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

Introduction to the General Discussion

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GENERAL DISCUSSION

Introduction to the general discussion

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The meeting has promoted a valuable exchange of ideas between field geologists, geologists engaged in petroleum exploration in and around the Red Sea, and geophysicists who have undertaken land, airborne and marine surveys. The results are of fundamental interest in several fields.

The ancient crystalline rocks, discussed by Brown and Beydoun, revealed little to suggest a control of the Red Sea geosuture by Precambrian structures. The old eugeosynclinal trough in Arabia perhaps trends N 30° W, but Brown had been unwilling to assign a direction to the postulated miogeosynclinal trough. The early sediments had been extensively annealed by metamorphism and by igneous intrusion on a large scale. It did not appear that an obvious case for the location of either the Red Sea or the Gulf of Aden along a pre-existing line of crustal weakness could be made out from the surface geology, though the case of the Dead Sea rift may be different.

Nor was there any very clear evidence of a proto-Red Sea with anything like its present outlines during Mesozoic times. Hutchinson had indeed shown a strong tendency for the Jurassic sandstones and limestone to thicken towards the Red Sea at Danakil, but Beydoun did not provide similar evidence from the Hadhramaut; indeed as the late Dr Henson had shown, the clearest tendency is for the Mesozoic rocks to thicken eastward across Arabia towards the Persian Gulf.

The first clear evidence of the Red Sea as a depression of approximately the present shape comes from Miocene times, when according to Dubertret, the sea entered from the Mediterranean and there was no connexion with the Indian Ocean. The linear down warping possibly followed the axial course of a major domal bulge; Gass had referred to this as the Afro-Arabian swell and certainly the relation between basement and cover rocks in Arabia, as indicated by the U.S.G.S. map, appeared to justify such a postulate. It might be recalled that Arthur Holmes had maintained that the African rift system was also situated along the axis of a major swell. Gass had suggested a possible petrological explanation of the phenomenon.

The Miocene age of the sediments in the Red Sea depression was proved by fauna, and Brown had given ages for lavas which presumably accompanied the downwarp. However, much of the sedimentation was chemical, producing thicknesses up to at least 3 km of evaporites, mainly halite. Reworking of earlier deposits perhaps several times would probably have to be postulated to account for the dominance of sodium chloride, which appeared to be present in relative quantities far greater than straight evaporation of sea water could yield.

One of the most important questions not resolved during the meeting concerns what underlies the Miocene in the Red Sea. Davies & Tramontini interpret their seismic refraction results as indicating basalt 'similar to the oceanic basaltic layer' as the local basement with about a

kilometre of sediment between the base of the evaporites and the basement. It is impossible to believe that deep boring is worth continuing unless permeable sediments underlie the salt and the hope may be expressed that before too long, publication of this aspect of the borehole information may be permitted. Meanwhile, Girdler's interpretation showing basalt of mantle origin under the median trench only is not regarded by him as final. One aspect of the dilemma is, of course, that the two coasts of the Red Sea cannot be fitted together if coastal rocks underlie three-quarters of the seabed.

The structural mechanisms by which the Red Sea and Gulf of Aden have opened are of the greatest interest. Strong cases for a spreading origin have been made for the Gulf largely on bathymetrical evidence by Laughton and on the basis of magnetic anomalies for the Red Sea by a number of authors. Nevertheless, the pattern of the spreading and the incidence of transform faulting cannot yet be said to be as clear for the Red Sea as, for example, for the eastern Pacific and there is a case for even greater detail and for more clarification. The supercrustal rocks have demonstrably been affected by faulting parallel to the Red Sea trend and this is so even in the Hadhramaut and Somali regions, as Beydoun showed. Of the northward continuing faults from the Red Sea, the Dead Sea rift received a very convincing demonstration as a sinistral transcurrent shift of 105 km from Freund; but it was disappointing that so little data for the Gulf of Suez had been given, for this should be a critical area, stratigraphically and structurally. Abdel-Gawad and Robson could perhaps add further details; the magnificent satellite photographs of the Red Sea shown by these authors brought out the major structures.

No further comment here is needed upon the fascinating Afar triangle save that more data, correlation and interpretation is highly desirable. Upon the subject of plate tectonics it is, however, justifiable to ask where the initiation and development of geosynclines fits into the scheme. Are there, for example, criteria which enable a sound claim to be made that the Red Sea is an incipient ocean basin, rather than a nascent geosyncline, destined to be the site of a future orogeny? Is it possible to distinguish positively between oceanic crust and the 'initial magmatism' or ophiolite phase of a eugeosyncline?

Finally, returning to the note on which Sir Edward Bullard opened the symposium, the mineral deposits and hypersaline brines in the hot pools of the Red Sea bottom, though geologically small in scale are already causing a revolution in thought about ore genesis, first because they yield actualistic evidence of mineralization contemporary with sedimentation; secondly, because the brine solutions are deficient in sulphur, as at the Salton Sea; and thirdly, because on the whole the hydrothermal water seems to be of surface, not deep-seated origin. If the metalliferous deposits described by Millon along the sides of the Red Sea had a comparable origin, sulphur must presumably have been supplied from biogenic souces. The hot bottom of the Red Sea may be found to contain a self-perpetuating metal deposit, but this is far from proved yet.

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