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Characteristics of Sediments in the James River Estuary, Virginia

Richard Moncure
Virginia Institute of Marine Science

Maynard Nichols
Virginia Institute of Marine Science

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W. J. Hargis, Jr.
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INTRODUCTION

This report presents data on the physical and chemical characteristics of bottom sediments in the James River estuary, Virginia. The data were generated as part of a comprehensive study of sedimentation in which the initial objective was to broadly define the distribution of sediment properties. Interpretation of the data and analyses are given in a separate paper.

PLAN OF SAMPLING

Most of the field sampling was accomplished during a series of short cruises between April 1966 and October 1966. The special series of Eh and pH measurements were made in July and August 1967.

The distribution of sampling stations is given in Figure 1 and the coordinates are tabulated, together with water depth, in Table I. Four additional stations (133, 134, 135, 136) were established in the river near Weyanoke, 92 to 100 kilometers (57-62 miles) above the mouth, beyond the coverage of Figure 1. All the stations were assigned a number constituting a running series beginning with the first station sampled. The letter prefix "J" was assigned for convenience in identifying certain supplemental samples used in detailed size analyses, whereas a letter suffix was used for duplicate samples taken less than 10 meters apart.

Stations were positioned to include a range of different sediment types from different water depths, morphological reaches as narrows and broad bays, and areas of active fill and scour (Table I). Because the bottom is characterized by numerous variations in topography and sediment properties, the network of stations does not cover all the local changes in the estuary. Future studies with greater sampling density at larger scales will undoubtedly show greater variations than those presented here. Moreover, the patterns of sedimentation may be expected to change with future modification of the estuary by man.

FIELD PROCEDURES

Collection of samples was carried out from the R/V W.K. Brooks, a 28-foot launch. Stations were positioned by ranging or sextant angles on buoys and landmarks. A total of 155 stations was occupied throughout the estuary.

Sample collection

Most of the bottom samples were taken with either a light-weight gravity corer or a hand corer fitted with 5-cm diameter tubing (Nichols and Ellison, 1966). In very coarse material, samples were obtained with a Petersen grab. The top 1 cm of each core was sliced off with a core cutter to obtain more or less equal volume and equal area samples of near-surface sediment. The samples were placed in glass jars and returned to the laboratory. At each "regular" station one core was taken, whereas at selected "reference" stations three cores were taken. The first core was used for particle size, clay mineralogy and coarse fraction analyses; the second core for determinations of water content, calcium carbonate, organic matter, and total carbon; and the third for on-board measurements of pH, Eh and color. The remainder of the third core was extruded and split lengthwise to observe minor sedimentary structures and thickness of the oxidation layer.

Soundings were taken with a lead line, pole, or a portable EDO fathometer on traverses across the estuary. Water depths were corrected for tidal height and recorded to the nearest 0.3 m (1 ft.) when greater than 3.6 m (12 ft.) or to the nearest 0.15 m (1/2 ft.) when less than 3.6 m (12 ft.).

Thickness of Soft Sediment

The thickness of soft sediment, or relative "bottom firmness," was determined with a special photo-electric probe designed at the Chesapeake Bay Institute (Whaley and Pritchard, 1955). After the probe was lowered close to the bottom, the instrument was adjusted to zero and the probe allowed to settle into the sediment for one minute. The measured thickness of soft sediment was obtained from three or more averaged readings. Measurements were taken mainly in the upper estuary around Hog Point near the upstream limit of oyster production. The data are given in Table II and the distributions are shown in Figure 2.

Oxidation Layer - Color

The thickness of the near-surface oxidation layer was measured visually on split cores. Measurements were made to the nearest millimeter for layers less than one centimeter, and to the nearest 5 millimeters for layers greater than one centimeter. Very thin layers in "soupy" cores, too thin for measurement, were recorded as "one millimeter." Color of wet surface sediment was determined in shaded daylight by comparison with color chips of the Munsell code. These data are tabulated in Table III.

pH and Eh

The pH and Eh were measured in two series at different times. For one series, the near-surface sediment pH and Eh and other parameters were measured; for a second series, the pH and Eh were measured at depth in cores. Core measurements were made by W. MacIntyre and W. Ferguson.

The pH of the upper 2 to 5 mm of fresh sediment was determined with a Beckman Model N pH meter using a combination pH electrode (Beckman number 39-182) inserted directly into the sediment. The meter was standardized before each measurement with a pH 7.0 buffer, and compensation made for temperature.

The oxidation-reduction potential (Eh) in the upper 2 to 5 mm of fresh sediment was determined on a Beckman Model N pH meter. Potentials were measured with a combination platinum electrode (Beckman number 39-186) inserted directly into the sediment. Values were corrected to the standard hydrogen electrode by adding 0.245 volt. For each measurement the meter was nulled and the temperature compensator set at 29°. Relatively stable readings were usually attained in less than 2 minutes. Data for the near-surface pH and Eh measurements are given in Table III.

Measurements of pH along the length of cores were made with a Beckman Model G pH meter. The electrode was initially standardized in a buffer solution of 0.25 M KH_2PO_4 and 0.025 M Na_2HPO_4 of pH 6.865 and inserted into the sediment through holes in the core tube. During the measurement series, uniformity of the analysis was checked frequently by standardizing in a buffer solution of 0.05 M $KHC_8H_4O_4$ of pH 4.008. Data for core measurements are given in Table IX. For measurements of Eh along the length of cores, a Model G pH meter was used and the calomel electrode was standardized in a solution consisting of 0.0033 M $K_3Fe(CN)_6$, 0.0033 M $K_4Fe(CN)_6$, and 0.1 M KCL. The same solution was used to verify standardization throughout the measurement series. Before each standardization the platinum electrode was de-polarized by abrasion with a mixture of diatomaceous earth and Triton X-100 detergent as suggested by Oppenheimer (1966). To preserve in situ conditions in so far as possible, measurements along the core length were made through pre-drilled holes at intervals of 2.5 centimeters. The readings obtained for core measurements are given in Table IX.

LABORATORY PROCEDURES

Particle Size Analyses

Particle size was determined by sieving and pipette analysis following the procedures of Folk (1961). Samples were initially disaggregated for at least 24 hours in a 4 percent solution of Calgon (sodium

hexametaphosphate) with 50 ml of dispersant per 20 grams of sample. The disaggregated samples were wet-sieved through 2 mm and 0.0625 mm size sieves. The silt and clay fraction was placed in a one-liter cylinder and analyzed by pipetting. In these analyses, sediment was withdrawn at specific time and depth intervals corresponding to size increments finer than 0.0625 mm (4 ϕ) and 3.9μ (8 ϕ), cf. Folk (1961).

To examine the size characteristics in greater detail, the fine-grained portion of selected samples was pipetted at intervals corresponding to 1 ϕ size fractions. Results of these analyses were plotted as cumulative curves on probability paper using a logarithmic phi (ϕ) scale for diameter (Figure 3). The particle diameters at the 16, 50, and 84 percentile values were obtained from the curves and used to derive parameters based on the relations of Inman (1952):

$$\text{Median diameter (Md } \phi) = \phi\ 50$$

$$\text{Mean diameter (M } \phi) = \frac{\phi\ 16 + \phi\ 84}{2}$$

$$\text{Standard deviation } (\sigma\ \phi) = \frac{\phi\ 84 - \phi\ 16}{2}$$

$$\text{Skewness } (\alpha\ \phi) = \frac{\text{M } \phi - \text{Md } \phi}{\phi}$$

From the sieve and pipette analyses, sand-silt-clay ratios were calculated as weight percentages of the total sand plus silt and clay. The sediments were further classified according to a scheme proposed by Shepard and Moore (1954) in which sand (2.0 - 0.062 mm), silt (0.062 - 0.004 mm) and clay ($<$0.004 mm) are end members of a triangle diagram. The sand-silt-clay terminology has been altered by adding a prefix "shelly" or "gravelly" when the whole sediment contains more than five percent by weight of shell or gravel of the total sample coarser than 2 mm in size (Curray, 1960). Silt-clay ratios were calculated as percentages of silt and clay in the fraction of sediment finer than 0.0625 mm (4 ϕ). The results of size analyses are given in Tables IV and V.

Coarse Fraction Analyses

Percentages of different constituents in the size fraction 0.062 - 2.0 mm were determined under a binocular microscope following the technique given by Shepard and Moore (1954). The sample material was initially wet-sieved without prior dispersing or drying. Several aliquots were spread out on a gridded petri dish and at least 300 grains were counted along the grid lines. Major constituents identified in this

study were light-colored minerals (mainly quartz and feldspar), fecal pellets, plant debris, and aggregates of silt and clay. Among the minor constituents were dark-colored minerals (mainly heavy minerals), mica, glauconite, and pyrite; shell fragments and ostracode valves; tests of foraminifera and thecamoebina; and particles of coal, fly ash, and cinder including black-coated wood debris. The frequency counts were reduced to percent of the whole coarse fraction; results for major and minor components are given in Tables VI and VII.

Calcium Carbonate

Analysis of calcium carbonate content was made on untreated samples of all size fractions by a titration method. Approximately 2 g of dried and ground sediment were weighed and placed in a 250 ml Erlenmeyer flask. Twenty ml of standardized 0.1 N HCl and 3 drops of Bromophenol Blue indicator were added to each sample as well as to a blank. The mixture was swirled thoroughly for several seconds and allowed to stand. If the sample became basic as indicated by a blue color, additional 0.1 N HCl was added. After standing for 24 hours the sample was boiled on a hot plate for 5 minutes to drive off dissolved carbon dioxide. If the sample became basic while boiling, another 10 ml of 0.1 N HCl was added and the mixture reboiled until it remained acidic. It was filtered through a tared glass fiber filter in a Buchner funnel under moderate vacuum. The residue retained on the filter was thoroughly rinsed with distilled water and the volume of filtrate adjusted to approximately 400 ml. The filtrate was back-titrated to the Bromophenol Blue end point with standardized 0.1 N NaOH solution containing 1 percent Na EDTA. The neutralizing equivalence as a percentage of calcium carbonate was computed from the normality of the reagents, the volumes used, and the pH at the Bromophenol Blue end point. The results (Table VIII) are accurate to at least 0.5 percent and reproducible to 0.1 percent.

Organic Matter

The organic matter content was determined gravimetrically by weight loss after digestion with hydrogen peroxide (Robinson, 1927). Determinations were made on sediment residue retained on the glass fiber filters used in the calcium carbonate analysis. The pre-acidified (carbonate-free) and washed sample residue was dried in an oven at 70°C, weighed, placed in a 400-ml beaker, and reweighed. The sample was soaked with 5 ml of distilled water, to which 20 ml of 30 percent hydrogen peroxide were added. The sample was allowed to digest for 24 hours in a covered beaker and an additional 10 ml of peroxide was added and digestion continued for 24 hours. The beaker and watch glass were rinsed down and the sample dried at 70°C; its net oven-dry sediment weight was determined by subtracting the weight of the filter plus the beaker from the total. The loss of weight after oxidation was reduced

to percent of total sample and interpreted as loss of oxidizable organic matter. It was assumed that digestion with dilute HCl and subsequent filtration removed all oxidizable ions that may have interfered with the analysis. It is not known that total digestion was completed. Small quantities of coal and cinder and vegetable matter may have been oxidized, and soluble organics may have been lost. Results are of limited accuracy, but they do suggest the level of organic matter throughout the estuary. Data are given in Table VIII.

Total Carbon

Determinations of total carbon were made on raw sample material using a LECO Carbon Analyzer (Laboratory Equipment Company, St. Joseph, Michigan). The samples were dried, ground and weighed in a ceramic crucible. They were then oxidized in an induction furnace at 1480°C using tin and iron accelerators under a stream of oxygen. The carbon dioxide evolved plus excess oxygen was passed through a trap to remove sulfur gases and subsequently collected in a graduated burette where it was measured gasometrically. The volume loss of carbon dioxide, corrected for temperature and pressure, is a measure of the total carbon in the sample. The working accuracy was not determined; however, the stated minimum accuracy of the unit is ± 0.12 percent. Data are given as percent of the total sample (Table VIII). The measured values include all forms of mineral and organic carbon, i.e., vegetable matter as well as elemental carbon and carbonate carbon.

Water Content

The water content was determined by weight loss (Van Andel and Postma, 1954). A small quantity of fresh sample was held in aluminum cans sealed with tape or in jars with tight-fitting lids. In the laboratory, the lids were removed, the samples were weighed and oven-dried at 70 - 80°C for 24 hours. After cooling to room temperature the samples were reweighed and the weight loss was taken as the weight of water in the sample. Samples were run in triplicate and mean values of water content are expressed as percent by weight of the wet sample to the nearest 0.05 g (Table VIII).

Clay Mineralogy

Preliminary determinations of "clay" mineralogy were made from X-ray diffraction traces. Two procedures were used. First, the estuary samples were compared with known "reference" clays on a weight basis (Talvenheimo and White, 1952), assuming that both had the same degree of disaggregation, crystallinity, and preferred orientation as well as like ion and X-ray absorption characteristics. Second, the areas under the peaks of different estuary clay types were compared on a percentage basis, a method that eliminates difficulties of weighing.

The sediment was prepared for analysis by first dispersing the sample in a graduated cylinder as for size analysis of fine-grained sediment (Folk, 1961). One ml of suspended clay, $< 37\mu$, was withdrawn by pipette from a depth of 2.5 cm after a 30-minute settling period. The suspension was spread as uniformly as possible on a level, pre-weighed, glass slide. The sedimented slide was air-dried and reweighed under atmospheric conditions. No chemical pre-treatment was applied.

Both reference and estuary samples were prepared in a like manner. The references consisted of American Petroleum Institute samples (Kerr and Kulp, 1949): number 7, kaolinite, Bath, South Carolina; number 25, montmorillonite, Upton, Wyoming; number 35, illite, Tithian, Illinois. Mounts of standard clay were prepared using different concentrations and different size fractions of dialized and non-dialized types. However, analysis showed that these characteristics did not significantly influence either the peak positions or the intensities.

The samples were X-rayed with a General Electric XRD-5 diffractometer using Ni-filtered Cu radiation. Because the thickness of the mounts varied, each slide of reference clay was X-rayed five times in different parts of the slide. The beam was directed to strike three positions: center, 1 mm and 3 mm right of center and 1 mm and 3 mm left of center. Typical X-ray diffractograms are illustrated in Figure 4. The peak area, i.e., the area bounded by that part of the trace forming the peak and a handdrawn, slightly curved baseline separating the peaks from the background, was determined with a planimeter for each of the five runs. The values were averaged and plotted as a function of total clay weight to obtain "working" curves of each reference clay type, with a peak of 15.5 Å for montmorillonite, 7 Å for kaolinite, 3.3 Å for illite. From the curves and the measured peak areas of the estuary clay, the relative weight of the estuary clay was determined. Relative proportions of the different constituents were also estimated by calculating the peak-area percentage, i.e., the ratio of the area within one peak to the total area bounded by the three peaks.

The following criteria were used to distinguish the clay minerals:

Kaolinite shows a prominent diffraction maxima at 7-Å and 3.5-Å without heating or glycolation.

Illite displays peaks at 10-Å and 3.3-Å without heating or glycolation. Because areas under the 10-Å peak were poorly defined, the 3.3 Å peak was used but this peak may include some quartz.

Montmorillonite-chloride mixed-layer clay. This is an undifferentiated group with a peak between 15 Å and 17 Å. The 15.5 Å basal spacing, typical of reference montmorillonite, is most common in the estuary samples. Although glycolation and heating caused changes in the position and intensity of the peaks, these changes were not sufficiently distinct to distinguish different types of estuary clay.

Table X lists relative quantities based on weight (left table) and percentages based on area that show variations of each constituent from station to station (right table).

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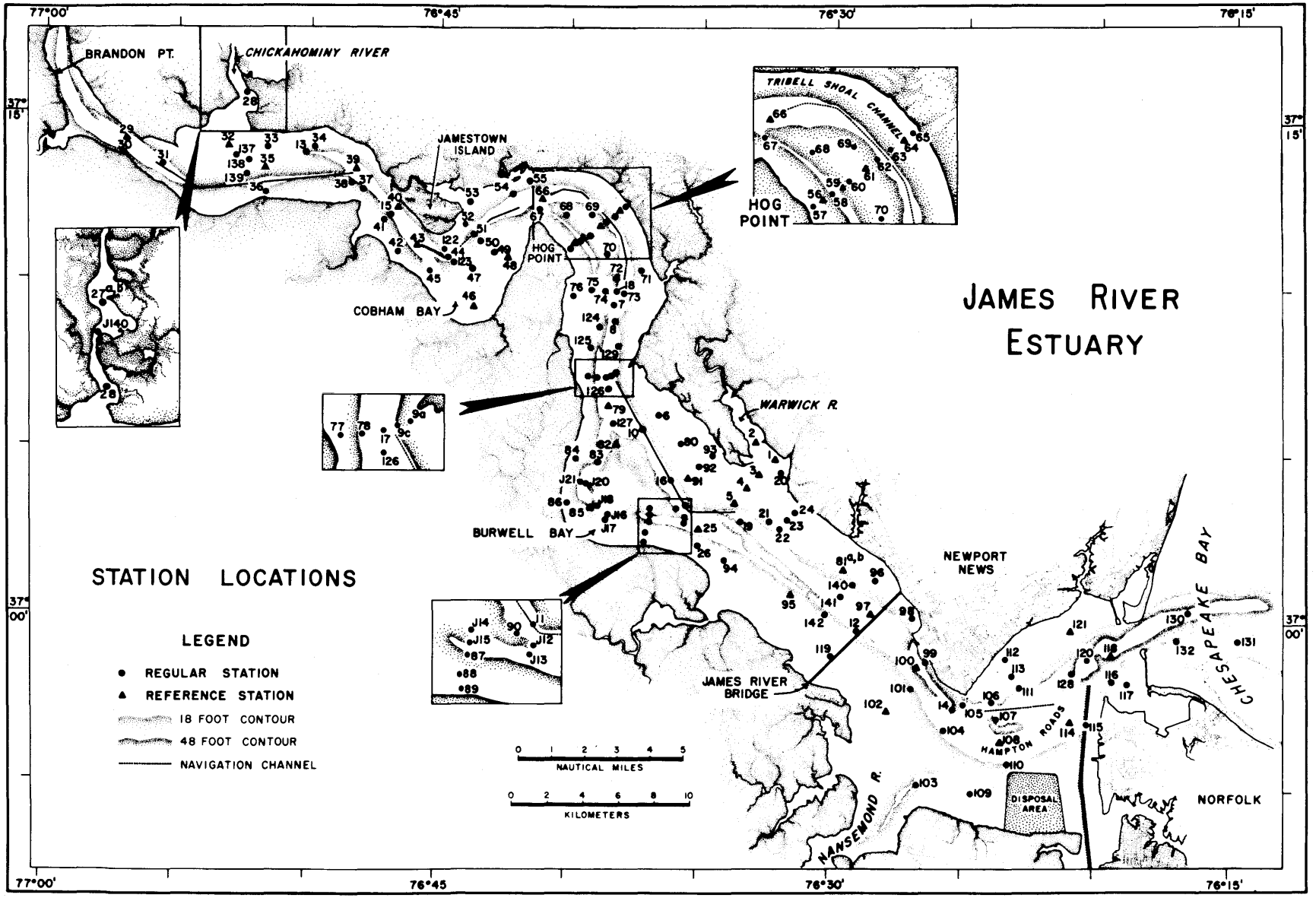

Figure 1. Location of sampling stations in the James River estuary.

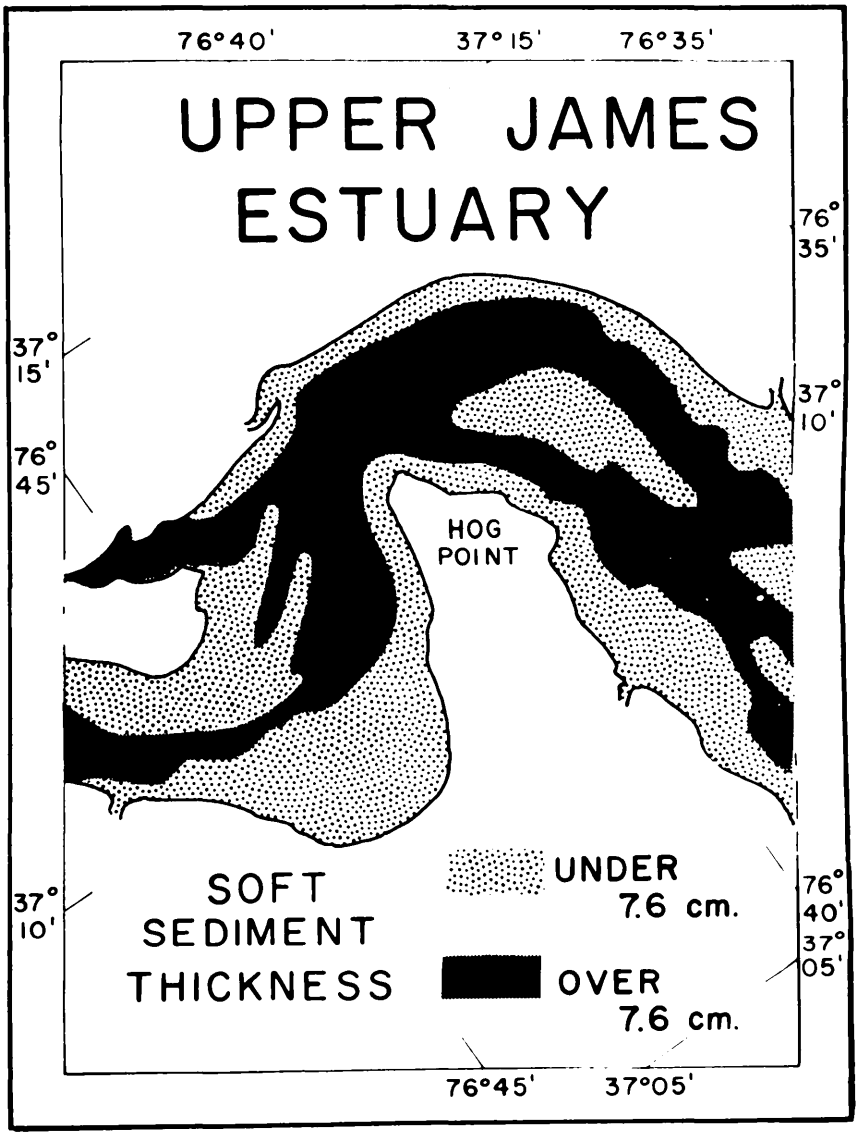

Figure 2. Distribution of soft sediment thickness in the vicinity of Hog Point.

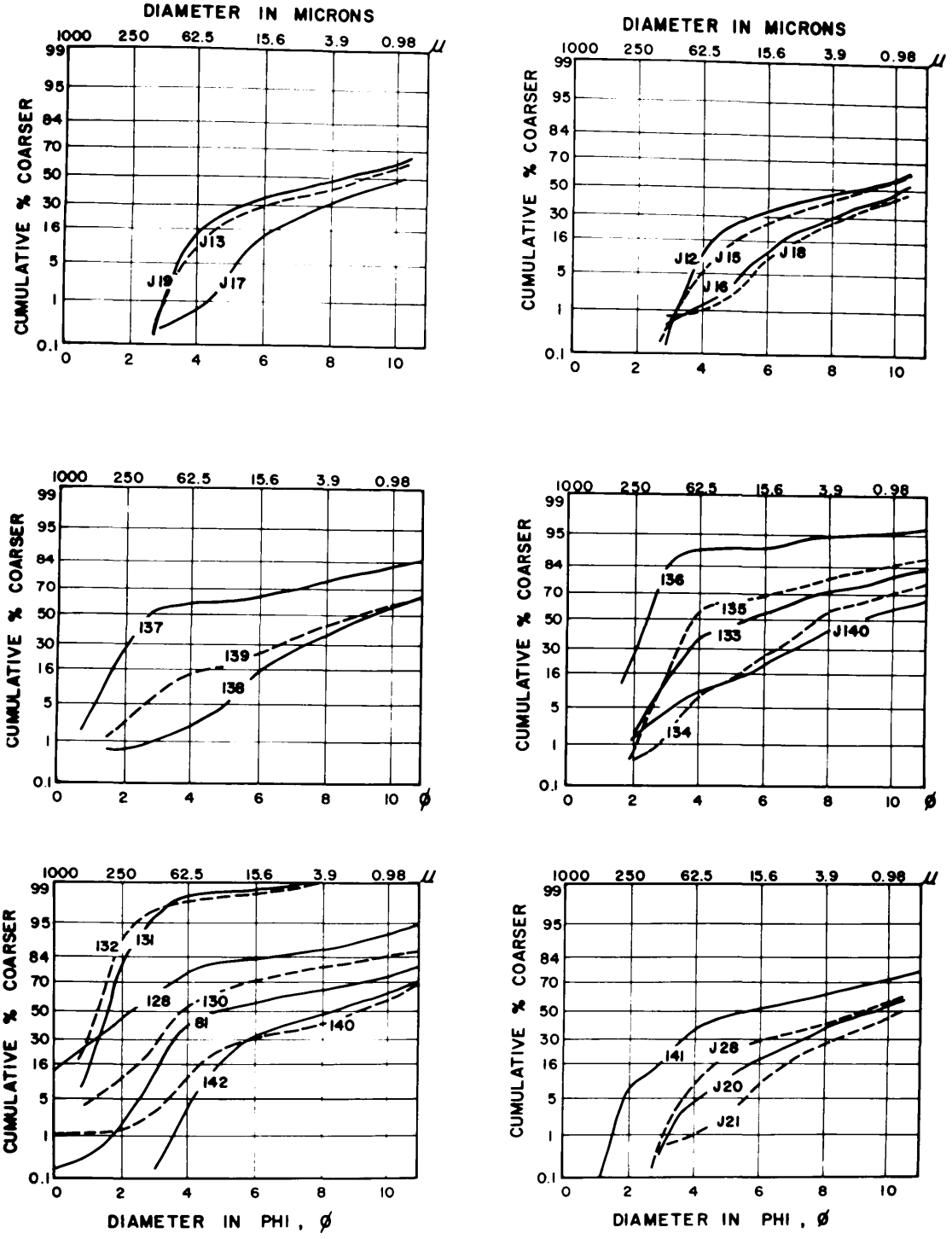

Figure 3. Cumulative curves of particle size. For station locations refer to Figure 1.

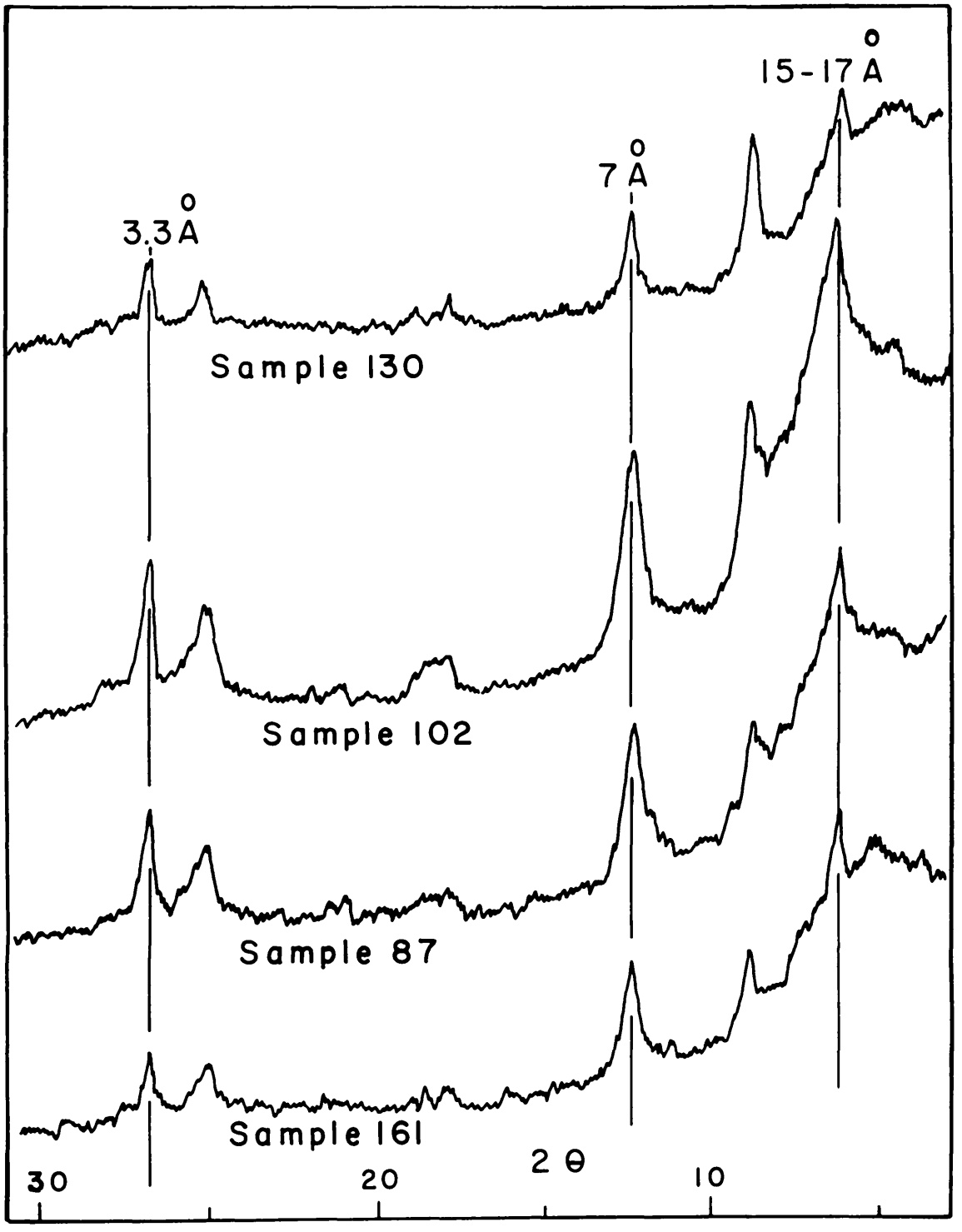

Figure 4. X-ray diffraction patterns of typical estuary clay samples; untreated, run at 2000 counts per second.

TABLE I. Station positions, water depth and distance above the mouth in statute miles and in kilometers.

STA. NO.	LATITUDE NORTH ° '	LONGITUDE WEST ° '	DISTANCE UPSTREAM MILES	DISTANCE UPSTREAM KM	WATER DEPTH FEET	WATER DEPTH METERS
001	37 04.8	76 32.3	18.1	29.1	5	1.5
002	37 05.3	76 32.9	18.8	30.2	8	2.4
003	37 03.3	76 32.8	18.2	29.3	4	1.2
004	37 03.9	76 33.4	18.3	29.4	5	1.5
005	37 03.5	76 33.8	18.3	29.4	10	3.0
006	37 06.2	76 36.7	22.6	36.4	6	1.8
007	37 09.4	76 38.3	26.8	43.1	35	10.7
008	37 08.9	76 38.4	26.3	42.3	90	27.4
009A	37 07.4	76 38.3	24.5	39.4	40	12.2
009C	37 07.4	76 38.4	24.5	39.4	36	11.0
010	37 05.7	76 37.3	22.2	35.7	30	9.1
011	37 03.3	76 35.6	19.4	31.2	30	9.1
J12	37 03.0	76 35.5	19.1	30.7	18	5.5
012	36 59.6	76 29.0	12.4	20.0	18	5.5
J13	37 02.8	76 35.5	19.1	30.7	22	6.7
013	37 14.0	76 50.3	42.1	67.7	9	2.7
J14	37 03.1	76 36.9	19.9	32.0	14	4.3
014	36 57.3	76 25.3	7.9	12.7	60	18.3
J15	37 03.0	76 36.9	19.9	32.0	17	5.2
015	37 12.1	76 46.8	38.4	61.8	34	10.4
J16	37 03.1	76 38.5	20.6	33.1	11	3.4
016	37 04.2	76 36.2	20.3	32.7	25	7.6
017	37 07.3	76 38.6	24.5	39.4	30	9.1
J17	37 03.0	76 38.5	20.5	33.0	10	3.0
J18	37 03.3	76 39.0	20.9	33.6	12	3.7
018	37 09.8	76 38.2	27.3	43.9	27	8.2
019	37 02.9	76 33.5	17.7	28.5	22	6.7
J20	37 04.0	76 39.3	21.6	34.8	25	7.6
020	37 04.3	76 32.0	17.6	28.3	5	1.5
J21	37 04.0	76 39.5	21.7	34.9	18	5.5
021	37 02.9	76 32.3	17.0	27.4	10	3.0
022	37 02.8	76 31.9	16.7	26.9	11	3.4
023	37 03.0	76 31.7	16.7	26.9	10	3.0
024	37 03.2	76 31.4	16.7	26.9	2	0.6
025	37 02.7	76 35.2	18.7	30.1	25	7.6
026	37 02.3	76 35.2	18.4	29.6	10	3.0
027A	37 18.3	76 52.5	4.5	7.2	21	6.4
027B	37 18.3	76 52.5	4.5	7.2	21	6.4
028	37 15.7	76 52.5	1.4	2.3	29	8.8
029	37 14.3	76 57.0	48.6	78.2	20	6.1

TABLE I. Cont'd.

STA. NO.	LATITUDE NORTH ° '	LONGITUDE WEST ° '	DISTANCE UPSTREAM MILES	DISTANCE UPSTREAM KM	WATER DEPTH FEET	WATER DEPTH METERS
030	37 14.0	76 57.0	48.4	77.9	32	9.8
031	37 13.8	76 55.5	47.0	75.6	20	6.1
032	37 14.1	76 53.3	44.9	72.2	3	0.9
033	37 13.9	76 51.8	43.5	70.0	6	1.8
034	37 14.1	76 50.0	41.9	67.4	10	3.0
035	37 13.5	76 52.0	43.8	70.5	14	4.3
036	37 12.9	76 52.0	43.7	70.3	22	6.7
037	37 12.8	76 48.2	40.0	64.4	13	4.0
038	37 12.9	76 48.5	40.4	65.0	10	3.0
039	37 13.4	76 48.3	40.5	65.2	25	7.6
040	37 12.3	76 46.8	38.6	62.1	58	17.7
041	37 11.9	76 47.3	38.5	61.9	9	2.7
042	37 11.2	76 46.8	37.7	60.7	15	4.6
043	37 11.2	76 45.9	36.9	59.4	27	8.2
044	37 10.8	76 44.8	35.8	57.6	29	8.8
045	37 10.3	76 45.3	36.2	58.2	15	4.6
046	37 09.4	76 43.8	35.6	57.3	6	1.8
047	37 10.3	76 43.9	35.4	57.0	12	3.7
048	37 10.8	76 42.6	34.3	55.2	11	3.4
049	37 11.0	76 42.9	34.4	55.3	9	2.7
050	37 11.3	76 43.5	34.5	55.5	8	2.4
051	37 11.5	76 43.7	34.5	55.5	28	8.5
052	37 11.8	76 44.0	34.5	55.5	7	2.1
053	37 12.4	76 44.0	33.9	54.5	4	1.2
054	37 12.7	76 42.3	32.7	52.6	28	8.5
055	37 13.2	76 41.6	32.2	51.8	2	0.6
056	37 11.1	76 40.0	29.4	47.3	11	3.4
057	37 11.0	76 40.2	29.4	47.3	3	0.9
058	37 11.3	76 39.8	29.5	47.5	22	6.7
059	37 11.4	76 39.6	29.5	47.5	15	4.6
060	37 11.5	76 39.3	29.5	47.5	10	3.0
061	37 11.8	76 38.9	29.6	47.6	18	5.5
062	37 11.9	76 38.7	29.6	47.6	33	10.1
063	37 12.2	76 38.4	29.7	47.8	11	3.4
064	37 12.3	76 38.2	29.7	47.8	18	5.5
065	37 12.5	76 38.0	29.8	47.9	7	2.1
066	37 12.5	76 41.3	32.0	51.5	25	7.6
067	37 12.3	76 41.3	32.0	51.5	21	6.4
068	37 12.2	76 40.4	31.0	49.9	11	3.4
069	37 12.2	76 39.5	30.2	48.6	17	5.2

TABLE I. Cont'd.

STA. NO.	LATITUDE NORTH ° '	LONGITUDE WEST ° '	DISTANCE UPSTREAM MILES	DISTANCE UPSTREAM KM	WATER DEPTH FEET	WATER DEPTH METERS
070	37 10.9	76 38.7	28.6	46.0	7	2.1
071	37 10.3	76 37.3	27.7	44.6	5	1.5
072	37 10.3	76 38.3	27.8	44.7	18	5.5
073	37 09.8	76 38.2	27.2	43.8	23	7.0
074	37 09.8	76 38.8	27.3	43.9	20	6.1
075	37 09.8	76 39.3	27.4	44.1	11	3.4
076	37 09.8	76 39.9	27.4	44.1	4	1.2
077	37 07.3	76 39.3	24.6	39.6	11	3.4
078	37 07.3	76 38.9	24.5	39.4	30	9.1
079	37 06.3	76 38.6	23.5	37.8	39	11.9
080	37 05.3	76 35.8	21.3	34.3	8	2.4
081A	37 01.5	76 29.5	14.3	23.0	13	4.0
081B	37 01.3	76 29.4	14.2	22.8	10	3.0
082	37 05.1	76 38.2	22.1	35.6	16	4.9
083	37 04.6	76 39.0	22.0	35.4	16	4.9
084	37 04.8	76 39.8	22.5	36.2	6	1.8
085	37 03.3	76 39.1	20.9	33.6	13	4.0
086	37 03.4	76 40.1	21.4	34.4	6	1.8
087	37 02.8	76 37.0	19.8	31.9	17	5.2
088	37 02.4	76 37.1	19.7	31.7	8	2.4
089	37 02.3	76 37.1	19.7	31.7	3	0.9
090	37 03.3	76 35.8	19.5	31.4	22	6.7
091	37 04.3	76 35.6	20.0	32.2	18	5.5
092	37 04.6	76 35.0	19.9	32.0	10	3.0
093	37 04.9	76 34.5	19.8	31.9	4	1.2
094	37 01.6	76 33.6	16.9	27.2	9	2.7
095	37 00.8	76 31.6	15.1	24.3	14	4.3
096	37 01.2	76 28.8	13.3	21.4	7	2.1
097	37 00.2	76 28.6	12.5	20.1	31	9.5
098	37 00.1	76 26.9	11.5	18.5	7	2.1
099	36 58.8	76 26.4	10.0	16.1	45	13.7
100	36 58.6	76 26.7	10.0	16.1	49	14.9
101	36 58.0	76 26.9	9.6	15.4	21	6.4
102	36 57.3	76 27.9	9.6	15.4	9	2.7
103	36 55.1	76 26.7	8.1	13.0	17	5.2
104	36 56.8	76 25.7	8.0	12.9	24	7.3
105	36 57.5	76 24.9	7.6	12.2	35	10.7
106	36 57.5	76 23.9	6.3	10.1	20	6.1
107	36 57.0	76 23.7	6.2	10.0	20	6.1
108	36 56.3	76 23.6	6.1	9.8	25	7.6

TABLE I. Cont'd.

STA. NO.	LATITUDE NORTH ° '	LONGITUDE WEST	DISTANCE UPSTREAM		WATER DEPTH	
			MILES	KM	FEET	METERS
109	36 54.8	76 24.6	7.1	11.4	10	3.0
110	36 55.7	76 23.3	5.9	9.5	21	6.4
111	36 57.9	76 22.8	5.3	8.5	15	4.6
112	36 58.8	76 23.3	5.7	9.2	13	4.0
113	36 58.4	76 23.1	5.5	8.8	12	3.7
114	36 57.0	76 20.9	3.6	5.8	27	8.2
115	36 57.0	76 20.3	3.2	5.1	45	13.7
116	36 58.2	76 19.3	2.0	3.2	7	2.1
117	36 58.1	76 18.8	1.7	2.7	13	4.0
118	36 59.0	76 19.3	1.4	2.3	61	18.6
119	36 58.8	76 30.1	12.5	20.1	5	1.5
120	36 59.0	76 20.1	2.2	3.5	62	18.9
121	36 59.8	76 20.8	2.3	3.7	10	3.0
122	37 11.1	76 44.8	35.7	57.4	15	4.6
123	37 10.5	76 44.6	35.7	57.4	15	4.6
124	37 08.8	76 38.9	26.2	42.2	6	1.8
125	37 08.2	76 39.3	25.4	40.9	6	1.8
126	37 06.8	76 38.6	24.0	38.6	42	12.8
127	37 05.7	76 38.4	22.8	36.7	36	11.0
128	36 58.3	76 21.2	3.6	5.8	43	13.1
129	37 08.1	76 38.2	25.2	40.5	22	6.7
130	37 00.3	76 16.7	-1.3	-2.1	80	24.4
131	36 59.7	76 14.7	-3.0	-4.8	15	4.6
132	36 59.5	76 17.0	-0.6	-1.0	17	5.2
133	37 18.2	77 05.4	61.7	99.3	10	3.0
134	37 18.3	77 04.9	61.8	99.4	22	6.7
135	37 17.2	77 02.7	57.0	91.7	29	8.8
136	37 17.1	77 03.2	57.5	92.5	2	0.6
137	37 14.0	76 52.5	44.3	71.3	5	1.5
138	37 13.6	76 52.7	44.4	71.4	7	2.1
139	37 13.3	76 52.8	44.5	71.6	15	4.6
140	37 01.0	76 29.8	13.8	22.2	13	4.0
J140	37 17.1	76 52.8	3.0	4.8	15	4.6
141	37 00.8	76 29.8	14.0	22.5	27	8.2
142	37 00.3	76 30.3	13.9	22.4	17	5.2

TABLE II. Thickness of soft sediment.

STA. NO.	THICKNESS	
	INCHES	C M
001	12.0	30.5
002	4.0	10.2
003	4.0	10.2
004	0.5	1.3
005	1.0	2.5
029	4.0	10.2
032	4.7	11.9
035	4.0	10.2
039	3.0	7.6
046	1.5	3.8
048	3.4	8.6
049	3.7	9.4
050	1.7	4.3
052	1.7	4.3
055	3.5	8.9
056	7.5	19.0
057	1.5	3.8
059	3.5	8.9
060	2.7	6.8
061	2.7	6.8
063	3.5	8.9
064	4.0	10.2
065	1.0	2.5
068	3.7	9.4
069	4.0	10.2
070	1.0	2.5
071	1.0	2.5

TABLE III. Field measurements. Munsell color given as hue-value/chroma, depth of oxidation layer in millimeters, near-surface pH and Eh (in volts). observed.

STATION NUMBER	MUNSELL COLOR	DEPTH OF OXIDATION	Ph	Eh volts
001	10 YR 4/2	10 mm	7.8	0.31
002	2.5 Y 4/2	10	7.2	*
003	2.5 Y 4/4	30	6.6	0.38
004	10 YR 4/4	30	6.9	0.40
005	5 Y 4/2	10	*	*
006	*	--	*	*
007	*	25	*	*
008	*	2	*	*
009A	*	10	*	*
009C	*	*	*	*
010	*	--	*	*
011	*	5	*	*
012	*	5	*	*
J12	*	*	*	*
013	*	*	*	*
J13	*	*	*	*
C14	*	--	*	*
J14	*	*	*	*
015	*	*	*	*
J15	*	*	*	*
016	*	10	*	*
J16	*	*	*	*
017	*	20	*	*
J17	*	*	*	*
018	*	10	*	*
J18	*	*	*	*
019	*	5	*	*
020	5 Y 3/2	--	*	*
J20	*	*	*	*
021	5 Y 3/2	--	*	*

*No measurement made. -- No oxidation layer

TABLE III.
Cont'd.

STATION NUMBER	MUNSELL COLOR	DEPTH OF OXIDATION	Ph	Eh volts
		mm		
J21	*	*	*	*
022	5 Y 4/4	--	*	*
023	5 Y 3/2	--	*	*
024	7.5 YR 3/2	20	*	*
025	7.5 YR 3/2	10	6.6	0.39
026	10 YR 3/2	5	*	*
027A	10 Y 3/2	2	*	*
027B	10 Y 3/2	3	*	*
028	5 Y 4/2	5	*	*
029	10 YR 3/2	5	7.0	0.43
030	7.5 Y 3/2	3	*	*
031	5 Y 3/2	3	*	*
032	7.5 Y 3/2	3	7.1	0.31
033	5 Y 2/1	1	*	*
034	2.5 Y 4/4	12	7.1	*
035	2.5 Y 4/4	13	7.1	*
036	2.5 Y 4/4	8	*	*
037	7.5 Y 3/2	3	*	*
038	7.5 Y 3/2	2	*	*
039	7.5 Y 3/2	1	7.5	0.40
040	2.5 Y 4/4	1	6.4	0.13
041	2.5 Y 4/4	1	6.8	*
042	2.5 Y 4/4	--	6.7	*
043	2.5 Y 4/4	60	6.8	0.18
044	5 Y 4/4	20	6.7	*
045	5 Y 4/4	10	6.9	*
046	2.5 Y 4/4	10	6.9	0.10
047	7.5 Y 3/2	5	7.1	*
048	7.5 Y 3/2	8	6.6	0.12
049	2.5 Y 4/4	2	6.8	*

TABLE III.
Cont'd.

STATION NUMBER	MUNSELL COLOR	DEPTH OF OXIDATION	Ph	Eh volts
050	2.5 Y 4/4	15 mm	6.8	*
051	2.5 Y 4/4	85	7.1	*
052	2.5 Y 4/4	10	7.1	*
053	2.5 Y 4/4	20	6.5	*
054	5 Y 4/4	15	6.8	*
055	5 Y 4/4	20	6.7	*
056	2.5 Y 4/4	5	6.7	0.04
057	2.5 Y 4/4	15	6.5	*
058	10 YR 4/4	20	6.6	*
059	2.5 Y 4/2	1	6.5	0.17
060	10 YR 4/4	2	6.2	*
061	2.5 Y 4/4	2	6.5	0.13
062	7.5 YR 4/4	5	6.3	*
063	2.5 Y 4/4	8	6.6	*
064	5 Y 4/4	20	6.7	0.28
065	2.5 Y 4/4	--	*	*
066	2.5 Y 4/4	15	6.8	0.36
067	2.5 Y 4/4	15	7.1	*
068	5 Y 4/4	11	7.0	*
069	2.5 Y 4/4	2	6.9	*
070	2.5 Y 4/4	15	*	*
071	2.5 Y 4/4	--	*	*
072	2.5 Y 4/4	2	6.7	0.31
073	5 Y 4/1	3	6.1	*
074	2.5 Y 4/4	10	6.3	*
075	2.5 Y 4/4	5	6.8	*
076	2.5 Y 4/4	60	6.6	*
077	2.5 Y 4/4	8	6.8	*
078	2.5 Y 4/4	30	6.9	*
079	2.5 Y 4/4	15	6.9	0.38

TABLE III.
Cont'd.

STATION NUMBER	MUNSELL COLOR	DEPTH OF OXIDATION	Ph	Eh volts
080	5 Y 4/4	2 mm	7.3	*
081A	5 Y 3/1	--	7.5	0.11
081B	*	*	*	*
082	7.5 Y 4/2	--	7.3	0.18
083	5 Y 4/4	8	7.0	*
084	5 Y 4/4	50	7.3	*
085	5 Y 4/4	10	7.0	0.34
086	5 Y 4/4	10	7.1	*
087	5 Y 4/4	4	7.0	*
088	5 Y 4/4	3	7.0	*
089	2.5 Y 4/4	50	7.4	*
090	5 Y 4/2	1	7.2	0.12
091	7.5 Y 4/2	--	7.5	*
092	7.5 Y 4/2	--	7.2	*
093	5 Y 4/2	1	7.3	*
094	5 Y 4/4	8	7.2	*
095	7.5 Y 4/2	1	7.2	0.33
096	10 Y 4/2	5	7.1	*
097	5 Y 4/2	5	6.6	0.13
098	5 Y 4/4	2	7.3	*
099	7.5 Y 4/2	2	7.3	*
100	10 Y 3/2	1	7.2	0.12
101	2.5 Y 4/4	2	6.9	*
102	5 Y 4/4	1	7.1	0.11
103	7.5 Y 4/2	1	7.3	*
104	7.5 Y 4/2	1	7.1	*
105	7.5 Y 4/2	--	7.2	*
106	10 Y 4/1	--	7.6	*
107	7.5 Y 4/2	--	7.3	*
108	7.5 Y 4/2	--	7.0	0.30

TABLE III.
Cont'd.

STATION NUMBER	MUNSELL COLOR	DEPTH OF OXIDATION	Ph	Eh volts
109	5 Y 4/4	1 mm	7.1	*
110	5 Y 4/2	--	*	*
111	7.5 Y 3/2	--	7.1	*
112	10 Y 4/2	--	7.1	*
113	7.5 Y 4/2	5	8.0	*
114	7.5 Y 4/2	2	7.1	0.11
115	7.5 Y 4/2	1	7.2	*
116	2.5 Y 4/4	15	7.0	*
117	10 Y 4/2	1	7.1	*
118	10 Y 2/1	1	7.0	0.10
119	2.5 Y 5/4	2	7.2	*
120	5 Y 4/1	--	7.1	0.11
121	5 Y 2/1	2	7.0	0.20
122	*	*	*	*
123	*	*	*	*
124	*	*	*	*
125	*	*	*	*
126	*	*	*	*
127	5 Y 4/4	3	*	0.34
128	5 Y 2/1	2	7.2	0.21
129	2.5 Y 4/4	*	7.0	*

TABLE IV. Sand-silt-clay ratios as percent by weight based on total content of sand plus silt and clay; silt-clay ratio as percent by weight of total silt and clay; gravel and shell coarser than 2 mm in percent of whole. Textural types: SD - sand, SC - silty clay, CS - clayey silt, SDSC - sand, silt, clay, C - clay, SC - sandy clay, CS - clayey sand, SH - shelly, GR - gravelly.

STATION NUMBER	SAND-SILT-CLAY RATIOS			GRAVEL	SHELL	SILT-CLAY RATIOS		SEDIMENT TYPE
	SAND, %	SILT, %	CLAY, %			SILT, %	CLAY, %	
001	21.4	29.0	49.6			37.0	63.0	SDSC
002	17.1	25.9	57.0			31.3	68.7	SC
003	65.1	17.2	17.8			49.1	50.9	SSD
004	93.6	1.9	4.5			30.3	69.7	SD
005	69.2	10.2	20.6			33.1	66.9	CSD
006	86.3	3.5	10.2			25.8	74.2	SD
007	6.8	34.1	59.1			36.6	63.4	SC
008	10.2	38.0	51.8			42.3	57.7	SC
009A	61.9	12.6	25.6			33.0	67.0	CSD
009C	95.6	2.4	2.0			54.6	45.4	SD
010	87.4	4.9	7.7			38.8	61.2	SD
011	47.8	20.2	32.0			38.7	61.3	CSD
J12	10.1	36.7	53.2			40.8	59.2	SC
012	10.9	38.0	51.2			42.6	57.4	SC
J13	9.5	31.8	58.6			35.2	64.8	SC
013	2.8	33.3	63.9			34.3	65.7	SC
J14	14.1	34.5	51.3			40.2	59.8	SC
014	75.6	11.4	13.0			46.8	53.2	SD
J15	6.4	37.1	56.5			39.6	60.4	SC
015	2.7	31.1	66.2			32.0	68.0	SC
J16	1.4	29.6	69.0			30.0	70.0	SC
016	69.9	13.5	16.6			44.9	55.1	CSD
017	81.1	8.9	10.1			46.8	53.2	SD
J17	0.7	30.9	68.4			31.1	68.9	SC
J18	1.1	25.4	73.6			25.6	74.4	SC

TABLE IV. Cont'd.

STATION NUMBER	SAND-SILT-CLAY RATIOS			GRAVEL	SHELL	SILT-CLAY RATIOS		SEDIMENT TYPE
	SAND, %	SILT, %	CLAY, %			SILT, %	CLAY, %	
018	10.7	32.4	57.0			36.2	63.8	SC
019	48.9	27.9	23.2			54.5	45.5	SDSC
J20	4.8	33.3	61.9			35.0	65.0	SC
020	73.9	7.4	18.7			28.4	71.6	CSD
J21	1.2	25.6	73.2			25.9	74.1	SC
021	54.4	17.0	28.6			37.4	62.6	CSD
022	9.1	36.9	54.0			40.5	59.5	SC
023	26.8	23.7	49.5			32.4	67.6	SDSC
024	95.1	1.7	3.2			34.7	65.3	SD
025	18.6	39.4	42.0			48.4	51.6	SC
026	1.2	28.2	70.6			28.5	71.5	SC
027A	76.0	11.3	12.6	52.0		47.3	52.7	GRSD
027B	12.3	37.5	50.2			42.8	57.2	SC
028	9.1	21.5	69.4			23.7	76.3	SC
029	2.1	43.1	54.8			44.0	56.0	SC
030	12.3	34.4	53.3			39.2	60.8	SC
031	1.6	42.7	55.7			43.4	56.6	SC
032	3.4	37.6	59.0			38.9	61.1	SC
033	53.5	17.9	28.6			38.5	61.5	CSD
034	40.9	17.7	41.4			29.9	70.1	SDC
035	1.0	32.7	66.3			33.0	67.0	SC
036	0.9	29.3	69.8			29.6	70.4	SC
037	7.9	34.0	58.1			36.9	63.1	SC
038	1.9	32.6	65.5			33.2	66.8	SC
039	7.9	28.0	64.1			30.4	69.6	SC

TABLE IV. Cont'd.

STATION NUMBER	SAND-SILT-CLAY RATIOS			GRAVEL	SHELL	SILT-CLAY RATIOS		SEDIMENT TYPE
	SAND, %	SILT, %	CLAY, %			SILT, %	CLAY, %	
040	23.4	21.5	55.1			28.0	72.0	SDSC
041	17.8	25.7	56.5			31.2	68.8	SC
042	60.1	13.7	26.2			34.4	65.6	CSD
043	88.8	3.9	7.3			34.6	65.4	SD
044	82.6	6.0	11.4			34.5	65.5	SD
045	1.1	34.0	64.9			34.4	65.6	SC
046	9.1	22.3	68.6			24.5	75.5	SC
047	1.2	34.1	64.8			34.5	65.5	SC
048	1.6	30.0	68.4			30.5	69.5	SC
049	52.0	21.0	27.0			43.8	56.2	SDSC
050	84.6	5.3	10.1			34.5	65.5	SD
051	2.7	31.6	65.7			32.5	67.5	SC
052	50.4	13.1	36.4			26.5	73.5	CSD
053	20.9	25.3	53.8			32.0	68.0	SDSC
054	13.4	25.0	61.5			28.9	71.1	SC
055	77.4	7.9	14.7			34.9	65.1	SD
056	8.5	32.3	59.2			35.3	64.7	SC
057	75.1	11.7	13.3			46.8	53.2	SD
058	51.0	18.6	30.4			37.9	62.1	CSD
059	14.9	30.7	54.4			36.1	63.9	SC
060	45.4	20.5	34.1			37.5	62.5	SDSC
061	27.4	23.8	48.8			32.8	67.2	SDSC
062	7.2	27.5	65.3			29.7	70.3	SC
063	3.0	29.7	67.4			30.6	69.4	SC
064	0.8	22.9	76.3			23.1	76.9	C

TABLE IV. Cont'd.

STATION NUMBER	SAND-SILT-CLAY RATIOS			GRAVEL	SHELL	SILT-CLAY RATIOS		SEDIMENT TYPE
	SAND, %	SILT, %	CLAY, %			SILT, %	CLAY, %	
065	92.8	2.2	5.1			29.8	70.2	SD
066	4.4	31.5	64.2			32.9	67.1	SC
067	41.1	21.6	37.3			36.6	63.4	SDSC
068	19.6	32.9	47.5			40.9	59.1	SC
069	1.4	33.3	65.3			33.7	66.3	SC
070	71.3	9.5	19.3			33.0	67.0	CSD
071	91.5	1.9	6.6			22.8	77.2	SD
072	43.6	31.1	25.4			55.0	45.0	SDSC
073	25.3	31.4	43.2			42.1	57.9	SDSC
074	17.5	34.1	48.5			41.3	58.7	SC
075	4.9	41.9	53.2			44.1	55.9	SC
076	67.3	15.3	17.4		26.0	46.7	53.3	SHSD
077	31.0	27.3	41.7			39.6	60.4	SDSC
078	21.1	29.5	49.4			37.4	62.6	SDSC
079	46.9	18.5	34.6			34.9	65.1	CSD
080	74.7	6.9	18.4			27.2	72.8	SD
081A	4.5	39.0	56.5		40.0	40.8	59.2	SHSDSC
081B	21.8	42.2	36.0			54.0	46.0	SDSC
082	22.6	26.0	51.4		49.0	33.6	66.4	SHCSD
083	4.7	36.1	59.3			37.8	62.2	SC
084	79.9	7.0	13.0	17.0	9.0	35.0	65.0	GRSHSD
085	0.6	28.3	71.1			28.5	71.5	SC
086	7.0	41.3	51.7			44.4	55.6	SC
087	4.0	43.0	53.0			44.8	55.2	SC
088	10.0	26.4	63.7			29.3	70.7	SC

TABLE IV. Cont'd.

STATION NUMBER	SAND-SILT-CLAY RATIOS			GRAVEL	SHELL	SILT-CLAY RATIOS		SEDIMENT TYPE
	SAND, %	SILT, %	CLAY, %			SILT, %	CLAY, %	
089	96.1	0.9	3.0			23.7	76.3	SD
090	30.8	34.8	34.4			50.3	49.7	SDSC
091	28.3	19.4	52.3		7.0	27.1	72.9	SHSDC
092	68.0	9.7	22.4		8.0	30.2	69.8	SHCSD
093	93.5	3.9	2.6			59.7	40.3	SD
094	1.3	23.6	75.2			23.9	76.1	C
095	4.6	44.8	50.6			47.0	53.0	SC
096	8.7	28.1	63.2			30.8	69.2	SC
097	52.4	20.6	27.0			43.3	56.7	SDSC
098	68.6	13.2	18.2			42.1	57.9	CSD
099	73.5	9.7	16.8			36.6	63.4	CSD
100	55.1	16.6	28.4		7.0	36.8	63.2	SHSC
101	18.3	36.6	45.1			44.8	55.2	SC
102	32.4	27.0	40.5			40.0	60.0	SDSC
103	1.5	34.8	63.7			35.4	64.6	SC
104	15.2	33.9	50.9			40.0	60.0	SC
105	86.5	4.9	8.6			36.3	63.7	SD
106	77.8	8.9	13.3		6.0	40.0	60.0	SHSD
107	79.0	7.1	13.9			33.9	66.1	SD
108	59.8	19.0	21.3			47.1	52.9	CSD
109	13.4	36.3	50.3			42.0	58.0	SC
110	39.5	27.9	32.6			46.1	53.9	SDSC
111	93.5	2.3	4.2			35.4	64.6	SD
112	92.2	3.0	4.8			38.0	62.0	SD
113	92.2	2.9	4.9			37.7	62.3	SD

TABLE IV. Cont'd.

STATION NUMBER	SAND-SILT-CLAY RATIOS			GRAVEL	SHELL	SILT-CLAY RATIOS		SEDIMENT TYPE
	SAND, %	SILT, %	CLAY, %			SILT, %	CLAY, %	
114	47.8	26.3	25.9		16.0	50.4	49.6	SHSDSC
115	14.9	42.3	42.8			49.7	50.3	SC
116	96.8	0.5	2.7			14.8	85.2	SD
117	70.6	14.5	14.9			49.3	50.7	CSD
118	63.6	16.7	19.7			45.8	54.2	CSD
119	9.3	27.9	62.7		8.0	30.8	69.2	SHSC
120	70.4	12.8	16.8		9.0	43.4	56.6	SHCSD
121	86.5	6.3	7.2		5.0	46.5	53.5	SHSD
122	58.2	13.5	28.3			32.2	67.8	CSD
123	74.8	8.0	17.2			31.9	68.1	CSD
124	46.2	16.4	37.4			30.5	69.5	CSD
125	58.3	16.5	25.2			39.6	60.4	CSD
126	44.3	16.6	39.2			29.8	70.2	CSD
127	13.5	30.3	56.2			35.0	65.0	SC
128	75.9	10.9	13.2			45.4	54.6	SD
129	12.3	33.0	54.7			37.6	62.4	SC
130	54.2	24.5	21.3			53.4	46.6	SDSC
131	98.3	0.7	1.0			42.9	57.1	SD
132	97.8	1.6	0.6			71.4	28.6	SD
133	36.0	35.2	28.9			54.9	45.1	SDSC
134	5.5	45.3	49.3			47.9	52.1	CS
135	55.8	22.4	21.8			50.6	49.4	SDSC
136	90.7	3.8	5.5			40.7	59.3	SD
137	58.7	15.4	25.9			37.3	62.7	CSD
138	2.3	34.3	63.4			35.1	64.9	SC

TABLE IV. Cont'd.

STATION NUMBER	SAND-SILT-CLAY RATIOS			GRAVEL	SHELL	SILT-CLAY RATIOS		SEDIMENT TYPE
	SAND, %	SILT, %	CLAY, %			SILT, %	CLAY, %	
139	14.0	29.3	56.7			34.0	66.0	SC
140	11.3	29.9	58.9			33.7	66.3	SC
J 140	9.0	33.2	57.7			36.5	63.5	SC
141	37.8	24.4	37.8			39.2	60.8	SDSC
142	3.2	54.1	42.7			44.1	55.9	CS

TABLE V. Grain size statistics in phi, ϕ, units based on Inman (1952).

STA. NO.	MEDIAN	MEAN	SORTING	SKEWNESS
081B	4.95	7.95	4.40	+0.682
128	2.40	3.43	3.13	+0.328
130	3.90	6.25	3.80	+0.618
131	1.50	1.60	0.56	+0.171
132	1.20	1.29	0.47	+0.183
133	5.45	7.09	3.92	+0.416
134	7.55	9.00	3.75	+0.387
135	3.77	6.20	3.15	+0.771
136	2.41	2.41	0.56	+0.000
137	2.60	6.03	4.38	+0.783
138	9.25	10.05	3.95	+0.203
139	8.75	9.70	5.10	+0.186
140	8.90	8.74	4.29	-0.037
140C	8.65	10.10	4.65	+0.312
141	5.50	7.78	4.88	+0.467
142	8.55	9.10	4.10	+0.134
012J	8.58			
013J	9.15			
014J	8.28			
015J	9.00			
016J	10.20			
017J	10.18			
018J	10.68			
020J	9.38			
021J	10.38			

TABLE VI. Major components of coarse fraction, 0.062 to 2.00 mm size in percent by number of whole fraction. T - trace.

COARSE FRACTION PERCENTAGES					
STATION NUMBER	LIGHT MINERALS	FECAL PELLETS	PLANT DEBRIS	AGGREGATES	MINOR COMPONENTS
001	34.5	47.9	8.5	1.6	7.5
002	71.8	16.0	3.5	1.1	7.6
003	93.3	1.6	1.3	0.6	3.2
004	89.7	0.7	T	2.0	7.6
025	47.0	32.0	1.0	7.7	12.3
029	42.3	2.0	29.7	8.1	17.9
032	19.7	6.7	35.8	16.5	21.0
035	25.8	9.5	21.6	19.6	23.5
039	82.6	5.2	3.5	0.9	7.8
040	94.0	0.4	0.7	0.5	4.4
043	85.5	2.1	3.9	1.5	7.0
046	4.7	73.0	8.3	3.0	11.0
048	80.9	8.9	4.8	T	5.4
056	62.8	20.4	5.5	0.3	11.0
059	14.3	57.0	9.0	2.0	17.7
061	24.7	60.7	4.7	0.7	9.2
064	16.7	59.9	6.8	4.2	12.4
066	2.3	72.4	11.5	7.8	6.0
072	80.8	7.8	0.5	0.8	10.1
079	79.3	10.3	0.3	2.7	7.4

TABLE VI. Cont'd.

COARSE FRACTION PERCENTAGES					
STATION NUMBER	LIGHT MINERALS	FECAL PELLETS	PLANT DEBRIS	AGGREGATES	MINOR COMPONENTS
081	38.0	40.7	2.2	0.8	18.3
082	73.4	15.9	1.7	0.9	8.1
085	2.7	59.4	25.5	1.9	10.5
091	39.0	44.3	4.3	1.3	11.1
095	26.6	64.2	2.4	0.3	6.5
097	69.6	21.8	0.3	0.6	7.7
100	70.2	14.9	3.8	1.3	9.8
102	60.0	31.7	1.9	0.5	5.9
108	81.2	8.5	3.8	0.3	6.2
114	69.4	21.5	T	T	9.1
118	85.0	3.3	1.6	T	10.1
121	80.0	7.5	1.3	0.3	10.9
130	89.4	0.2	0.3	1.0	9.1
132	90.7	0.0	0.0	0.2	9.1

TABLE VII. Minor components of coarse fraction, 0.062 to 2.00 mm size, in percent by number of whole fraction. T - trace, G - trace Glauconite, P - trace Pyrite, H - trace Thecamoebina, O - trace Ostracod. The number prefixing the above letters indicates the percentage, if other than trace.

COARSE FRACTION PERCENTAGES								
STATION NUMBER	DARK MINERALS	MICA	DIATOMS	COAL	CINDER & ASH	SHELL	FORAMS	OTHER
001	1.6	T	2.6	0.0	T	0.0	3.3	G H
002	1.4	1.1	0.5	0.0	T	0.5	3.0	1.1G H
003	1.6	0.3	0.3	0.0	T	0.6	0.3	G
004	2.7	1.0	T	4.0	T	0.0	0.0	G
025	3.0	7.0	1.0	0.7	T	0.3	0.3	G
029	1.7	10.0	3.7	0.2	2.0	0.3	T	G 2.0H
032	2.6	8.1	3.6	1.6	4.8	T	0.3	G 1.3H
035	1.0	10.5	3.8	1.6	5.8	T	0.8	G H
039	3.3	1.4	0.2	0.9	0.0	0.7	0.5	0.7G P
040	3.0	0.2	T	T	0.6	0.4	0.2	G P
043	3.3	1.2	0.6	0.3	0.9	0.0	0.6	G
046	1.3	4.7	1.7	0.3	1.3	0.7	1.0	
048	1.6	T	0.3	T	T	T	3.5	G
056	3.1	3.1	1.2	1.2	1.5	T	0.9	G P
059	2.0	8.0	4.7	1.3	1.7	T	T	G
061	1.7	2.7	2.0	T	1.7	0.3	1.0	G
064	2.6	2.6	3.0	T	2.4	0.3	1.5	G
066	1.6	2.5	1.6	0.0	T	T	T	G
072	2.9	0.8	1.3	0.0	0.3	T	3.9	1.0G HP
079	3.3	1.3	0.3	1.7	T	0.3	0.3	G

TABLE VII. Cont'd.

COARSE FRACTION PERCENTAGES									
STATION NUMBER	DARK MINERALS	MICA	DIATOMS	COAL	CINDER & ASH	SHELL	FORAMS	OTHER	
081	3.0	3.0	0.6	0.8	0.8	8.5	1.6	G	O
082	1.2	2.6	0.3	T	0.0	T	4.1	G	
085	1.6	1.1	7.1	T	0.5	0.0	0.3		
091	2.7	1.3	1.3	2.0	3.0	0.7	T		
095	1.5	2.1	1.2	0.9	0.9	0.0	T	G	
097	1.1	2.5	0.3	1.7	2.2	0.0	0.0	G	
100	1.3	0.3	2.9	1.9	1.9	1.3	0.3	G	O
102	2.4	0.7	0.2	1.2	1.0	0.2	0.0	G	
108	4.4	0.3	T	0.9	0.6	0.0	T	G	
114	4.4	1.9	0.6	T	2.2	T	T		
118	1.8	3.3	1.0	0.7	2.0	1.0	0.3	G	
121	6.9	1.3	1.0	0.7	1.0	T	T	G	
130	2.0	4.2	1.2	0.2	T	1.4	0.1		
132	1.7	2.2	2.2	0.8	1.8	0.3	0.1		

TABLE VIII. Calcium carbonate, organic matter, total carbon, and water content (wet weight), in weight percent of total sample.

STA. NO.	$CaCO_3$, %	ORGANIC MATTER, %	TOTAL CARBON, %	WATER CONTENT, %
001	2.1	2.1	2.2	69
002	6.0	1.4	2.4	79
003	1.6	0.5	1.1	40
004	1.2	0.3	1.0	33
005	32.2	0.7	3.6	36
025	2.4	0.4	1.7	51
029	2.5	3.7	3.1	65
032	2.6	2.0	2.2	60
035	2.1	3.2	2.7	66
039	6.1	1.7	3.0	67
040	1.3	1.5	2.0	63
043	0.5	0.2	0.3	27
046	3.1	1.9	1.8	65
048	2.6	1.4	1.6	61
056	4.5	1.8	1.7	59
059	1.3	3.3	2.6	62
061	6.6	2.6	2.2	66
064	5.0	2.6	2.3	66
066	6.1	3.2	2.2	73
072	9.3	0.0	1.8	50
079	4.1	1.4	1.1	50
081A	40.8	1.4	5.9	49
082	34.0	1.3	4.7	48
085	4.3	3.3	2.6	70
091	6.1	1.3	2.8	48
095	2.7	0.2	2.9	55
097	3.8	0.8	1.7	44
100	10.5	0.0	3.3	39
102	2.8	0.5	1.5	54
108	2.5	0.0	0.8	42
114	3.4	0.1	1.5	43
118	5.0	0.1	1.0	42
121	3.4	0.3	0.6	28

TABLE IX. Eh and pH with depth in cores taken by MacIntyre and Ferguson, Eh values in volts.

STA. NO.	CORE DEPTH cms	Eh	pH
8	0-0.5	+.18	---
	1.0	+.16	---
	2.5	+.15	---
	5.1	0	---
	7.6	-.01	---
	10.2	-.01	---
	12.7	0	---
	15.2	-.09	---
	17.8	-.13	---
10	0-0.5	+.04	---
	2.5	+.02	---
	5.1	+.04	---
	7.6	-.07	---
	10.2	00	---
	12.7	-.02	---
	15.2	+.02	---
11	0-0.5	+.04	---
	1.0	-.09	---
	2.5	-.13	---
	5.1	-.16	---
	7.6	-.19	---
	10.2	-.18	---
	12.7	-.17	---
	15.2	-.20	---
	20.3	-.15	---
	25.4	-.12	---
	30.5	-.12	---
12	0-0.5	-.03	7.8
	5.1	-.02	8.0
	10.2	-.16	8.1
	15.2	-.20	8.0
	20.3	-.14	7.8
	25.4	-.15	---
	30.5	-.06	7.8
	35.6	-.07	---
	40.7	-.10	7.7
	45.8	-.15	---
	50.9	-.12	7.5
	56.0	-.16	---
	61.0	-.22	7.3

STA. NO.	CORE DEPTH cms	Eh	pH
J16	0-0.5	+.22	7.0
	2.5	+.02	6.9
	5.1	-.01	7.0
	7.6	-.04	7.0
	10.2	-.04	7.1
	12.7	-.07	7.1
	15.2	-.11	7.1
	17.8	-.11	7.2
	20.3	-.12	7.2
	22.9	-.12	7.1
	25.4	-.22	7.1
	27.9	----	7.1
	30.5	----	7.1
25	0-0.5	+.04	---
	2.5	+.02	---
	5.1	+.04	---
	7.6	-.07	---
	10.2	00	---
	12.7	-.02	---
	15.2	+.02	---
26	0-0.5	+.04	---
	1.0	-.09	---
	2.5	-.13	---
	5.1	-.16	---
	7.6	-.19	---
	10.2	-.18	---
	12.7	-.17	---
	15.2	-.20	---
	20.3	-.15	---
	25.4	-.13	---

TABLE IX. Cont'd.

STA. NO.	CORE DEPTH cms	Eh	pH
29	0-0.5	----	7.0
	1.2	+.05	---
	2.5	----	6.8
	3.7	+.05	---
	5.1	----	6.7
	5.3	+.04	---
	7.6	----	6.7
	8.8	+.04	---
	10.2	----	6.8
	11.4	+.02	---
	12.7	----	6.7
	13.9	+.03	---
	15.2	----	6.7
	16.5	+.03	---
	17.8	----	6.8
	19.0	+.03	---
	21.5	+.02	---
31	0-0.5	----	7.2
	1.2	+.01	---
	2.5	----	7.0
	3.7	+.02	---
	5.1	----	6.9
	6.3	+.02	---
	7.6	----	6.8
	8.8	-.02	---
	10.2	----	6.8
	11.4	+.01	---
	12.7	----	6.8
	13.9	.00	---
	15.2	----	6.8
	17.8	----	6.8
33	0-0.5	+.15	---
	1.2	----	6.6
	2.5	+.05	---
	3.7	----	6.7
	5.1	+.04	---
	6.3	----	6.7
	7.6	+.03	---
	8.8	----	6.8
	10.2	+.03	---
	11.4	----	6.8
	12.7	+.04	---
	13.9	----	6.8
	15.2	+.03	---

STA. NO.	CORE DEPTH cms	Eh	pH
33	16.5	----	6.8
	17.8	+.02	---
	19.0	----	---
	20.3	-.03	---
38	0-0.5	-.02	---
	1.0	-.13	---
	2.5	-.01	---
	5.1	-.02	---
	7.6	.00	---
	10.2	.00	---
	12.7	-.03	---
	15.2	-.02	---
39	0-0.5	-.02	7.1
	2.5	-.01	7.0
	5.1	-.02	7.0
	7.6	-.03	6.9
	10.2	-.01	6.8
	12.7	.00	6.9
	15.2	+.04	---
	17.8	-.07	---
	20.3	-.02	---
66	0-0.5	+.02	---
	1.0	.00	---
	2.5	-.00	---
	5.1	-.05	---
	7.6	-.08	---
	10.2	-.18	---
	12.7	-.17	---
	15.2	-.18	---
	17.8	-.20	---
67	0-0.5	+.09	---
	1.0	-.01	---
	2.5	-.02	---
	5.1	-.03	---
	7.6	-.01	---
	10.2	-.02	---
	12.7	-.03	---
	15.2	-.03	---

TABLE IX. Cont'd.

STA. NO.	CORE DEPTH cms	Eh	pH
83	1.2	+.08	6.8
	3.7	.00	6.9
	6.3	+.06	7.1
	8.8	-.09	7.1
	11.4	-.16	7.1
	13.9	-.22	7.1
	16.5	-.18	7.2
	19.0	-.24	---
	21.5	-.20	---
104	0-0.5	+.02	7.3
	2.5	+.05	7.5
	5.1	+.01	7.3
	7.6	+.05	7.4
	10.2	+.07	7.3
	12.7	+.10	7.3
	15.2	+.07	7.2
	17.8	+.08	7.3
105	0-0.5	+.17	---
	1.0	+.13	---
	2.5	+.03	---
	5.1	.00	---
	7.6	-.07	---
	10.2	-.15	---
	12.7	-.16	---
	15.2	-.18	---
	17.8	-.18	---
109	0-1.0	-.01	7.6
	2.5	-.07	7.7
	5.1	-.07	7.8
	7.6	-.11	7.9
	10.2	-.04	7.7
	12.7	-.10	7.7
	15.2	-.10	7.6
120	2.5	+.09	7.0
	5.1	+.02	7.3
	7.6	.00	7.1
	10.2	-.01	7.1
	12.7	-.01	7.1
	15.2	+.04	7.1

STA. NO.	CORE DEPTH cms	Eh	pH
134	0-0.5	+.04	---
	1.0	-.01	---
	2.5	+.01	6.7
	5.1	-.03	6.7
	7.6	-.06	6.7
	10.2	-.06	6.7
	12.7	-.07	6.7
	15.2	-.04	---
135	0-0.5	+.03	---
	1.0	-.02	---
	2.5	+.04	---
	5.1	+.02	---
	7.6	+.02	---
	10.2	+.02	---
	12.7	+.05	---
	15.2	+.01	---
	17.8	+.03	---
140	0-0.5	+.07	---
	1.0	+.01	---
	2.5	+.03	---
	5.1	+.03	---
	7.6	-.02	---
	10.2	+.04	---
	12.7	-.01	---
	15.2	+.02	---
	17.8	+.04	---
141	0-0.5	+.18	7.1
	2.5	+.12	7.2
	5.1	+.06	7.2
	7.6	-.04	7.3
	10.2	-.08	7.2
	12.7	-.12	7.4
	15.2	-.11	7.2
	17.8	-.03	7.2
	20.3	----	7.1
142	2.5	+.01	---
	5.1	-.11	---
	7.6	-.08	---
	10.2	-.16	---
	12.7	-.13	---

TABLE X. Clay mineral analyses. Values in probable parts of ten based on weight relative to "reference" clays, left; values as probable peak-area percent of total, right.

STATION NUMBER	KAOLINITE	ILLITE	MONTMORILLONITE-CHLORITE-MIXED LAYER	KAOLINITE	ILLITE	MONTMORILLONITE-CHLORITE-MIXED LAYER
130	1	5	4	18	18	65
128	0	6	4	22	20	58
114	1	9	0	23	21	57
105	0	10	0	34	35	31
104	0	5	5	36	29	36
102	1	7	3	25	14	61
97	1	6	3	41	21	37
12	1	9	0	48	27	24
119	0	5	5	31	20	49
94	1	4	5	47	24	29
19	0	8	1	24	16	60
87	0	3	7	27	16	58
91	0	2	8	32	14	54
85	0	4	6	27	16	56
79	0	4	6	45	24	31
8	0	2	8	50	20	30
59	1	5	4	34	17	49
39	0	2	8	43	24	33
31	1	2	7	51	18	31
160*	1	2	7	48	19	32
161**	1	3	7	56	26	19

*At Hopewell in the river. **At Richmond in the river.