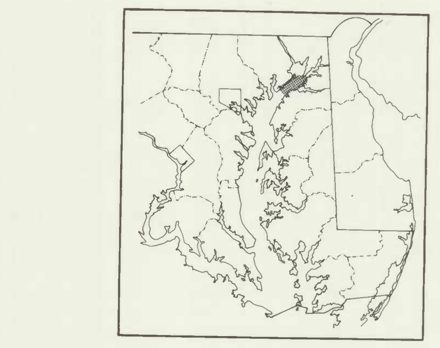
CHESAPEAKE BAY
EARTH SCIENCE ATLAS NO. 1

STATE OF MARYLAND
DEPARTMENT OF NATURAL RESOURCES
MARYLAND GEOLOGICAL SURVEY
KENNETH N. WEAVER, Director



FUNDING PROVIDED BY
THE U.S. ENVIRONMENTAL PROTECTION AGENCY,
CHESAPEAKE BAY PROGRAM CONTRACT NO. R805965
AND DEPARTMENT OF NATURAL RESOURCES:
CAPITAL PROGRAM ADMINISTRATION, ENERGY ADMINISTRATION,
TIDEWATER ADMINISTRATION THROUGH THE OFFICE OF
COASTAL ZONE MANAGEMENT, NOAA

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
HYDROGRAPHIC CHART 12264

MAP 1-3

SEDIMENT DISTRIBUTION

BY

DARLENE V. WELLS, JEFFREY P. HALKA, RANDALL T. KERHIN,
LAMERE HENNESSEE AND PATRICIA J. BLAKESLEE

1987

EXPLANATION

Introduction

Many interrelated and complex factors such as estuarine circulation, wave activity, sediment availability, and biogenic activity contribute to the distribution of sediments in the Chesapeake Bay. Our knowledge of these controlling factors is limited, but even less has been known about the characteristics of the bottom sediments in the Chesapeake Bay estuary. Ryan (1953) provided a general picture of the characteristics of the bottom sediments and expanded knowledge beyond the general statement that muds occur in the channels and sands along the margins. However, a more detailed characterization of the bottom sediments has been required to provide the necessary geological information needed to adequately interpret the processes leading to the distribution of these sediments and to help solve the host of complex problems facing managers of the Bay.

Physically, the sediments are defined and classified in the Chesapeake Bay Earth Science Study by the relative proportions of SAND, SILT, and CLAY. SAND consists of particles with diameters ranging from 2 millimeters to 0.063 millimeters (-1ϕ to 4ϕ), SILT from 0.063 millimeters to 0.004 millimeters (4ϕ to 8ϕ), and CLAY finer than 0.004 millimeters ($(8\phi$). A minor amount of sediment contains particles greater than 2 millimeters in diameter, termed GRAVEL.

All samples were prepared according to a systematic procedure before undergoing analysis for particle size distribution. These procedures represent careful standardization and are derived from those commonly used in sedimentological research today. Before each sample was analyzed, it was completely dispersed to separate the individual sediment particles. Each of the samples was cleaned to remove any substance which could interfere with the dispersion of the particles, such as soluble salts, carbonates, and organic matter. Following sample preparation, the sediments were analyzed with a Rapid Sediment Analyzer, Coulter Counter, and pipette techniques, as required.

Grain size distribution of the sand fraction was determined with a Rapid Sediment Analyzer (RSA) (Halka et al., 1980). The silt-clay fraction was analyzed using a combination of the pipetting technique (Krumbein and Pettijohn, 1938) and a Coulter Counter particle analyzer. The results from the RSA, pipetting technique, and Coulter Counter were then combined, defining a grain-size distribution ranging from coarse sand through very fine clay. Each sediment sample was then typed into one of ten categories based upon the percentages of SAND, SILT, and CLAY (see legend) using the classification scheme designed by Shepard (1954).

Distribution

In the map area the Susquehanna River is the dominant sediment source and shoreline erosion a secondary source. An estimated 50% of the sediment transported by the Susquehanna is of SILT size with 10 percent as SAND and 40 percent as CLAY (Williams and Reed, 1972). In addition to being the dominant source of sediment, the Susquehanna River flow controls the circulation pattern that dictates the distribution of the sediment particles throughout the Northern Bay.

Where the Susquehanna River empties into the head of the Bay (between Spesutie Island and Turkey Point) current velocities diminish and coarser grained sediments are deposited. SAND/SILT/CLAY, SILTY SAND and SANDY SILT are the dominant sediment types found in this area.

Farther south, the fresh water from the Susquehanna River interacts with the more saline water of the Chesapeake Bay producing a zone of maximum turbidity that extends from the mouth of the Sassafras River south to Tolchester (see Atlas 2, 2-2). Within this turbidity zone particles are resuspended during maximum tide and redeposited during slack water. Through this sedimentation process, particles from the suspended populations combine with the coarser grained materials from the head of the Bay and are deposited. The resultant sediments are CLAYEY SILTS. The mid-Bay area between the Sassafras River and Tolchester are dominated by fields of CLAYEY SILT which are interrupted by patches of SAND/SILT/CLAY and SILTY SAND in the areas where smaller streams such as Still Pond or Worton Creek intersect the Bay.

Along the shallower margins of the Bay, SAND is found, reflecting the high energy wave dominated processes which constantly rework the sediments and selectively remove the finer grained components.

A plot of the samples (Figure 1) indicates that silty sediment types are found in the map area. Only one sample (SANDY CLAY) from the CLAY family is represented; all other samples (106) fall in categories toward the coarser SAND and SILT components.

References

Halka, J., R. Conkwright, R. Kerhin, and D. Wells, 1980, The design and calibration of a rapid sediment analyzer and techniques for interfacing to a dedicated computer system: Md. Geol. Survey, Inform. Circ. 32, 32 p.

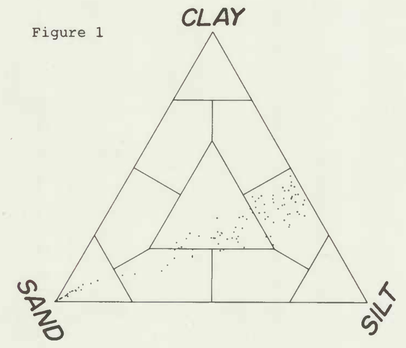
Krumbein, W.C., and F.J. Pettijohn, 1938, Manual of Sedimentary Petrography: New York, Appleton-Century-Crofts, 549 p.

Ryan, J., 1953, Sediments of Chesapeake Bay: State of Maryland, Dept. of Geology, Mines, and Water Resources, Bull. 12, 117 p.

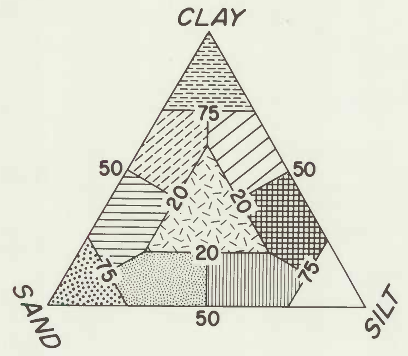
Shepard, F., 1954, Nomenclature based on sand-silt-clay ratios: Jour. of Sed. Petrology, vol. 24, p. 151-158.

Williams, K.F., and L.A. Reed, 1972, Appraisal of stream sedimentation in the Susquehanna River Basin: U.S. Geol. Survey Water Supply Paper 1532-F.

Figure 1



LEGEND



SHEPARD'S CLASSIFICATION

MAP 1-4

WATER CONTENT

BY

DARLENE V. WELLS, LAMERE HENNESSEE,
AND ROBERT H. CUTHBERTSON

1987

EXPLANATION

Introduction

In the characterization of the surficial sediments of the Chesapeake Bay bottom, the sedimentary environment is defined as consisting of the particulate matter (inorganic and organic) plus water. This assumes that the surficial sediments are 100% saturated with free water, water that is not bound in the internal structure of the clay minerals. The content of water (in percent) in the sediments is calculated as:

$$\text{Water Content \%} = \frac{\text{weight of water (grams)}}{\text{wet weight of sample (grams)}} \times 100$$

The weight of the water is determined as the difference between the wet weight and dry weight of the sample after drying at 65°C. In engineering studies, water content is expressed as a percentage of the dry weight of the sample instead of the wet weight as reported here.

Water content is closely related to various physical and geotechnical properties of the sediment. Numerous investigations have shown that water content is directly proportional to porosity and organic carbon and inversely proportional to unit weight and grain size (Harrison et al., 1964; Keller, 1974). Water content also provides a first approximation of the cohesiveness and erodability of sediments, and insight into the compaction history of the finer-grained muds (SILTY CLAYS, CLAYEY SILTS and CLAYS). Current velocity studies have shown that within a given sediment type the higher the water content the lower the current velocity needed to erode and transport the sediment.

Distribution

Water content, as determined from the analyses of 103 samples, is strongly related to grain size (Table 1). Generally, SAND averages 34%, SAND/SILT/CLAY, 53%, and SILT, 64% (CLAY is not represented) indicating that grain size is inversely correlated with water content.

The distribution of water content in the bottom sediments conforms to the Bay geometry and correlates with the distribution of sediment types. The finer grained sediments (CLAYEY SILT) with high water content (54-70%) are generally located in the main channel areas. Proceeding towards the shoreline, water content decreases to 20% or less for the SAND of the nearshore areas. However, the overall water content, on the average, in the map area is lower compared to the rest of the Chesapeake Bay reflecting the coarser sediment types found within this area.

Table 1. Percent water measured in the different sediment size classifications.

TYPE	RANGE % H_2O	MEAN % H_2O	NUMBER
SAND	15.43-54.81	26.15	20
SILTY SAND	43.99-57.59	50.22	10
CLAYEY SAND	-	-	-
(SANDS)	(15.43-57.59)	(34.17)	(30)
SILT	-	-	-
SANDY SILT	57.20-58.23	57.72	2
CLAYEY SILT	54.00-70.31	64.17	41
(SILTS)	(54.00-70.31)	(63.87)	(43)
CLAY	-	-	-
SANDY CLAY	-	-	-
SILTY CLAY	-	-	-
(CLAYS)	-	-	-
SAND/SILT/CLAY	46.91-66.68	57.97	30
TOTAL	15.43-70.31	53.50	103

References

Harrison, W., M. Lynch, and A. Altschaefel, 1964, Sediments of Lower Chesapeake Bay, with emphasis on mass properties: Jour. of Sed. Petrology, vol. 34, p. 727-755.

Keller, G., 1974, Marine geotechnical properties: interrelationships and relationships to depth of burial: in Inderbitzen, A.A., ed., Deep Sea Sediments, Physical and Mechanical Properties: New York, Plenum Press, p. 77-100.

LEGEND

CONTOUR INTERVAL 15% WET WEIGHT