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Clay Mineral Composition of Bottom Sediments: Western Great South Bay and South Oyster Bay, Long Island, New York

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Introduction

As part of an integrated study of the oceanographic and biological environments of the Western Great South Bay and South Oyster Bay, bottom sediment samples were obtained from 37 stations. Since other portions of this study (Baylor, 1973), included detailed investigations of physical, chemical and biological aspects of the region, a unique opportunity was established for studying the sediments in relation to their depositional regimes. The results of this study are described by Ali, Lindemann and Feldhausen (in prep.). The purpose of this paper is to describe the distribution and mineralogy of the clay-size portion of the bottom sediments of Western Great South Bay and South Oyster Bay, and to determine their source.

Western Great South Bay and South Oyster Bay are part of the coastal lagoon complex on the South Shore of Long Island (Fig. 1). These bays are situated on a shallow submerged surface of a glacial outwash plain that constitutes the southern portion of the fluvio-glacial deposits that form Long Island (Cohen, Franke and Foxworthy, 1968).

A series of barrier beaches separates the Western Great South Bay and South Oyster Bay from the Atlantic Ocean. Oceanic water flows into the bays through two inlets - Jones Inlet on the west and Fire Island Inlet on the east. The bays are typically characterized by their shallowness and by a restricted tidal exchange with the adjacent Atlantic Ocean.

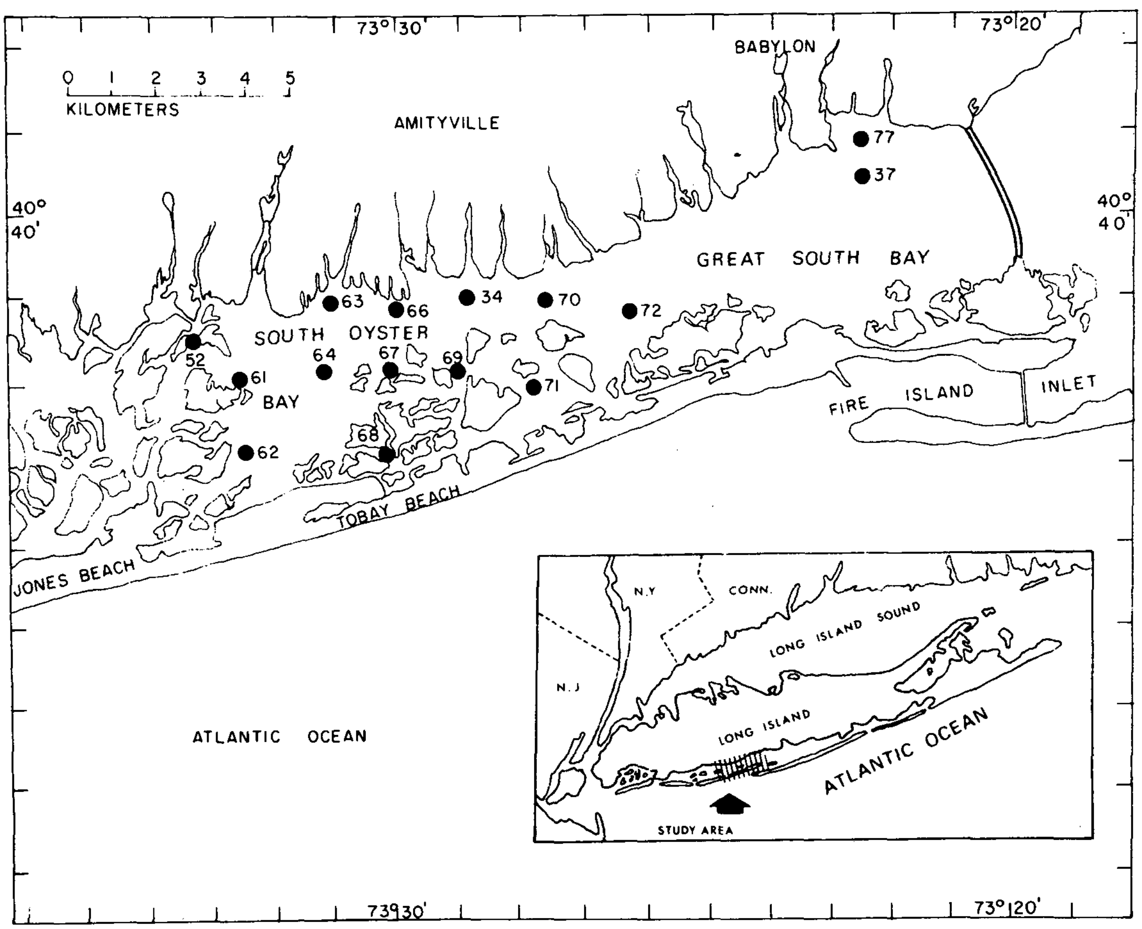

FIG. 1: Study area and sample locations.

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Great South Bay is linked on the east to Moriches Bay via Narrow Bay channel. The water exchange through Narrow Bay channel has an important effect on the hydrography of Great South Bay. South Oyster Bay lies west of Great South Bay and is connected by a shallow area generally less than 2 ft. deep, which is interrupted by numerous low islands and eelgrass beds. Wind is the dominant mechanism mixing the water in these bays.

Sampling and Laboratory Procedures

Fifteen sediment samples were collected with a bottom grab operated from a shallow draft Boston Whaler. Complete size analyses of the sediment samples were carried out using standard sieve and pipette technique (Folk, 1968).

Sediment samples were prepared for X-ray analysis by the oriented aggregate technique. Mineral identification of the < 2 micron size was further facilitated by glycolation for 24 hours and heat treatment at $550^{\circ}C$ and $500^{\circ}C$. Some samples were treated with warm 1 N HCL to facilitate identification of kaolinite and Fe and Mg chlorites.

Results and Discussion

Sediment distribution within the study area is related to the complex tidal currents of variable velocities. Maximum velocities are attained within the tidal inlets and the adjacent dredged channels. Although the net movements of the water masses within South Oyster Bay and Western Great South Bay are complex, the tidal currents within the inner regions of the bays move in an east-west direction parallel to the main navigational channels (Hardy and Gross, 1972). Accordingly, currents velocities are highest in the deeper east-west natural or dredged channels. Current velocities are reduced within the shallow areas of South Oyster Bay and Western Great South Bay by dense growths of eelgrass and the general shallowness of the area.

Four major sedimentary environments occur within the study area: shallow sand flats, shallow muddy sand, deeper open bay and the navigational channels (Smith and Ali, 1973, unpub. data). The shallow sand flats consist of very fine sands and dominate the western and southern portions of western Great South Bay and the southeastern portion of South Oyster Bay (Fig. 1, Table 1). Shallow flats consisting of very fine muddy sands dominate the central and northern portion of South Oyster Bay (Fig. 1 Table 1). Variations of water mass circulation and tidal current velocities apparently account for the presence or absence of silts and clays within the shallow areas dominated by dense growth of eelgrass.

Sediment type and distribution in the deeper part of the open bay is variable; significant percentages of silt and clay occur at all stations.

Sediments in the channels reflect the relative strength of tidal currents. Gravely coarse sands are present in Fire Island Inlet. Finer silts, clays and organic detritus accumulate within the channels of the bay where currents are weak.

Table 1

Size Distribution of Bottom Sediment

Sample	%:Gravel	Sand	Silt	Clay
34	0	59.70	25.50	14.80
37	0	82.70	12.10	5.20
52	.33	94.28	3.08	2.31
61	0	59.22	23.05	17.73
62	0	51.42	26.15	22.43
63	0	53.50	25.92	20.58
64	0	66.01	20.42	13.57
66	0	65.92	13.14	20.97
67	0	63.66	17.68	18.26
68	0	52.04	23.62	24.34
69	0	35.14	44.97	19.89
70	0	92.43	4.26	2.35
71	0	54.06	24.43	21.51
72	0	92.88	3.07	4.05
77	0	49.52	50.48	16.56

Table 2

Mineralogy of the Clay Size Fraction of Bottom Sediment

Sample	Relative abundance
34	Illite > chlorite (a); Mixed-layer (m)
37	Illite > chlorite (a); Mixed-layer (m)
52	Illite > chlorite (a); Mixed-layer (m)
61	Illite > chlorite (a); Mixed-layer (m)
62	Illite > chlorite (a); Mixed-layer (m)
63	Illite > chlorite (a); Mixed-layer (m)
64	Illite > chlorite (a); Mixed-layer (m)
66	Chlorite > Illite (a); Mixed-layer (m)
67	Illite > chlorite (a); Mixed-layer (m)
68	Illite > chlorite (a); Mixed-layer (m)
69	Illite > chlorite (a); Mixed-layer (m)
70	Illite > chlorite (a); Mixed-layer (m)
71	Illite > chlorite (a); Mixed-layer (m)
72	Illite > chlorite (a); Mixed-layer (m)
77	Illite > chlorite (a); Mixed-layer (m)

(a) abundant (m) minor

The clay-size portion of the bottom sediments contains abundant illite and chlorite with minor amounts of mixed-layered clay (Table 2). Techniques to distinguish chlorite from kaolinite consisted of those described by Brindley (1961, p. 264) and also by slow X-ray scanning from 23° - 26° 20 in order to resolve the (004) chlorite peak from the (002) kaolinite peak. Both techniques indicated the absence of kaolinite. Intense X-ray diffraction peaks at 7 Å and 14 Å which are unaffected by glycolation indicated the presence of chlorite. Due to the intensity of both the (001) and (002) chlorite peaks, it is suggested that both Fe and Mg chlorites may be present.

Conclusions

X-ray analysis of the clay-size fraction of sediment in Western Great South Bay and South Oyster Bay indicates a uniformity in mineral composition. Illite and chlorite predominate with illite greater in abundance in the clay-size fraction. Mixed-layered clays are present but to a much lesser amount.

These mineralogical findings concur with those of Hathaway (1972) who surveyed clay mineral distribution in estuaries and the continental margin of the United States east coast. He observed that illite and chlorite are the characteristic minerals of the estuaries as far south as Chesapeake Bay with chlorite lower in concentration than illite. Due to the similarity in clay mineral composition and uniformity of distribution, the authors support Hathaway's (1972) explanation for the source of sediment in the study area. He states during the Pleistocene epoch, glacio-fluvial processes permitted sediment distribution on the exposed continental shelf and that these sediments would have consisted largely of unweathered materials of the sedimentary and metamorphic rocks of the northern Appalachian region - rocks tending to be mostly mica or illite and chlorite. As the sea level rose, Hathaway, states that this fine bottom sediment was flushed shoreward into embayments and estuaries. Although information is incomplete as to the contribution of land derived sediment to the study area, it seems likely that the illite and chlorite content of the clay-size fraction in Western Great South Bay and South Oyster Bay has resulted in the same manner suggested by Hathaway for other sediment on the northeast continental margin.

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