Ancient Monuments Laboratory
Report 89/90

PRELIMINARY ARCHAEOMAGNETIC STUDY OF GRAVEL FROM CASTLE MALL, NORWICH.

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Summary

A preliminary archaeomagnetic study was caried out on an oriented block of gravel from the Castle Mall excavations, Norwich (County code no. 777N; Feature no. 1170; Context no. 91099). The material was consolidated with PVA and six subsamples of the coarse sand grade fraction obtained by the button method. The remanence was found to be very weak and the directions were highly scattered, suggesting that the material had either not acquired a thermoremanent magnetisation in antiquity or had been subsequently disturbed.

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Preliminary archaeomagnetic study of gravel from Castle Mall, Norwich

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INTRODUCTION

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 by cooling from high temperatures while the directional method enables the age of a broader range of archaeological materials, including sediments, to be determined. An analysis of dated archaeomagnetic directions, lake sediment and observatory records has enabled a master curve for the UK region to be synthesised for the period 2000B.C. - present (Clark, Tarling & Noel, 1988).

The Castle Mall excavations in Norwich (County Code No. 777N) uncovered an area of gravel which had been redenned, presumably as a result of burning (feature No. 1170; context No. 91099). This report presents the results of a preliminary archaeomagnetic study of the deposit with the following aims:

1 Establish whether the natural remanent magnetisation bears evidence that the sediment had been heated in antiquity and remains undisturbed.

2 Investigate the stability of the magnetisation in a number of pilot specimens from the deposit in order to provide further evidence in respect of (1).

Discovery of a stable, primary, archaeomagnetism due to firing would then justify the effort of a more detailed magnetic dating study.

SAMPLING AND MEASUREMENT

On-site sampling was carried out by staff at the Castle Mall excavation and a gravel block of approximately 8 litres volume delivered to the archaeomagnetism laboratory. The specimen had been oriented using an adaptation of the button method (Clark, Tarling & Noel, 1988), employing a magnetic compass and spirit level to provide reference directions. On arrival, five buttons (film cannister caps) remained securely attached to the surface of the gravel block which was then re-oriented on pedestals of plasticene in order to restore the mean level of the buttons to an approximate horizontal.

Prior to subsampling, the lithology of the sediment was recorded. The material can be described as a 'matrix supported granule-pebble gravel' in which framework clasts are up to 5cm in diameter but most have diameters in the range 5 to 15mm. Of those in this group, 45% (w/w) are rounded to well rounded vein quartz (some clasts show signs of mineralisation), 11.5% subrounded to rounded very fine grained sandstone, 29% mid to dark grey angular to subrounded chert and 15% rounded to well rounded very fine sand grade sedimentary quartzite. The matrix consists of subangular to subrounded medium to very coarse sand grade grains, predominantly unicrystalline quartz (<25% rose quartz). Elongate grains define a weak foliation but imbrication is not evident. The deposit is unlithified. From this, we conclude that the formation is a recent fluvial (channel) deposit. The suite of framework clasts and particularly chert characteristic of Carboniferous limestone, point to the deposit being associated with a river system that drains or drained a region of limestone and sandstone that is, in part, mineralised.

Owing to its extreme friability, preparation of undisturbed gravel subsamples for magnetic measurement was a difficult operation. The supported block was first allowed to dry slowly and the surface was then gently brushed and blown to remove loose material. This enabled the patches of most intense reddening to be identified and these were then consolidated to a depth of several centimetres using a solution of PVA in acetone. A total of ten standard 25mm archaeomagnetic buttons were then glued in position using a fast setting epoxy resin with their top surfaces set horizontal using bullseye spirit levels. Small beads of plasticene beneath the buttons held them steady while the resin cured. Each sample button was then numbered and marked with an arrow corresponding to the mean direction of magnetic north obtained from the original orientation discs. The gravel was then carefully carved away until the buttons could be removed with 1-2ml of sediment adhering to the base as shown in Figure 1. Despite every effort, four samples disintegrated leaving a total of six. Finally, these specimens were trimmed to fit the magnetometer and again consolidated with PVA solution.

MEASUREMENT

The natural remanent magnetisation (NRM) of all the samples was first measured in a Molspin fluxgate spinner magnetometer (Molyneux, 1971) with a minimum sensitivity of around 5×10^{-9} Am^2. Remanence directions were corrected for the local magnetic variation and are displayed on the equal area vector plot of Figure 2. Table 1 summarises all the archaeomagnetic data. Generally, the NRM of an archaeological material will comprise a primary magnetisation, (in this case presumed to be of thermal origin), together with secondary components acquired in a later geomagnetic field due to chemical alteration or partial reheating. Usually, a weak viscous magnetisation is also present reflecting a tendency for the remanence to adjust to the recent field. If the secondary components are of relatively low stability, then partial demagnetisation can provide a convenient method for preferentially removing secondary magnetisation, leaving the primary remanence of archaeological interest. This technique was applied to the two most strongly magnetised specimens of gravel in order that magnetometer error would contribute a minimum of error to the results.

The samples were partially demagnetised in alternating magnetic fields, in increments, up to a peak field of 20mT and the changes in remanence induced at each stage recorded in the spinner magnetometer. The results of this procedure are shown in Figure 3.

RESULTS AND DISCUSSION

The specimens of gravel from Castle Mall contained a very weak natural remanent magnetisation in the range 0.60-16.77x10^{-6}Am^{2}kg^{-1} . The set of NRM directions are highly scattered with four of the six samples yielding negative (ie. upward) archaeomagnetic inclinations (Figure 2). Thus, on the basis of the NRM results, there is no evidence that the gravel has acquired a unform archaeomagnetism by heating in the ancient geomagnetic field.

The demagnetisation tests revealed that the two pilot specimens contained highly unstable remanences as indicated by the major swings in direction and rapid fall in intensity seen in Figure 3.

CONCLUSIONS

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

1 Scattered directions of magnetisation indicate that the gravel from Castle Mall has not acquired an archaeomagnetic remanence as a result of heating in the ancient geomagnetic field.

2 The magnetisation was found to be very unstable. Thus, the presence of scattered NRM directions suggests that the gravel matrix has been recently disturbed.

REFERENCES

Clark, A.J., Tarling, D.H. & Noel, M., 1988. Developments in archaeomagnetic dating in Britain, Archaeometry, **15**, 645-667.

Molyneux, L., 1971. A complete result magnetometer for measuring the remanent magnetisation of rocks, Geophys. J. R. astr. Soc., **24**, 429-433.

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Date: ....

Table 1
Archaeomagnetic results from Castle Mall

Sample	J	D	I
CAM1	3.32	74.8	-20.2
CAM2	1.61	231.1	-15.1
CAM3	1.76	68.3	-55.0
CAM7	16.77	258.7	-9.1
CAM9	0.60	251.5	58.7
CAM10	1.11	82.6	3.3

UNITS:
D=declination, I=inclination, J=intensity $Am^2 kg^{-1} x10^{-6}$

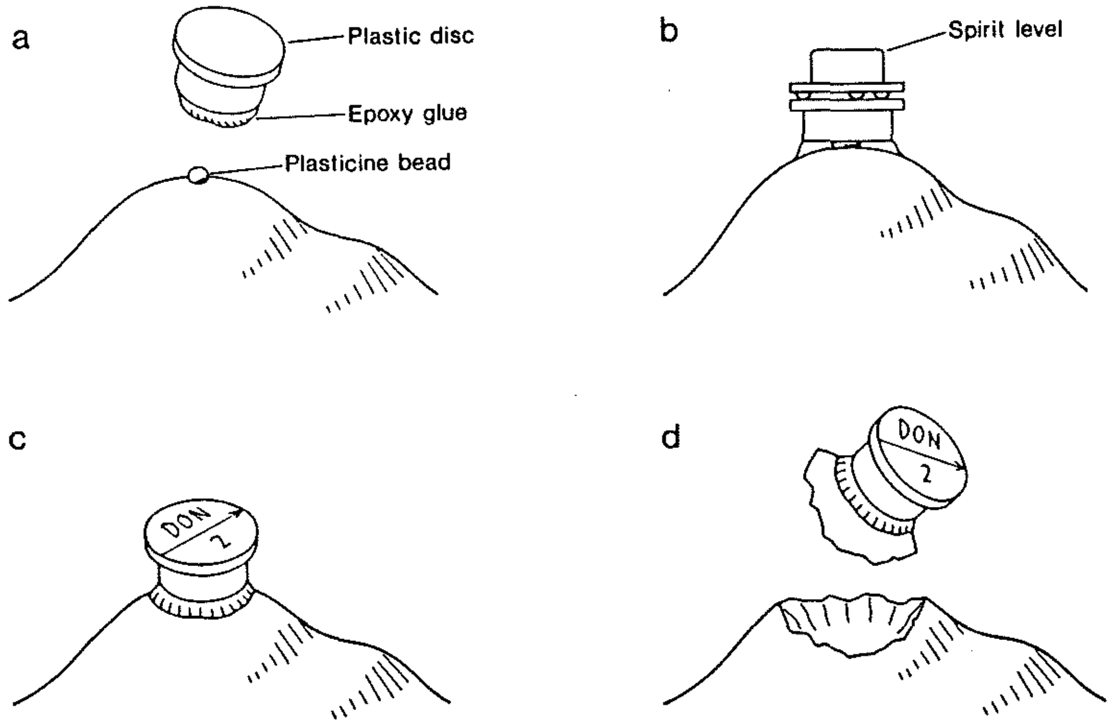

Figure 1. Archaeomagnetic sampling by the button method

CASTLE MALL
natural remanence

CASTLE MALL NRM

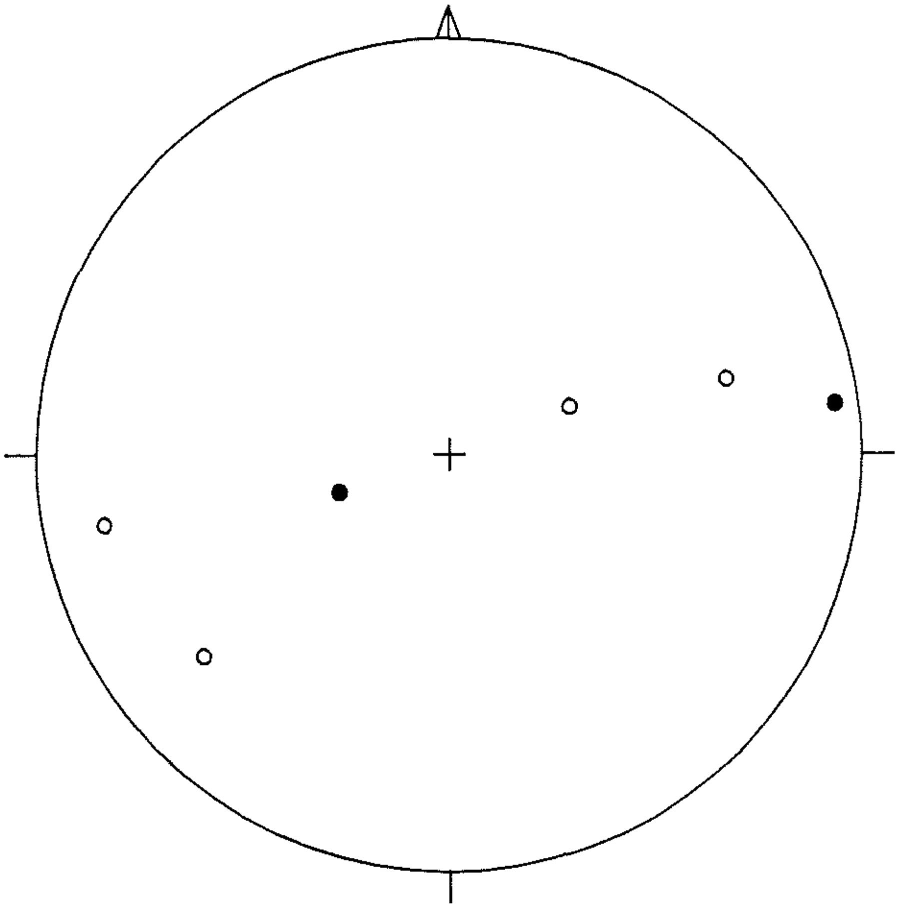

Figure 2. Equal area stereographic projections of the directions of the natural remanent magnetisations in the samples of gravel from Castle Mall. In this graphical format, inclination increases from 0° to 90° from the equator to the centre of the projection, while declination increases in a direction clockwise from the north arrow.

CASTLE MALL

demagnetisation tests

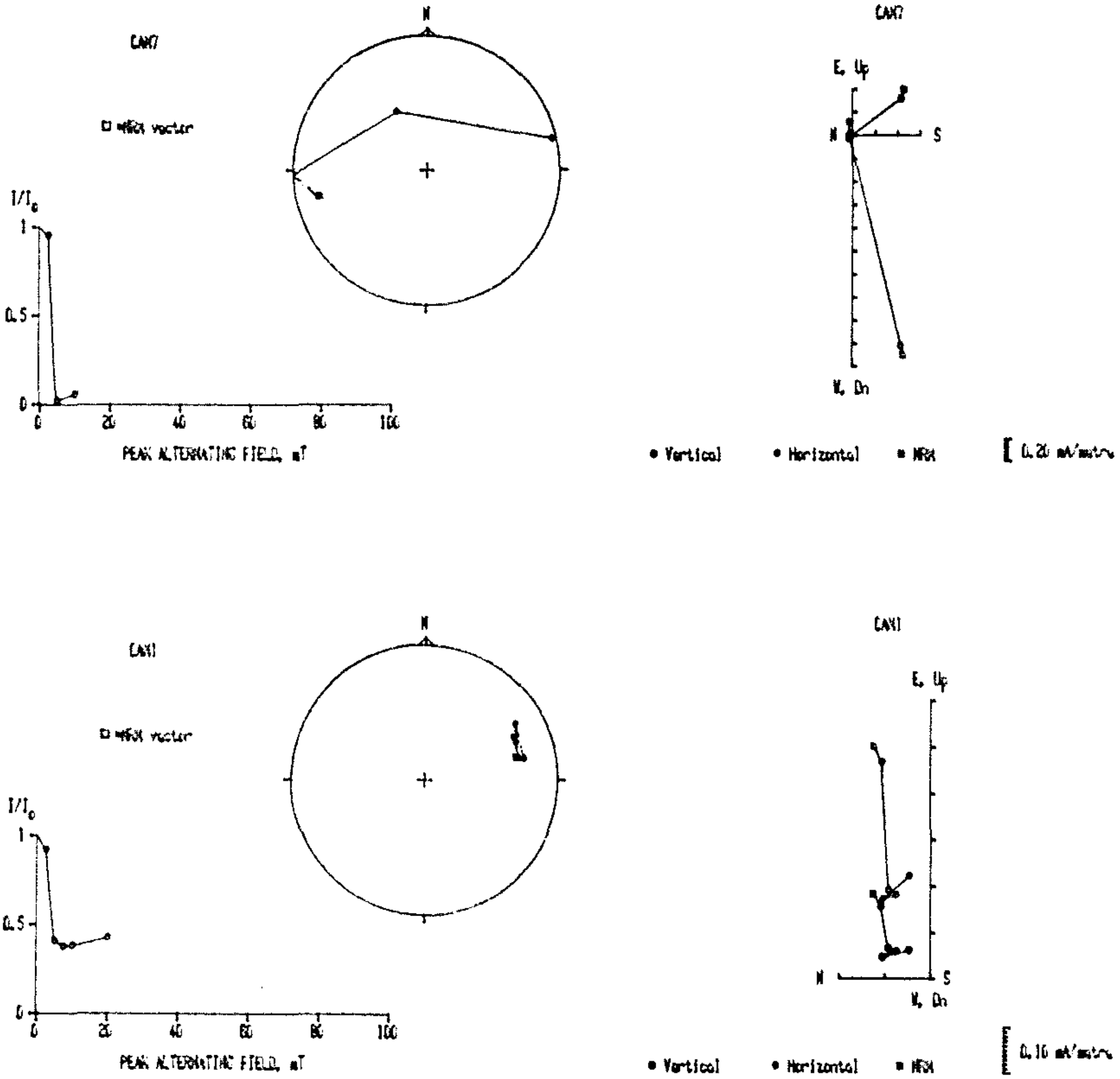

Figure 3. Demagnetisation of samples 1 and 7 shown as a graph of change in the intensity with increasing field along with a stereographic projection of associated directions (left). The results are also portrayed as a vector endpoint or Zijerveldt plot in three dimensions (right).