Paleogene Sediment from a Fracture Zone of the Mid-Atlantic Ridge[1]

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ABSTRACT

A dredge haul from a transverse fracture zone in the equatorial Atlantic Ocean yielded sediment of the Paleocene and the early Eocene ages. This sediment is the oldest thus far recorded from the Atlantic outside of the continental margins. Its occurrence is consistent with the view that transverse fracture zones are faults along which sea-floor spreading has taken place.

Introduction. For several years, dredge hauls by vessels of the Woods Hole Oceanographic Institution have yielded a wide variety of consolidated sediments. The age, composition, and mode of consolidation of these sediments are important factors in the structure and history of the oceanic basins. These sediments, some of which are sufficiently indurated to be regarded as rocks, are, after all, the known observable sedimentary constituents of the oceanic crust from which the geohistoric record of the oceanic basin may be deduced.

Here we discuss the sediments of one dredge haul that yielded a consolidated but not particularly hard or dense sepiolitic and calcareous sediment. Investigation of the calcareous nannoplankton by M. N. Bramlette and of the Globigerinacea by us shows that the sediment is of the Paleocene and Early Eocene ages.

Samples A. II and B. II were obtained in dredge 11 during cruise 35 of the R/V CHAIN in April 1963 at about 01°23.5′S, 29°12.0′W.[4] The area is

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3. British Petroleum Co., Ltd., Sunbury-on-Thames, England.

4. The position of dredge 11 as originally given by Hathaway and Sachs is incorrect (V.T. Bowen and P. L. Sachs, personal communication).

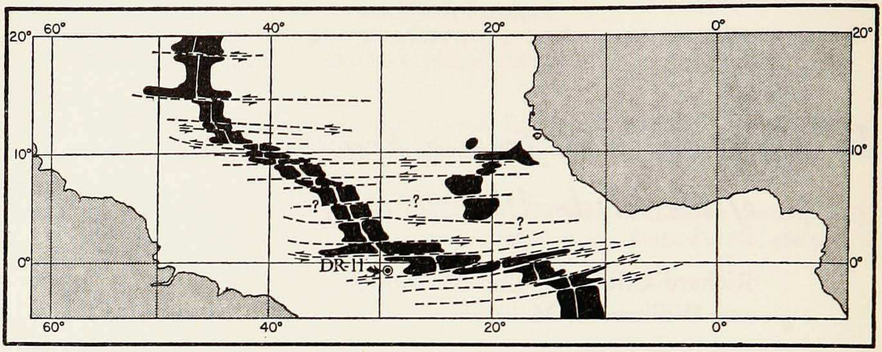

Figure 1. Location of dredge 11 with respect to fracture zones in the equatorial Atlantic (after Heezen and Tharp 1965: fig. 5).

situated in one of the postulated transverse fracture zones of the Mid-Atlantic Ridge, about 2° south of St. Paul's Rocks (Fig. 1). The dredge was hauled across a slope between depths of 4200 m and 3600 m. Hathaway and Sachs (1965), who have reported on the various rocks recovered from the dredge, have noted the presence of rounded cobbles and pebbles of serpentine and granular magnetite together with masses of "white waxy material with pearly lustre" [sepiolitic] sediment; they also recorded the presence of "cobbles and pebbles of friable chalky material containing numerous burrows." The material examined by us consisted of two types of sediment: Sample A. II consisted of an admixture of chalky friable ooze and sepiolitic material (with burrows) in close sedimentary contact; Sample B. II consisted entirely of chalky ooze without discernable sepiolitic fraction. From these same samples, M. N. Bramlette recorded the presence of Middle Paleocene and Lower Eocene coccoliths. We are grateful to M. N. Bramlette for drawing our attention to the age of these samples and for permitting us to quote from the results of his investigations, with which we are in full agreement.

Paleontology. Sample A. II yielded a diagnostic planktonic foraminiferal assemblage that included specimens referable to *Globorotalia (G.) velascoensis*, *G. (G.) pseudomenardii*, *Globorotalia (Turborotalia)* cf. *pseudoiota*, *G. (T.) tribulosa*, *Globigerina aequiensis*, and *G. triloculinoides*. Both *G. (G.) velascoensis* and *G. (G.) pseudomenardii* occur in only the later Paleocene and both are present in the Velasco formation. Loeblich and Tappan (1957) recorded *G. (T.) tribulosa* and *Globigerina aequiensis* for the Aquia formation of Maryland and Virginia, and it seems to us that the horizon represented by sample A. II is biostratigraphically close to those included in the Aquia formation and in the upper parts of the Velasco formation. In accord with the zonal scheme proposed by Bolli (1957), we suggest that the sample came from a horizon that is most likely referable to the *Globorotalia pseudomenardii* Zone, which is considered to be in the later, but not in the latest, Paleocene. The presence of the forms recorded here as *Globorotalia (T.)* cf. *pseudoiota* are of considerable biostratigraphic significance, since these forms appear to be an ancestral form of *Pseudohastigerina*, which characterizes the Ypresian-Lutetian-Priabonian and Oligocene of tropical and subtropical areas at least. The development and first appearance of *Pseudohastigerina* provides an excellent biostratigraphical datum at, or near, the Early Eocene-Paleocene boundary, and it is evident that sample A. II is from a horizon that antedates this boundary.

Sample B. II yielded specimens of planktonic foraminifera referable to *Globorotalia (G.) formosa formosa*, *G. (G.) formosa gracilis*, *G. (G.)* cf. *aragonensis*, *G. (Turborotalia) quetra*, *G. (T.) broedermanni*, *G. (T.) pseudotopilensis*, *G. (T.) collactea*, *G. (T.) aspensis*, *Globigerina prolata*, *Globigerina* (?) *soldadoensis*, and *Pseudohastigerina eocenica*. This fauna is determinative for either the *Globorotalia formosa formosa* Zone or the *Globorotalia aragonensis* Zone *sensu* Bolli (1957). We consider the horizon represented by sample B. II to be more referable to the *formosa* Zone than to the *aragonensis* Zone, since the specimens recorded here as *G. (G.)* cf. *aragonensis* are evidently phylogenetically and morphologically primitive. The presence of *Pseudohastigerina eocenica* is biostratigraphically the most significant, since the development of this form occurred at a horizon that is very close to the Early Eocene-Late Paleocene boundary as placed by us within the *rex* Zone of Bolli. Thus, the assemblage is strictly comparable to those from the *G. formosa formosa* Zone (as seen in Trinidad) and indicates an age within the middle part of the Early Eocene, according to the scheme of Bolli.

From the above discussion it is evident that sample A. II is referable to the earlier Paleogene horizons within the later Paleocene (Thanetian), sample B. II to the earlier Eocene (Ypresian). The stratigraphic relationships of these samples cannot be decided from this material alone. There is obviously an interval between the latest Paleocene and earliest Eocene that is not represented in these two samples. However, other material collected in the dredge haul (presently under investigation) may throw further light on these relationships and give further evidence as to whether stratigraphic continuity exists. In any case, the samples discussed above show, without reasonable doubt, the presence of earlier Paleogene horizons over the path of the dredge 11 traverse.

Discussion. These horizons of Paleocene and Early Eocene age in the Mid-Atlantic Ocean are seemingly anomalous, since sediments of this age and older are normally found only along, or near, the continental margins. Past records tend to suggest that midoceanic sediments are mostly Miocene or younger. To our knowledge, the only other Paleogene sediment occurrence reported for the mid-Atlantic is of lower Middle Eocene age, from the west end of Vema fracture zone (Saito et al. 1966).

It does not seem fortuitous that the two Mid-Atlantic Paleogene discoveries thus far recorded are from transverse fracture zones. By comparison, for example, the median valley of the Mid-Atlantic Ridge, with a relief of over 2000 m, has been cored and dredged far more extensively but has yielded ages no older than Miocene. We believe that the older midoceanic sediments will continue to be recovered from transverse fracture zones.

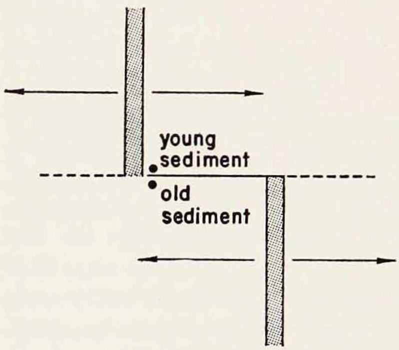

Figure 2. Example of sediments of contrasting ages on opposite sides of a transform fault having dextral movement. The crest segments are represented by double line, the transform fault by a single line (after Sykes 1967: fig. 1).

Also, our discovery is consistent with the proposal that transverse fracture zones are faults along which sea-floor spreading has taken place (Heezen and Tharp 1965). If we assume spreading movement away from the crest segments along the faults, the sediment from dredge 11 would have been derived from a location much farther to the west (Fig. 1), since the dredge site was on the wall of the fracture zone that faces south. The source of the sediment would have been from the west, regardless of whether the faults are transcurrent (with motion as shown in Fig. 1) or transform (with a sense of motion opposite to that in Fig. 1) (Sykes 1967).

An important stratigraphic consequence of spreading movement along transform faults is that sediments in close proximity may differ appreciably in age if they are on opposite sides of the fracture zone. An example is shown schematically in Fig. 2, where crest segments are offset by a transform fault having a dextral sense of motion (cf. Fig. 1). At the particular point shown along the fault, the sediment in the lower block will be older than that in the upper block because of the greater distance traveled from a crest segment. Also, the old sediment in the lower block is in close proximity to the crest segment in the upper block. Therefore, in evaluating sediment ages with respect to sea-floor spreading, it is important to identify the location of the sampled sediments with respect to a specific fracture zone and crest segment. While such a possibility is suggested in Fig. 1, it must be remembered that the bathymetry in that chart is generalized. In fact, the equatorial Atlantic is poorly surveyed west of 20°W. There is insufficient data for assigning dredge 11 to a particular fracture zone, and it appears unwarranted at present to estimate rates of sea-floor spreading on the basis of our observations.

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