

## DIPOLES

## How the Earth's Field Reverses

from our Geomagnetism Correspondent

ONE of the most important implications of the dynamo theory for the origin of the geomagnetic field is that when the field reverses, the dipole moment decreases to zero and then builds up in the opposite sense. But what happens to the non-dipole field at this point? Does it also decrease, or are the dipole and non-dipole fields more or less independent? Certainly some of the magnetic field remains throughout the whole of a transition; and calculations carried out by P. J. Smith (*Geophys. J.*, **12**, 321; 1967) suggest that this is the non-dipole field.

But Creer and Ispir (*Phys. Earth Planet. Interiors*, **2**, 283; 1970) have another interpretation. They have analysed the intermediate palaeomagnetic pole positions determined from rocks magnetized in all known transition fields, and find that they often trace out very similar paths irrespective of the continent. For example, in four polarity transitions from Japan and one from western Europe, the north palaeomagnetic pole traces a simple reversal path across the eastern hemisphere; and in one other transition from the western United States, the south palaeomagnetic pole traces out the same path. The question thus arises as to whether this uniformity in transition zones, which range in age from  $2 \times 10^4$  to  $2 \times 10^7$  years, is too strong to be explained by the existence of only a non-dipole field which is essentially random.

To explain the pattern, Creer and Ispir have turned to a model of the geomagnetic field proposed by Bochev (*Geofis. Pura Appl.*, **74**, 29; 1969) in which the Earth's field is simulated by three dipoles rather than one and several non-dipole components. Dipoles 1 and 2 are roughly parallel to the axis of rotation, although dipole 1 is about seven times stronger than dipole 2; and dipole 3, which is about twice as strong as dipole 2, is aligned obliquely to the Earth's axis. Creer and Ispir then go further than Bochev in suggesting that the three dipoles represent three different dynamo processes which are largely independent. Thus when the stronger dipole 1 reverses its polarity, the main field reverses; but dipole 2 does not necessarily reverse at the same time. The possibility that dipole 2 might reverse independently of dipole 1, and thus at different times, would explain why sometimes the north and sometimes the south palaeomagnetic pole path lies in the eastern hemisphere during a reversal of dipole 1. In any case, the continued existence of dipole 2 during a main field reversal would ensure that the transition field remains dipolar and regular rather than non-dipolar and irregular.

All transition pole paths are not, of course, quite so simple. Several others, including those from Iceland and the United States and additional ones in Japan, are different both from the rest and from each other. Nevertheless, even these may be explained largely by the three-dipole model. Parts of the present geomagnetic field are known to be drifting westwards, so that Bochev's fitted dipoles must also be drifting with time. This, combined with the fact that dipole 2, being much smaller than dipole 1, probably possesses a shorter time constant, introduces complexities into transition pole paths. Thus although known transition paths cannot be used to prove the validity of the

Bochev model which may, in any case, give an oversimplified picture of the reversal process, they are at least consistent with it.

## CHEMICAL REACTIONS

## Mechanisms in Solution

from a Correspondent

REACTION mechanisms was the subject of a conference arranged by the Chemical Society, at the University of Kent at Canterbury, from July 20 to 24. With about five hundred people considering reports on inorganic, organic, physical and biological aspects of these mechanisms, this was the largest conference of its kind so far. Consequently, interesting work was reported on a wide front. Professor G. Porter (Royal Institution) described the development of the pulsed laser as a light source in the study of nanosecond transients and the use of this technique to follow the kinetics of singlet states, short lived triplet states, quenching of excited states, and primary photoprocesses in ketones and quinones. He also discussed the promise of techniques to study picosecond transients.

There were reports from Dr W. J. Albery (University of Oxford) and Professor M. M. Kreevoy (University of Minnesota) of the use of Brønsted " $\alpha$ " and solvent and primary isotope effects in determining the degree of proton transfer in a transition state, a topic which is becoming very popular. But no satisfactory solution was forthcoming for the different degrees of proton transfer predicted by the Brønsted " $\alpha$ " and by the deuterium isotope method. The impression gained was that neither method was reliable at present.

The " $\alpha$ -effect", another popular topic, was discussed by Dr J. D. Aubort and Professor R. F. Hudson (University of Kent). Convincing arguments showed that nucleophiles exhibiting the phenomenon of enhanced reactivity (as judged by basicity) were of two types: those where, on the ground of electronic structure and conformation, an important lone pair interaction is expected, leading to significant repulsion and consequent enhanced reactivity in covalent interaction with an electrophile; and those where negligible lone pair overlap is expected, but where electrophilic intramolecular participation is possible.

An important review by Dr B. Capon (University of Glasgow) enunciated general rules for the existence of general acid catalysis of acetal hydrolysis, thus systematizing a very tangled area of enzyme and organic mechanism. When Professor E. M. Arnett (University of Pittsburgh) reviewed the general problem of basicity of weak bases in strong acids and its measurement, he described an interesting method of measuring  $pK_a$ s, not involving indicator bases but using calorimetric measurements.

The most pertinent observation of the biological session was made by Professor D. C. Phillips (University of Oxford), who essentially stated that the observing tool can affect the resulting observation so much that the latter is of little apparent significance. Phillips's restatement of the uncertainty principle was concerned with the general physical organic use of structure variation as a technique in enzymology, but the rule can, of course, be applied to any chemical (or physical) technique. The uncertainty principle is of little significance in the simple systems usually studied by physical