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Tectonic evolution and trace element composition of basement rocks of the Mid-Atlantic Ridge: 8° S

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Rapidly growing information regarding the rocks of the Mid-Atlantic Ridge has led Melson & Thompson to postulate a basement consisting of an upper layer of oceanic tholeiites with subsidiary hydrothermal metabasalts, and a lower plutonic layer of peridotites, serpentinites and gabbros. These layers may correspond to the second and third layers of refraction seismology. The same data permit the assumption that the oceanic tholeiites are underlain by an intermediate layer of metabasalts resulting from isochemical regional metamorphism under increased temperature and pressure. Laboratory measurements of magnetic properties have shown that the Koningsberger ratio of oceanic metabasalts is generally less than unity. Thus, such a regional metamorphic layer would place a floor under the zone responsible for the observed geomagnetic anomaly patterns.

The tectonic history of the Mid-Atlantic Ridge probably has been complex and cannot be described by simple lateral transfer to the flanks of structural elements generated at the crest alone. Vine, Phillips *et al.* have shown that a change in spreading rate has occurred several million years ago. Major changes in the development of some fracture zones may have occurred at approximately the same time. J. & M. Ewing have shown that the distribution of sediments over the Ridge indicates the existence of two spreading phases separated by a long period of quiescence. Van Andel & Bowin concluded that a period of intensive deformation and volcanism on the crest began during the Pliocene or early Quaternary and that this was accompanied by block faulting on the flanks.

By combining the concept of a regional metamorphic zone with structural models developed by van Andel, Watkins & Richardson have shown that the observed geomagnetic anomaly patterns can be explained by these factors alone and that substantial modification of sea-floor spreading anomaly patterns must result if intensive block faulting and regional metamorphism exist.

During Circe cruise of R.V. *Argo* of Scripps Institution of Oceanography in the South Atlantic in 1968, we carried out detailed geophysical and sampling studies of four small areas on the crest and east flank of the M.A.R. at 8° S, with the purpose of examining the structural and magmatic evolution of the Ridge. The data show marked progressive changes in sediment distribution, morphology, magnetic anomaly patterns, and nature of the basement with distance from the Ridge crest.

Menard, van Andel & Bowin, and Cann have drawn attention to the fact that the morphology, basement rock types, crustal structure, and spreading rates of mid-oceanic ridges are different in different parts of the world, and they have concluded that more than one deep-seated mechanism is involved in the creation of mid-oceanic ridges. Thus, the lateral changes in the nature of the Mid-Atlantic Ridge in the South Atlantic, referred to above, may result either from variations in time of the tectonic mechanisms, or from successive superpositions of deformations centring on the crest but also affecting the flanks.

Corliss & Goles, using trace element abundance data on oceanic basalt from many localities on the crest of the M.A.R., have found regional compositional variation in these rocks. These may arise from compositional variations in the mantle source or from variations in the mechanism which extract basaltic magma from the mantle and transport it to the surface. These differences may be reflected in variations in the intrusive behaviour and structural deformation which produce the features of the sea floor.

In addition to spatial variations of zero age, temporal variations in basalts erupted at any specific locality may also exist. Trace element data for the Circe samples, dredged across the flanks of the ridge at one latitude, will have implications for the sea-floor spreading theory. They should set some limits on the composition of the mantle source of this supposedly continuous supply of basalt and reflect the history of the processes which produce it. In order to investigate applications of trace-element data to these problems, effects of post eruption processes must be taken into account. Our geochemical work allows preliminary conclusions to be drawn concerning the direction and magnitude of these effects. At the time of writing this summary, the geochemical data from the Circe cruise have not been fully processed. In this paper, we shall examine the geochemical and geophysical data from the 8° S traverse in the light of the concepts discussed above.