

Petrology of the Marine Sediments off the Mid-Atlantic Coast¹

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AREA AND SAMPLES

The area included the continental shelf off the coast from Delaware Bay north to Marthas Vineyard. Seven hundred samples from all parts of this area were studied. Mechanical analysis, including pipetting when necessary, was carried through for 200 samples and heavy mineral studies included 60 of the analyzed samples.

TYPES OF SEDIMENTS

The sediments of the continental shelf in this area are largely sand, but many zones of pebbles and silt are found scattered over all parts of the shelf. There are two principal zones which outline the distribution of the sediments in a general way. A southern zone from Delaware Bay to Block Island contains sediments composed almost entirely of sand with subordinate amounts of gravel but with almost as coarse sediment outside as near shore. The northern zone extending to Georges Bank has finer sediment on the outer portion of the shelf, but the inner portion shows the same patchy arrangement of coarse and fine sediment found farther south.

Histograms and medians show irregularities in grain size along and across the shelf and there is no general decrease in median size from the shore to the edge of the shelf.

PETROGRAPHY OF THE SANDS

Abundance of the minerals on the shelf.—The most abundant mineral on the shelf is quartz. Off Long Island feldspar, which is next in abundance, comprises from 20 to 30 per cent of the light fraction, with quartz making up almost all of the remainder. The sediments off New Jersey contain only 10 to 20 per cent feldspar.

The heavy minerals vary from .01 to 8.0 per cent in the sands. The amount of heavy minerals is usually lower in the samples near shore than in samples farther out on the shelf. Heavy minerals are even found with the silt and clay on the continental slope and on the deep ocean bottom at the base of the slope.

¹From a doctor's thesis completed under the direction and supervision of Dr. F. P. Shepard of the Department of Geology and Geography of the University of Illinois.

Localized zones of heavy minerals.—The distribution of the heavy minerals over the sea bottom is very general, but some minerals are found to be diagnostic of certain zones. Hornblende is most abundant on the east side of the Hudson submarine valley off New York, especially in the silt-sand zone. Biotite is also common in this same zone. Angular salmon colored garnets are numerous on the New Jersey shelf near the submarine valley of the Hudson. These angular grains, in contrast to the well rounded grains of most of the shelf in this area, suggest that they were possibly derived from the glacial debris carried out by the streams during lowered sea-level. The cover of the shelf contains well rounded, frosted, and pitted pink garnets, staurolite, titanite, and tourmaline. These mineral grains may have been derived from re-worked Coastal Plain sediments.

Authigenic minerals.—Glauconite was found in almost every sample examined, even off Long Island within three miles of the shore and in a depth of from 10 to 15 fathoms and at a little greater distance from shore but in the same depth of water off New Jersey. Since the glauconitic Cretaceous and lower Tertiary formations crop out along the shore north of Asbury Park, New Jersey, it is possible that much of the glauconite very near shore and for a short distance south may be derived from these formations.

Colony² states that no glauconite is present in the beach sands off Long Island. Its presence in the samples near shore and in shallow depths suggests conditions of non-deposition of sediment. Glauconite formation, according to Hadding³, is favored in agitated waters with limited deposition of detritus, particularly fine detritus, and under reducing or neutral conditions.

Gallihier⁴ concluded that glauconite is formed by the alteration of biotite and that very little, if any, biotite would be found where there is much glauconite and conversely where the biotite abounds there would be little or no glauconite. In accord with Gallihier's conclusions little biotite was found in samples containing much glauconite.

Limonite is widely distributed over all parts of the sandy zone of the shelf off New Jersey and Long Island but occurs in no great abundance. Where the limonite pellets are found very little biotite is present. Alexander⁵, in a recent study of some continental shelf sediments, explains this condition by the oxidation of the biotite flakes to form the limonite pellets. A hardening of a gel-like hydrosol around the pellets gave the grains a varnish-like surface which probably resisted further chemical action.

² R. J. Colony, Source of Long Island and New Jersey Sands. *Jour. Sed. Petrol.* Vol. 2 (1932), p. 156.

³ A. Hadding, Glauconite and Glauconitic Rocks Review by W. H. Twenhofel in *Jour. Sed. Petrol.* Vol. 2 (1932).

⁴ E. W. Gallihier, Geology of glauconite. *A.A.P.G.* Vol. 19 (1935), pp. 1569-1601.

⁵ A. E. Alexander, A Petrographic and Petrologic Study of some Continental Sediments. *Jour. Sed. Petrol.* Vol. 4 (1934), pp. 12-22.

Pyrite is very abundant in the silt-sand zone east of the Hudson submarine canyon but is scarce off New Jersey and Long Island. However, small amounts have been found in samples within a short distance of both shores.

Calcium carbonate found in the sediments was in the form of shells and shell fragments. The shells exhibited weathered powdery surfaces suggesting solution rather than precipitation of the calcium carbonate.

Dr. Shepard and the writer believe that the wide distribution of authigenic minerals over all parts of the shelf indicates conditions without pronounced sedimentation whether these conditions be neutral or reducing. A period of oxidation during which limonite was formed may have preceded the present neutral or reducing condition. The most favorable conditions must have existed at a time when the shore line was nearer the limonite areas and the water was shallower.

ORIGIN OF THE SEDIMENTS ON THE SHELF

The characteristic flat, elongated pebbles and well rounded heavy and light mineral grains suggest reworked materials from the old Cretaceous and Tertiary formations of the Coastal Plain. This material was left upon the shelf during the period of sub-aerial erosion in Pleistocene time⁶.

South and east of Long Island for a short distance the sediment appears to be largely glacial debris of the outwash plain from the moraines of Long Island⁷.

The silt which forms a secondary maximum in the samples of the silt-sand zone southeast of Long Island was possibly eroded from the morainic material of Georges Bank⁸ by strong currents sweeping southwestwardly, and deposited on this part of the shelf where the water was deeper and the currents slackened.

Occasionally angular pebbles are found on various parts of the shelf which may have been carried out and dropped by ice-rafting.

⁶ F. P. Shepard, *Submarine Valleys*. Geog. Review, Vol. 23 (1933), p. 83.

⁷ A. C. Veatch et. al: *Underground water resources of Long Island, N. Y.* U. S. G. S. Prof. Paper 44, p. 50.

⁸ F. P. Shepard, J. M. Trefethen, G. V. Cohee, *Origin of Georges Bank*. Geol. Soc. Amer. Bull. Vol. 45 (1934) p. 291.