Recent Archaeomagnetic Results in England

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Since 1959 we have been engaged in a continuous programme of collecting orientated samples from archaeological kilns, ovens, and hearths, mainly in the southern half of Britain. Our collection technique follows that established by Professor Thellier and we acknowledge a great debt of gratitude to him for his help and encouragement. The sample size was usually 4 inches by 4 inches enclosed in a 5 inch cube of plaster; these were measured on a large 5 cps spinner magnetometer again following the principles established by Professor Thellier.

We report here the results obtained from some 80 archaeological structures; at least 12 samples were taken from each structure and often as many as 20. Allowance for viscous components was made either by storage techniques or by thermal washing at 100°C; the correction involved rarely exceeded a few degrees. The average direction for each structure was calculated using Fisher statistics and also the circle of confidence at the 80% level. With one exception the structures were located with 200 miles of London; the values for the angle of inclination ($I$) have been reduced to the latitude of London (51.1°N) on the assumption

![Fig. 1. Secular variation in Britain versus archaeologically derived date. Bauer's values derived from recorded direct observations are shown as a full curve (---), and the values inferred from the archaeomagnetic measurements are shown as a broken curve (-----). The vertical height of the crosses represent the 80% confidence limit and the horizontal width represents the uncertainty in the archaeological date. When either is in doubt the points are shown as broken crosses or dots.](391)
Fig. 2. Secular variation in Britain. Bauer's curve is shown in full (—) and the curve derived from the archaeomagnetic measurements of fig. 1 is shown broken (-----).

Fig. 3. Comparison of observed secular variation with variation inferred from Westward drift of presentday field. Curve labelled 'N-D' would result from drift of nondipole components only, 'TOTAL' refers to drift of field as a whole. Longitudes are shown on these two curves. 'SH' indicates the magnetic direction corresponding to the inclined centered dipole that has been held fixed in calculating 'N-D'. 'A' indicates the magnetic direction corresponding to axial centered dipole.
of an axial dipole field. The results are shown in Figs. 1 and 2. Particular attention was
given to the reliability of the archaeological date quoted for each structure and a summary
of the archaeological evidence has been given elsewhere (2, 3) Structures for which the dat-
ing evidence was problematical have been omitted.

In considering the geophysical significance of these results it is first of all of interest to
compare them with the predictions of past geomagnetic direction that would be made on
the hypothesis of westward drift (4). This is done in Figure 3 on two bases. The curve la-
belled ‘N-D’ is the past direction for London on the assumption that the inclined central
dipole component has remained fixed but the nondipole components have been drifting
Westward; this is broadly the deduction made by Bullard et al (4) from comparison of the
geomagnetic fields for 1907 and for 1945. The curve labelled ‘TOTAL’ assumes that the
g geomagnetic field has been drifting Westward as a whole; this is simply obtained by looking
West along the latitude of London and assuming that the variation of direction with longi-

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Fig. 4. Virtual pole positions for Britain and Iceland. ‘SH’ indicates the
direction of the centered dipole component derived by spherical
harmonic analysis of the present-day field. ‘D’ indicates the cen-
tral dipole direction derived by Aldredge and Hurwitz (7) from
analysis in terms of radial dipoles.
tude represents the past time-variation for London. Neither of the two predicted curves bear any resemblance to the observed values in London once one goes further back than a few hundred years. This finding is of course in agreement with current ideas that the disturbances responsible for the secular variation have a lifetime of only a few hundred years. Nevertheless it is interesting to have obtained supporting experimental evidence for the short lifetime.

The archaeomagnetic results of Fig. 2 can be used to infer that the past secular variation could not have arisen from Westward drift of the spherical harmonic components of the present-day geomagnetic field on more general grounds than the detailed comparisons of Fig. 3. Runcorn (5) has shown that for drift of the spherical harmonic components that predominate today the motion of the secular variation curve must be clockwise. From A.D. 1000 to A.D. 1300 the curve is distinctly anti-clockwise and consequently one must conclude that in that period either the drift was Eastward or that other components such as $n=4$, $m=1$ and $n=4$, $m=4$ predominated.

Finally in Fig. 4 we have plotted the virtual pole positions that would correspond to our observed secular variation in London if one ascribes the field entirely to a centered dipole. The virtual pole positions corresponding to Brynjolfson's Icelandic lava flow measurements (6) are also shown. Since Iceland and Britain are not far apart the broad similarity is to be expected whether or not it is valid to express the field in terms of a dipole. However the pole positions obtained by Kawai (reported later in these proceedings) from archaeomagnetic measurements in Japan show the broad features of Fig 4 also. This implies that directional movement of the dipole component of the field is dominant in the secular variation. It now becomes of much greater interest to note that the virtual pole reversed its direction of drift, around A.D. 1350, from Eastward to Westward.

References