PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

Introductory Remarks

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Introductory remarks

The Red Sea Discussion Meeting originated in the desire of the other organizers to bring together as many as possible of the earth scientists who have been working recently in that area to examine the latest evidence and ideas on its structure and origin, to see how they accord with modern continental and sea-floor spreading concepts.

The Red Sea, Gulf of Aden and Afar crustal depressions, now known to be continuous with the extension of the world ocean rift system, have been claimed as a manifestation of crustal separation, but some Earth scientists still consider that the evidence can be explained by less drastic crustal rifting. Definite solutions to the many outstanding problems were not expected but discussions would clearly assist further researches.

It was known that vital subsurface geological and geophysical data was being obtained by commercial organizations active in oil and mineral exploration in the area and it was hoped that some of this would be divulged, as it has been. The number of collaborators has been impressive, from many countries and organizations, and the organizers express their gratitude to all concerned.

As one of the world's major topographical features awareness of the Red Sea depression is a part of general education. It is not perhaps generally known that curiosity about its origin has been expressed for at least 2400 years, as the following extract from Herodotus proves:

'In Arabia, not far from Egypt, there is a long and narrow gulf running inward from the sea called the Erythraean, of which I will here set down the dimensions. Starting from its innermost recess, and using oars, you take forty days to reach the open main, while you may cross the gulf at its widest part in the space of half a day. (The commentator notes that Herodotus has taken the length of the Red Sea but the width of the Gulf of Suez.) In this sea there is an ebb and flow of the tide every day. My opinion is, that Egypt was formerly very much such a gulf as this—one gulf penetrated from the sea that washes Egypt on the north, and extended itself towards Ethiopia; another entered from the southern ocean, and stretched towards Syria; the two gulfs ran into the land so as almost to reach each other, and left between them only a very narrow tract of country. Now if the Nile should choose to divert his waters from their present bed into this Arabian gulf, what is to hinder it from being filled up by the stream within, at the utmost, twenty thousand years? For my part I think it would be filled up in half the time. How then should not a gulf, even of much greater size, have been filled up in the ages that passed before I was born, by a river that is at once so large and so constantly at work?'

(From the *History of Herodotus of Helicarnassus* as translated by G. Rawlinson, revised by A. W. Lawrence. The second book, para. 11).

This astonishingly acute conception contains the germ of the idea that an early marine gulf extended south from the Mediterranean and a later gulf penetrated north from the Indian ocean!

The task of assembling the papers for this volume has fallen largely on C. R. Argent of The Royal Society, but the responsibility for decisions is mine. Discussion volumes containing invited contributions from authors in different countries, working in different disciplines and types of organization, are not appropriate for editing in the normal sense; the content, style and treatment

of the subject-matter are inevitably different. The main contributions have been produced as received, except for a few minor rearrangements. A certain amount of editing has been necessary for contributions to discussions; as far as possible this has been done with the concurrence of those concerned. Time and international correspondence however do not assist early publication and this has not always been possible, but I hope no errors have been committed. Tribute must be paid to W. G. Evans and D. Tillotson of the Society's Editorial Staff for their handling of the printing arrangements for the many maps and diagrams.

In the interests of the general reader two post-meeting written contributions have been included. A. S. Laughton's new bathymetric chart of the Red Sea speaks for itself (Herodotus would have liked it). Its contours provide geomorphological evidence highly relevant to Red Sea contributions. M. Abdel-Gawad's second contribution 'The Gulf of Suez: a brief review of stratigraphy and structure' (p. 41) was invited to fill a gap referred to by several speakers in discussion.

Sir Edward Bullard in his opening remarks referred to 'the normal state of chaos characteristic of the earth sciences'. Those who attended the meeting will recall the enthusiastic and skilful way R. Freund presented the case for considerable transcurrent movement along the Dead Sea rift zone. It is an example of the chaos which geological evidence can cause that in spite of the number of his co-workers some very experienced geologists and recent field workers still maintain that much can be explained by vertical movements, or are reverting to that conception. For instance, L. Dubertret recanted in his opening paper, and L. Picard of the University of Jerusalem has recently dissented verbally to the writer. Interest in this problem is likely to continue: the effects of the movement were recorded as long ago as the writing of Psalm 114. Accumulating evidence from the whole of the Africa–Arabia rift system up to February 1969 did not deter Picard from remaining in favour of explanation by vertical tectonics; his review entitled 'Africo-Arabian Graben Tectonics' is in the press.

The organizers are grateful to M. Abdel-Gawad for his willingness to accept the hazardous task of interpreting satellite photographs in an area where much unpublished ground information is available. Whether the field geologist agrees with his suggestions or not the investigation has been invaluable as a demonstration of the relative value of small-scale photographs as compared with larger scale photographs and of the difficulties of assessing published geological data, and has stimulated useful discussion (see J. G. W. Greenwood, *Nature, Lond.* (1969), **224**, 506).

It was apparent during the meeting that the concept of transform faulting introduced by J. Tuzo Wilson in 1965 (*Nature, Lond.* (1965), **207** (4995), 343–347) was not understood by some geologists, and some geophysicists appeared to think the term synonymous with transcurrent, shear, tear or wrench faults. It may therefore be useful to recall here that Tuzo Wilson summarized the difference as follows (*Science, N.Y.* (1965), **150** (3695), 482):

'Conventional discussions of fault mechanisms such as that given by Anderson have tacitly assumed that the faulted medium is continuous and conserved, but if new crust is created on ridges and old crust is destroyed in trenches or mountains this assumption is not true, and other kinds of faults can be envisaged in addition to normal, thrust and transcurrent types. If plates in the crust move horizontally relative to one another a class of strike-slip faults called transform faults can exist which have a different behaviour from conventional transcurrent faults. On transcurrent faults shear motion continues indefinitely, but in transform faults it ends abruptly by transformation into extension across a rift or compression across a mountain belt or thrust.'

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This valuable new concept of transform faulting must be used with caution or confusion will result in the literature. It is not, as at present defined, appropriate for use in land geology. Faults with the same type of behaviour separating vast masses of rock and ending abruptly are known in orogenic belts and areas of salt tectonics where no crust is being created or destroyed. As more detail is obtained from the faulted marine areas it will be found that the terms transcurrent or wrench fault will have to be used there also with increasing frequency.

It is hoped that the Red Sea discussion meeting will further collaboration between governmental, academic and industrial scientists in the various Earth science disciplines: they have a common interest in the search for the truth, although short-term motives may be different. The need for close cooperation between geophysicists and geologists is increasing. The former with their relatively simple mathematical models need the assistance of the latter to evaluate the geological evidence available: the latter know by painful experience that the enthralling reconnaissance stage of most Earth science inquiries is usually followed by increasing doubts and uncertainties in proportion to the amount of factual or supposedly factual data which becomes available. It is by the provision of major new facts of stratigraphy and structure that the oil industry makes its contribution to truth. Although some data may have to be withheld from publication for a time because it represents a financial asset to the owners, this necessity passes and ultimate release is of benefit to all, stimulating further activity. The problem is to find mutually beneficial ways of communication during the confidential stage—discussion meetings are one method. The cost of obtaining the essential deep bore hole data for checking interpretations of indirect evidence is so great, particularly in the marine environment, that cooperative endeavours, of which J.O.I.D.E.S. (Joint Oceanographical Institutions Deep Earth Sampling) is a prime example, should become more common. We can only keep our sense of proportion in the Earth sciences by collaboration, not fragmentation.

N. L. Falcon

Note on units of terrestrial magnetism

The use of SI units in terrestrial magnetism raises the question of the physical quantities measured pertaining to the Earth's magnetic field. There is some confusion concerning magnetic flux density, B (teslas) and magnetic field strength H (A m^{-1}). A working group of I.A.G.A. has been formed to elucidate these difficulties. It is assumed *pro tempore* that 1 gamma = 1 nanotesla (nT).

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