating, this work being undertaken by staff from Museum of London Archaeology. Specimens were oriented *in situ* using the button method, combined with spirit levels and a north-seeking gyro compass. Demagnetisation tests showed that the magnetisation in the material is highly stable and the remanence vectors were found to be exceptionally well-grouped, indicating negligible movement following the last firing and subsequent burial. The mean archaeomagnetic vector was compared with the UK Master Curve to suggest that the last firing occurred in the date range AD 205–225.

CONTRIBUTORS
Mark Noel

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Surrey Archaeological Society: David Bird, Margaret Bloomfield
Museum of London Archaeology Geomatics team (particularly Mark Burch and Catherine Drew, who undertook the archaeomagnetic sampling); comments by Paul Linford (EH)

ARCHIVE LOCATION
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DATE OF INVESTIGATION
2010

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INTRODUCTION

Excavation at Ashtead Roman Villa has been carried out during the 1920s and 1960s and the site (Fig 1, TQ1787060259, 51.32°N 0.32°W) is currently being excavated during annual summer seasons by the Surrey Archaeological Society. The Roman tile kiln in question was discovered by magnetometer survey in 2008 and partially excavated in 2009, after which the trench was backfilled and reopened in August 2010 for further excavation (Fig 2). The kiln is thought to have been for tile manufacture during the Roman period and is likely to be associated with the villa.

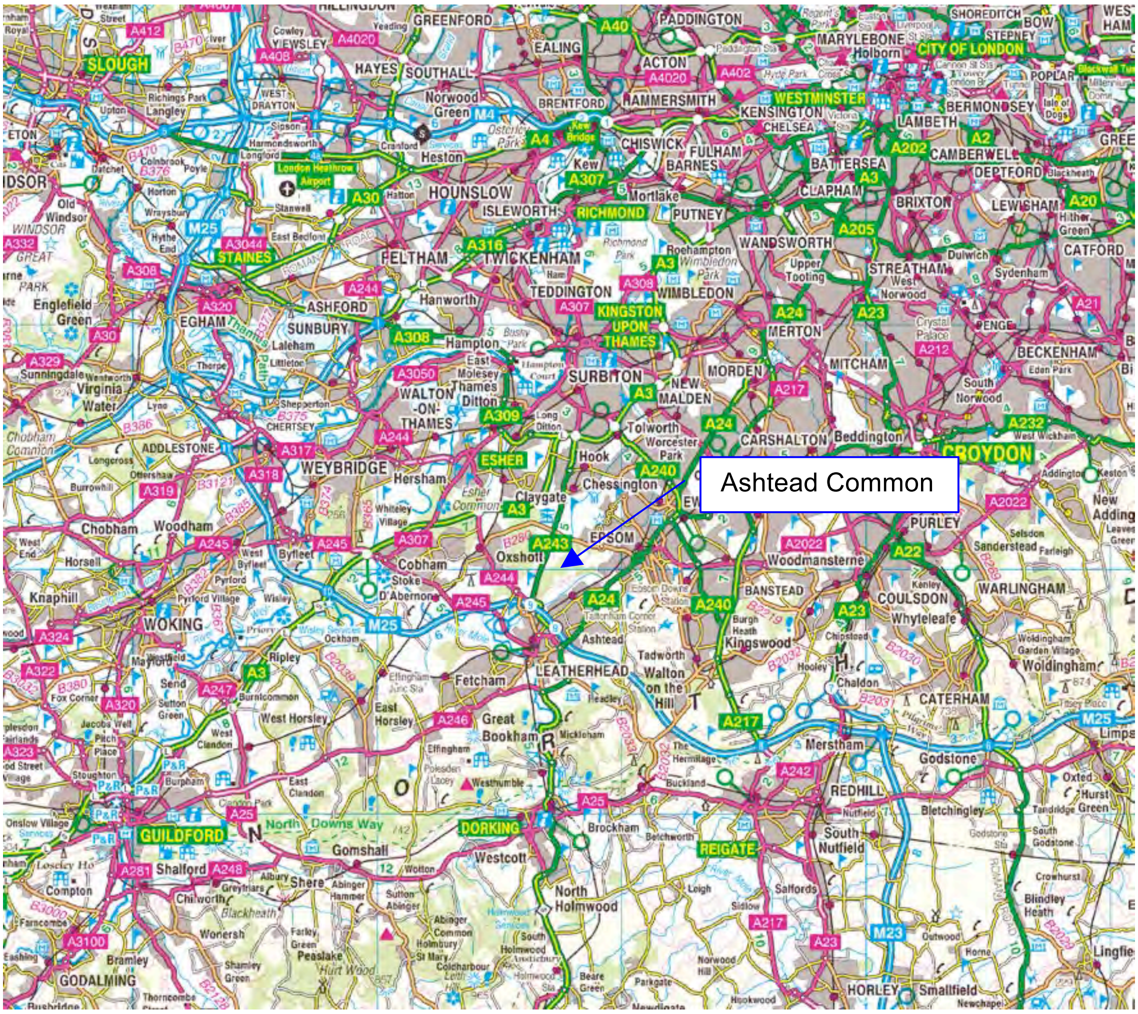


Figure 1: location of Ashtead Common, Ashtead, Surrey (based on the Ordnance Survey map with permission of the Controller of Her Majesty's Stationery Office, ©Crown Copyright)

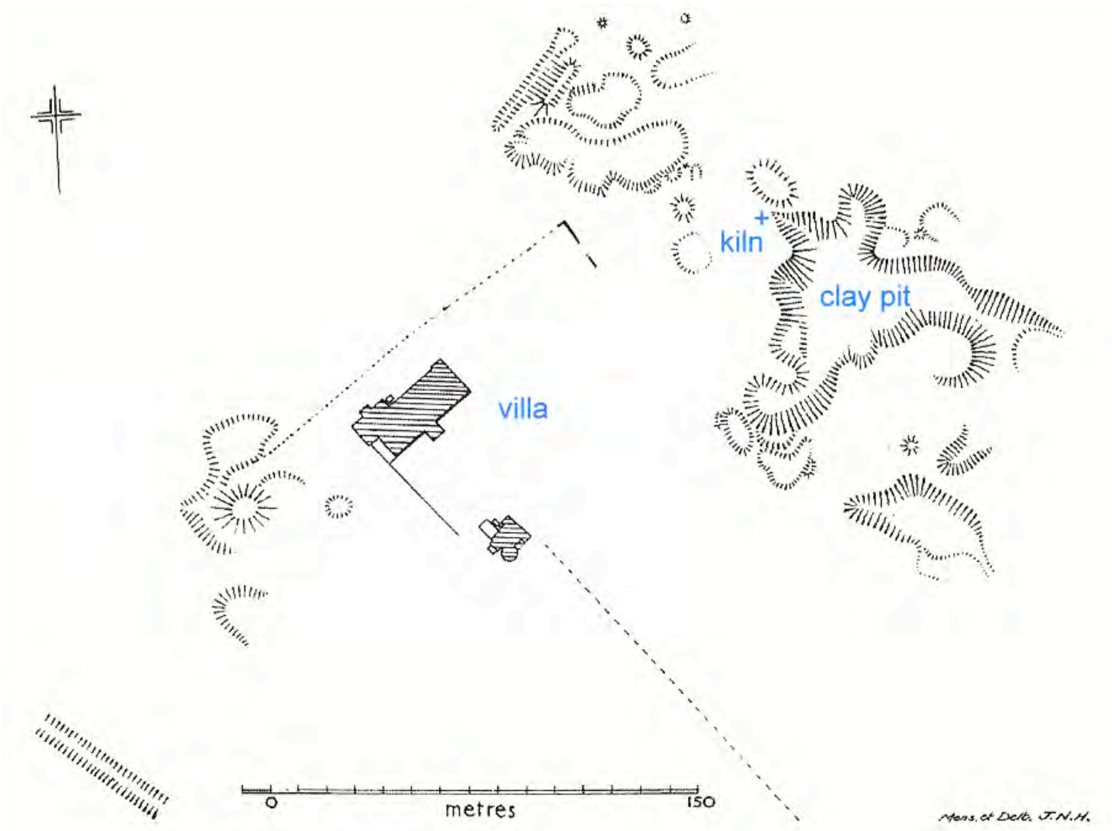


Figure 2: site plan (John Hampton, locations marked by David Bird)

PRINCIPLES OF MAGNETIC DATING

Magnetic dating is based on comparing the remanent magnetisation in an archaeological structure with a calibrated reference curve for the geomagnetic secular variation. Two distinct methods have evolved. The intensity technique relies on obtaining estimates of the past strength of the Earth's magnetic field while directional magnetic dating uses archaeomagnetic measurements to derive the orientation of the geomagnetic vector in antiquity. Intensity dating can only be applied to fired materials which have acquired a thermoremanent magnetisation upon cooling from high temperatures (>600º C) while the directional method enables the age of a broader range of archaeological materials to be determined. For example, sediments and soils may have acquired a dateable 'detrital remanence' if magnetic grains had been aligned by the ambient field during deposition. The growth of magnetic minerals during diagenesis or as a result of manufacturing processes can also give rise to a magnetisation which may enable materials such as iron-rich mortars, for example, to be dated. However hearths, kilns and other fired structures are the most common features selected for magnetic dating primarily because their thermoremanence is generally strong, stable, and sufficiently homogeneous that the ancient field can be determined with sufficient precision from a small set of specimens. An analysis of dated archaeomagnetic directions, largely from fired structures, together with lake sediment and observatory records has enabled a master curve for the UK region to be synthesised for the period 2000 BC to the present (Clark *et al* 1988).

For directional magnetic dating, it is essential to obtain specimens of undisturbed archaeological material whose orientation with respect to a geographic coordinate frame is known. A number of sampling strategies has evolved, enabling specimens to be recovered from a range of archaeological materials with orientations being recorded relative to topographic features, the direction of the sun, magnetic or geographic north. Modern archaeomagnetic magnetometers are sufficiently sensitive that only small volumes of material (~1mL) are required for an accurate remanence measurement (Molyneux 1971). This has the advantage of reducing the impact of sampling on archaeological features – of particular significance if they are scheduled for conservation and display. For dating, all archaeomagnetic vectors are transposed to Meriden, the reference location for the UK Master Curve (Noel and Batt 1990).

FIELDWORK

Archaeomagnetic sampling was undertaken by the Museum of London Archaeology Geomatics Team, on 8 September 2010. The miniaturised 'button method' was employed (Fig 3 and 4; Clark *et al* 1988; English Heritage 2006) with orientation by north-seeking gyro compass.

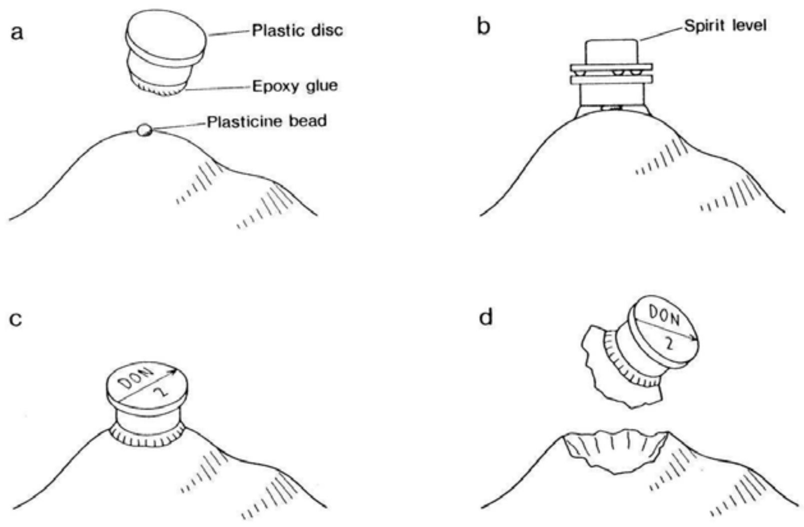


Figure 3: the button technique

Figure 4: central flue of tile kiln showing archaeomagnetic sampling (Nikki Cowlard, Roman Studies Group, Surrey Archaeological Society)

When the samples were taken, the kiln had only been partially excavated, the central flue had been identified and the backfill removed in a section about 6m long. The base of the flue had not yet been reached and was covered with a thick charcoal deposit (Fig 5). The sides of the flue were constructed of large tiles, apparently lining the sides of a linear cut in the natural clay and reaching a depth of about 0.5m (to current excavation levels). The tiles forming the flue walls had obviously been subjected to extreme heat and had become vitrified on their inner faces. Clay material used for bonding had been baked solid between the tiles, and on the top level of the structure it was possible to see that the discolouration of the tiles extended back at least 130mm from the heated face.

Figure 5: central flue showing samples on southern wall (908), looking west (Alan Hall, Roman Studies Group, Surrey Archaeological Society)

Part of the northern wall of the flue appeared to have been disturbed, so it was decided to take the samples from the southern wall (908). The more broken tiles from the top layer were removed to expose solid, drier tiles below, and the samples were positioned as close to the vitrified edge as possible (Figs 6 and 7).

Figure 6: fixing the sample buttons (Nikki Cowlard, Roman Studies Group, Surrey Archaeological Society)

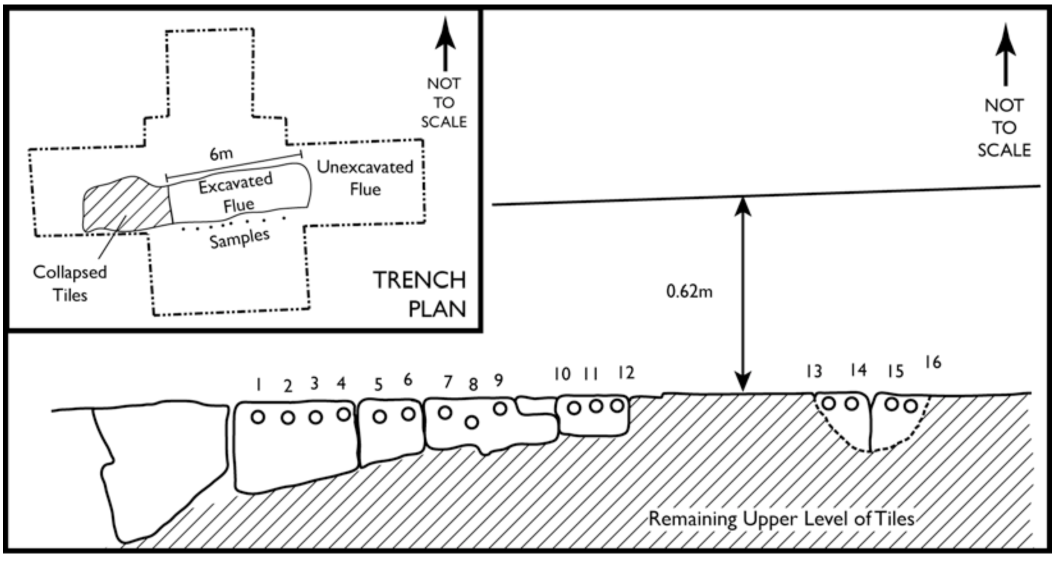


Figure 7: plan showing the sample positions (after Museum of London Archaeology field drawn diagram)

ANALYTICAL METHODS

Archaeomagnetic remanence was measured using a Molspin fluxgate spinner magnetometer, and stability was assessed using stepwise, alternating field demagnetisation. Secondary components of magnetisation were removed by partial demagnetisation.

RESULTS

The results of archaeomagnetic analyses are given in Table 1. The orientation buttons for three samples became detached during the cutting process, leaving a set of 13 for the final analysis. Demagnetisation tests showed that the magnetisation in the material is highly stable and the remanence vectors were found to be exceptionally well-grouped, indicating negligible movement following the last firing and subsequent burial.

The mean of all 13 measured vectors was computed (with unit weights) and corrected to Meriden. The mean archaeomagnetic vector was compared with the UK Master Curve to obtain a last-firing date (Fig 8), which is estimated to have occurred within the date range AD 205–225 or AD 1300–1315 (95% confidence).

Table 1: results of archaeomagnetic analyses, Context [908]

SAMPLE	J	D	I	A.F.	D	I
ASH1	575.0	352.6	60.3	2.5	356.9	61.6
ASH3	1092.1	1.9	60.5	2.5	1.8	60.0
ASH4	2128.2	1.5	57.7	2.5	3.7	57.4
ASH5	1075.6	354.4	56.2	2.5	357.0	57.0
ASH6	1357.9	355.6	57.4	2.5	358.2	57.2
ASH7	427.1	354.0	59.1	2.5	353.3	59.3
ASH8	1524.6	352.9	59.0	2.5	352.2	58.2
ASH9	4439.8	4.7	58.8	2.5	4.0	60.4
ASH10	3022.7	3.8	60.0	2.5	5.3	60.2
ASH11	3300.2	1.6	57.9	2.5	5.6	58.6
ASH14	1505.6	358.6	58.6	2.5	358.0	58.5
ASH15	2370.9	2.7	56.1	2.5	3.7	56.0
ASH16	2291.5	3.9	59.3	2.5	2.9	58.2
MEAN	K=817.9	Alpha95=1.5	c.s.e.=0.8		0.2	58.7
MERIDEN					359.9	59.7

D=declination, I=inclination, J=intensity in units of mAm-1x10^{-2}. A.F.=peak alternating demagnetising field in milliTesla. K=precision parameter, c.s.e.=circular standard error, alpha95=semi-angle of the 95% cone of confidence.

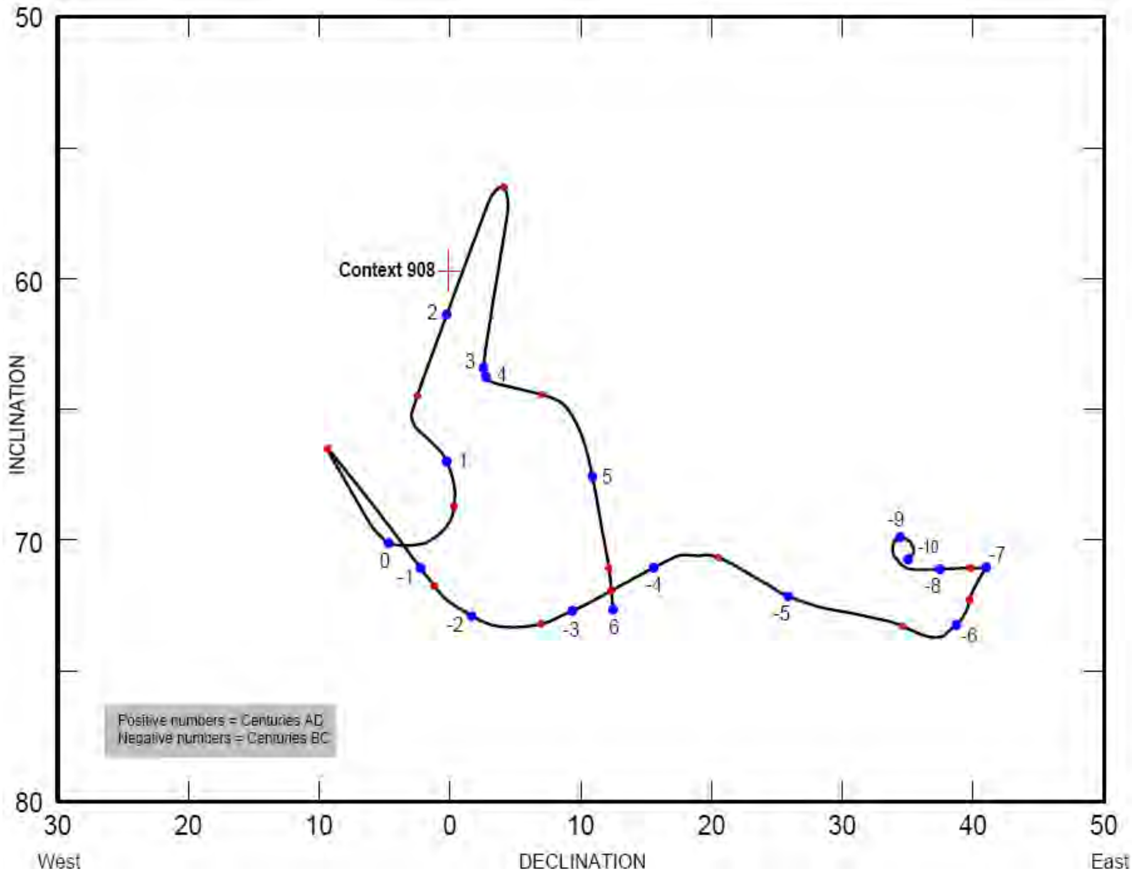


Figure 8: Comparison between the mean archaeomagnetic vector in the kiln with the UK Master Curve 1000 BC to AD 600. Numbers refer to the date in centuries. The error bar is based on the circular standard error given in Table 1

DISCUSSION

The kiln conforms very well to what is known of Roman tile kilns, and is constructed of what would normally be assumed to be Roman tiles. The central flue was backfilled with large amounts of tile debris that included characteristic *tegulae* (D Bird pers. comm.). Given this evidence and the fact that there is no evidence on the site or in the area of a medieval tile or pottery industry, the feature is most certainly Roman and not medieval in date. Therefore the date range of AD 205–225 is the most likely age estimate.

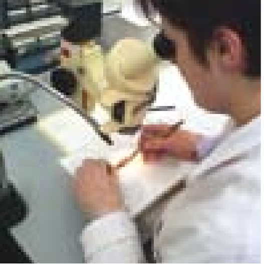
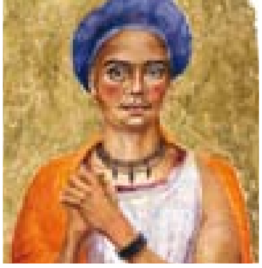
BIBLIOGRAPHY

Clark, A J, Tarling, D H, and Noel, M, 1988 Developments in archaeomagnetic dating in Britain, *Archaeometry*, 15, 645–67

English Heritage, 2006 *Archaeomagnetic Dating: Guidelines on producing and interpreting archaeomagnetic dates*

Molyneux, L, 1971 A complete result magnetometer for measuring the remanent magnetisation of rocks, *Geophys J Int R Astronom Soc*, 24, 429–33

Noel, M, and Batt, C M, 1990 A method for correcting geographically separated remanence directions for the purpose of archaeomagnetic dating, *Geophys J Int R Astronom Soc*, 102, 753–56



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