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RESEARCH NOTES AND APPLICATION REPORTS

PALAEOMAGNETIC STUDY OF HOXNIAN LACUSTRINE SEDIMENTS

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INTRODUCTION

Current excavations by the Department of Anatomy, University of Chicago, at the type site of the Hoxnian Interglacial, at Hoxne, Suffolk, have given an opportunity to extract orientated cores of sediment from a section cut through lacustrine clay-muds. The natural remanent magnetization (NRM) in such cores is acquired on deposition (or shortly after), thus providing a record of the variation of the geomagnetic field direction during the period spanned.*

The lacustrine deposits lie in a depression some 600 m long and 320 m wide in the Chalky Boulder Clay till sheet, which became filled with water soon after the disappearance of the Anglian ice. Two archaeological horizons are within this sequence, as shown by the current work: one at the top of the detritus mud, stratum D of West (1956), (in this section slightly disturbed by old clay diggings and covered by 1 m of made-up ground), and another 10–30 cm below the same detritus mud within the upper part of the lacustrine clay-mud. Both are in a primary context: that on top is typologically Late Acheulian and represents actual occupation on the fringes of the lake, that below is only represented by a few flint flakes and is interpreted as casual losses of artifacts within the lake derived from human activity on the sides nearby. It was this latter horizon which was apparently recorded by West (West and MacBurney 1954). The remainder of the lacustrine clay-muds are archaeologically sterile

* Such NRM is due to the alignment of magnetic particles during settling and consolidation, or to chemical changes subsequent to deposition. This *detrital* remanent magnetism (DRM) is quite different in origin to the *thermo*remanent magnetism (TRM) acquired by clay and rocks on cooling down from firing and which is the usual basis of archaeomagnetic studies.

and were probably deposited in deeper water, beyond the reach of wading or missile-throwing humans.

STRATIGRAPHY

The biogenic sediments at Hoxne have been described in detail by West (1956). The palaeomagnetic samples were taken in the process of the archaeological work from the section, referred to as Cutting II, from the detritus mud (0 cm in figure 1) of Hoxnian Zone III (late-temperate) down to till (215 cm in figure 1). Examination of pollen samples from this section by W. W. Mullenders of the University of Louvain has shown that this is the same succession as reported by West (his layers D to G).

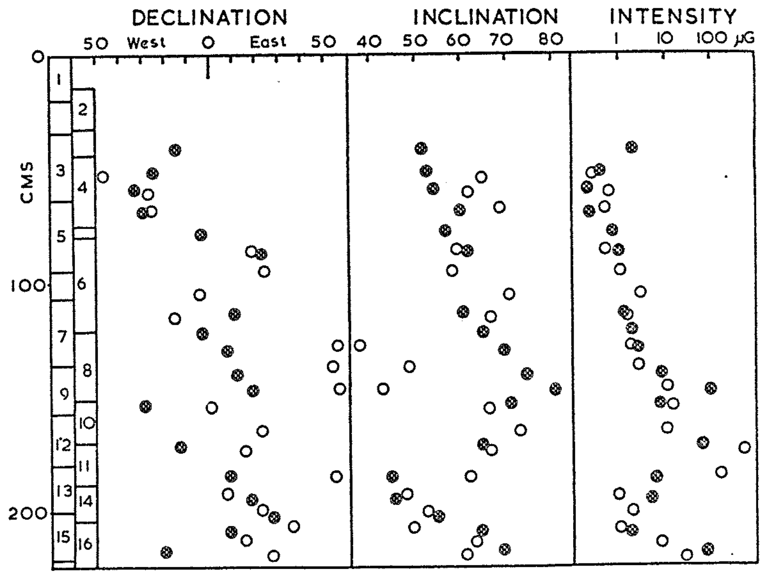

Figure 1 *NRM declination, inclination and intensity (N.B. log scale) vs. depth of sediment from Hoxne cutting II. Declination referred to true north. Depth of cores 1–16 indicated on left hand side. Closed circles, 10 cm lengths from column 1–15; open circles, 10 cm length from column 2–16. Top of core 1 (0 cm) lies at 29.7 m O.D.*

In cutting II, stratum G, the till is overlain (215 cm in figure 1) by a light grey calcareous silty clay. This is laminated near the base and very variable in thickness. West interprets these clays as shallow water sediment (stratum F) deposited during the late glacial and early interglacial period, before the onset of fully temperate conditions. These clays fall into the late Anglian and Zone 1 of the Hoxnian interglacial. Deepening of the water in the basin (over 3 m) and amelioration of climatic conditions brought about a change in sedimentation. A black clay-mud was deposited (stratum E), which is now hard and blocky, the colour change from stratum F being probably due to increased organic content. This sediment shows no stratification, suggesting a long period of constant conditions, ascribed by West to Hoxnian Zone II. A conformable passage occurs from stratum E to stratum D which comprises brown detritus mud. The amount of mineral matter is reduced in this horizon and possibly the water level also dropped, but sedimentation rate seems to have not greatly altered. West places these deposits in Zone III. These sediments are truncated by a grey-brown highly organic detritus mud, stratum C (0 cm in figure 1). Apart from the weathering of the upper metre of the lacustrine clay-muds, the sediments appear completely undisturbed by later movements such as irregular compression, cryoturbation or faulting.

SAMPLING

Each sample was obtained by carving the sediment into a rough free-standing cylinder of length 20–30 cm, using a knife. A piece of 10 cm diameter plastic pipe was then placed over the cylinder and positioned to within 5° of vertical. Empty space inside the cylinder was filled up with potter's plaster and a flat horizontal surface formed at the top; a compass was placed on this surface and Magnetic North marked. Successive cylinders were overlapped vertically and the sixteen cylinders so obtained gave continuity in sampling through the 215 cm depth of sediment.

MEASUREMENT

The sixteen cores of sediment were cut into 10-cm lengths. The NRM (natural remanent magnetization) of each length was then measured on a computerized, slow speed, spinner magnetometer extension used for measuring cores of sediment (Molyneux *et al.* 1972). The chuck used for holding the cores was adapted so that the 10-cm lengths could be spun in six orientations as in conventional palaeomagnetic measurements (Molyneux 1971). The declination, inclination and intensity of NRM of each 10-cm length was thus determined (figure 1). Alternating magnetic field (AF) cleaning (Collinson *et al.* 1967) on cylindrical shaped, 2.5 cm high, 2.5 cm diameter, pilot specimens from the lower black lacustrine clays was performed in up to 500 Oersteds peak field.

PALAEOMAGNETIC RESULTS

The direction of magnetization of the pilot specimens remained constant during AF cleaning up to a peak field of 300 Oersteds. The fall of intensity with increasing field (M/M_0 vs H) is shown in figure 2. The graph is convex at low fields which is typical of lake sediments holding a stable remanence. The NRM of the black clay-mud can thus be inferred to be of a stable, primary remanence.

The NRM from the 10-cm lengths is plotted in figure 1 as individual circles on three graphs of declination, inclination and intensity vs. depth. The closed circles are from the column of sediment collected in cores 1 to 15 and open circles from the column of sediment collected in cores 2 to 16. The NRM of the lower 10 cm of core 12 was very weak, probably below the range of sensitivity of the instrument, and has not been included in the diagram. The remanence of the upper two cores (1 and 2) was weak and the directions scattered. This material was iron stained and had clearly been affected by weathering. The results are therefore unreliable and they too have not been included in the diagram. The directions of

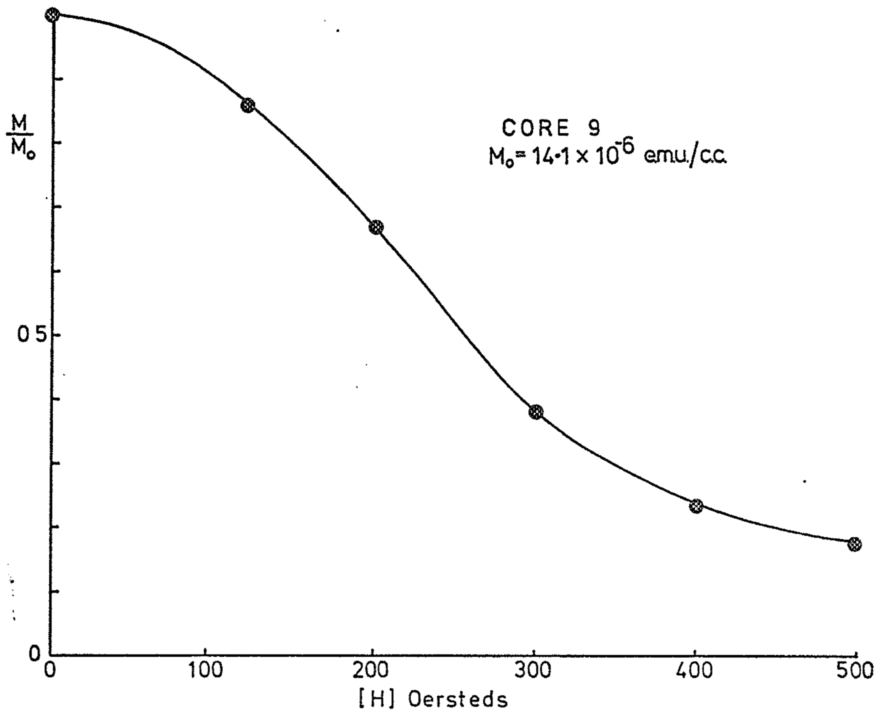

Figure 2 *Alternating magnetic field demagnetization curve. Normalized intensity* (M/M_0) vs *peak applied field* (H). *NRM intensity shown. The convex shape of the curve at low fields combined with a constant direction of magnetization indicate that the natural remanent magnetization is stable.*

magnetization from the two sediment columns can be seen to be reasonably repeatable, particularly in inclination, except for core 8. Both declination and inclination of the three lengths from core 8 are askew, possibly resulting from an error in the orientation of core 8, and must be discounted.

The great majority of the results then, delimit the secular changes of direction of the Earth's magnetic field during the time span during which the sediments were deposited. The magnetization of all the samples is *normal*, indicating that the time span concerned does not include a period when the geomagnetic direction was *reversed* with respect to the present-day direction—the *Blake event*, occurring 110 000 years ago and lasting for several thousand years, is relevant here. The total declination changes are over 60°, whereas the inclination only varies by about 30°. These trends of the changing direction of magnetization are very similar to those found in lake sediments deposited more recently, such as during the last 10 000 years in Lake Windermere (Mackereth 1971, Thompson 1973). The intensity of magnetization varies in a similar manner in both the Hoxne and Lake Windermere successions; in particular it reaches a maximum during climatic optima (stratum E, Hoxnian Zone II). Such correlation may be due to climate affecting the acquisition of the magnetization but there is also the possibility that the geomagnetic field affects climate (see, for instance, Wollin *et al.* 1971).

CONCLUSIONS

It is possible to use palaeomagnetic data from lacustrine successions as a chronological tool (Thompson 1973). More palaeomagnetic results are being obtained from other Hoxnian lakes (e.g. Marks Tey) and as deposits from other interglacial periods (e.g. Ipswichian) are investigated it is hoped to build up a pattern of changes of the geomagnetic field and to be able to use the patterns as a stratigraphic tool for Pleistocene correlations.

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APPENDIX

Note on the duration of the Hoxnian Interglacial

J. J. Wymer

Assessments of the duration of the Hoxnian Interglacial have differed greatly. Marks Tey, Essex, is an interglacial lacustrine site which, on pollen evidence, is equated with the Hoxnian (Turner 1970). Laminated lake clays at Marks Tey, or at least those deposited in the earlier part of the interglacial, are believed to be annual. If so, the duration of the Hoxnian would be in the order of 30 000–50 000years. The period from Zones I to III could be about 10 000–15 000 years. It may be relevant that this is the same range of time as estimated for the period from the last Glaciation to the present day, and it is thus perhaps no coincidence that the character of the natural remanent magnetization in both the Hoxne and Lake Windermere successions is similar.