CUNY, New York).

Developments in the neurophysiology of eye movements still relied largely on evidence from animal studies or human pathological studies, with the consequent problems of generalisation. Experiments using monkeys provided evidence for 'express saccades', having latencies as short as 75msec and also contributed to our knowledge about neural mechanisms involved in convergence and accommodation. The possibility of eye movement recording outside the laboratory has permitted various industrial inspection and quality-control tasks to be studied. Those reported included the inspection of apples for blemishes and the inspection of roller bearings for faults, but the results do not yet seem to have direct consequences for improving performance. □

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Earth sciences

Geomagnetic impulses and deep mantle conductivity

from K.A. Whaler

IT now seems certain that around 1969 a spectacular change took place in the geomagnetic field. The change was almost synchronous over the whole of the Earth's surface, took place in less than two years, and is now known to have consisted of a 'jerk': a step change in secular acceleration of the magnetic field[1-3] that has its origin inside the Earth[4,5]. A new paper from G.E. Backus[6] investigates the propagation of magnetic impulses — of which the jerk is one example — through the electrically conducting mantle and provides a rigorous mathematical framework in which to investigate constraints on the mantle's electrical conductivity profile provided by jerk data. The results show once again how 'geophysical intuition' can lead us astray — observations of rapid changes in the geomagnetic field originating in the core, which one would tend to associate with weak electrical screening by the mantle, do not necessarily imply low values of mantle conductivity.

Backus regards the mantle as a linear filter which acts on impulses injected from the core, and whose output is observed at the Earth's surface. The filtering is different for each harmonic component of the signal; the most useful indicators are the zero-frequency delay time and smoothing time, both in principle wavelength dependent. The zero-frequency delay time is the time a given harmonic degree impulse takes to propagate through the mantle, and the smoothing time is its spread by the time it reaches the Earth's surface; Backus sets bounds for the ratio of the two timescales. Both characteristic times are functionals of the conductivity profile of the mantle — the delay time is linearly related, and the smoothing time quadratically related, to the conductivity — so estimates of them could provide the data for an inversion scheme (although there are no standard non-linear procedures).

The magnetic observatory records from Western Europe provide the clearest indication of the jerk[2]. Data from a single area of the Earth's surface do not, however, provide any spatial resolution so do not permit wavelength content to be analysed. Backus therefore interprets the European data in terms of a fictitious 'mixed' filter, which combines all the important, low harmonic degree filters. The output from such a 'mixed' filter can have a smoothing time shorter than that of any of the constituent filters, and explains why observed rapid magnetic changes do not require low mantle conductivity values.

More detailed studies using globally distributed data are needed to determine the parameters of individual mantle filters, which are more closely related to mantle conductivity values. Worldwide, a picture similar to that seen in Western Europe emerges[5], suggesting that the delay and smoothing times are similar for each mantle filter. The main effect of the conducting mantle is, then, to impose a uniform delay on the core field observed at the Earth's surface; this means that the spherical harmonic coefficients of the field we see today are those of the field the geodynamo generated a time τ_1 ago, where τ_1 is the (common) delay time of the mantle filters.

One crucial question remains; what is the starting time of the impulse at the core? The answer cannot come from magnetic data alone and, without it, the delay time of the mantle filters cannot be determined from the emergence time of the signal. There is some evidence, however, of a correlation between changes in the magnetic field and changes in the length of day[7-9], assumed to reflect changes in the balance of angular momentum between the core and mantle, such that the total for the Earth is conserved. The date of the length of day change which correlates with the 1969 magnetic jerk could be taken as the starting time of the impulse at the core. Backus identified an 'elbow' in the length of day curve[10] in 1956 as the date of the impulse — a highly controversial decision and one on which inferences concerning the conductivity of the mantle depend strongly.

There are two main problems with Backus' choice. First, previous calculations based on long time spans suggest that length of day changes lead magnetic changes by about five years[7,8], not thirteen years, while others find length of day lagging magnetic changes by a similar amount[9]! Second, not every published length of day curve shows an elbow in 1956. Many geophysicists might perhaps prefer to regard Backus' calculations as merely illustrative numerical examples!

Despite the very great importance of this problem Backus' theory gives investigations of core impulses a firm quantitative basis. Clearly, mantle conductivities will be difficult to extract, but with the current state of knowledge even quite general results would represent a considerable step forward. The jerk is one of the most exciting recent geomagnetic events, and Backus' paper demonstrates how to maximise the possible information from it. □

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100 years ago

M. Raphael Perulta writing to *La Nature* under date Manilla, September 14, states that the detonations of the Java eruption of August 27 were distinctly heard throughout the Philippine Islands; so distinctly were the sounds heard that gunboats were sent out under the impression that a fight was going on at Java, or that a ship in distress was firing for help.

On October 26 at about 7 p.m. a splendid meteor was seen in the district of Hernö and, Sweden. A traveller on the road to Ragunda states that he suddenly saw the night lit up as in broad daylight, which was caused by a large meteor appearing with a blinding white lustre in the zenith and travelling very rapidly down to the horizon. When half way, as it appeared to the observer, between zenith and the earth it suddenly burst, throwing a quantity of sparks in every direction.

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