CHESAPEAKE BAY
EARTH SCIENCE ATLAS NO. 3

MAP 3—2

SEDIMENT DISTRIBUTION

BY

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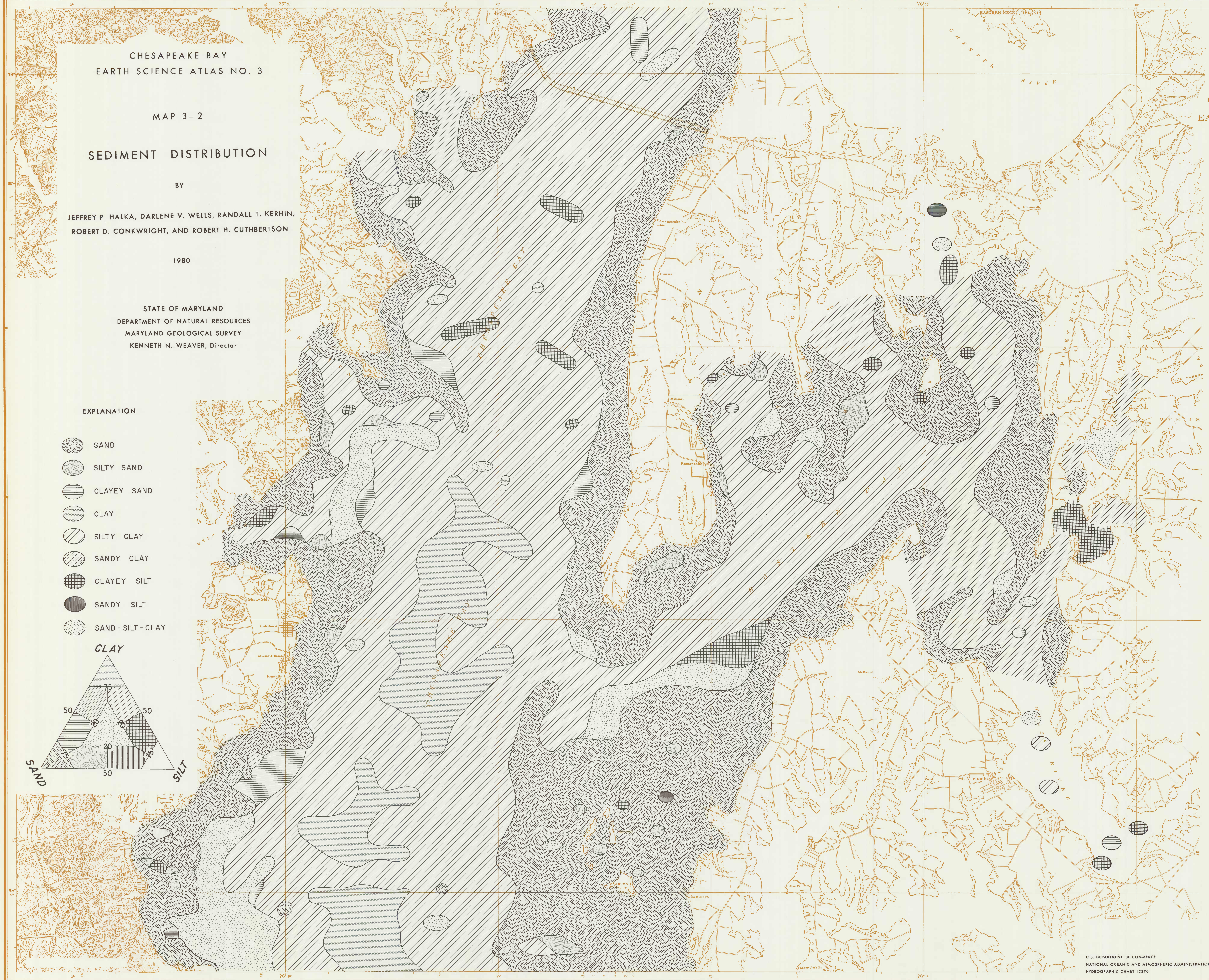
UNITED STATES - EAST COAST
MARYLAND

CHESAPEAKE BAY
EASTERN BAY AND SOUTH RIVER



SEDIMENT DISTRIBUTION

Introduction

Many interrelated and complex factors such as estuarine circulation, wave activity, and sediment availability contribute to the distribution of sediments in Chesapeake Bay. Our knowledge of these factors is limited, but even less is 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 our 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 is required to provide the necessary geological information needed to solve the host of complex problems facing managers of the Bay.

The bottom sediments can be described in a variety of ways: in terms of chemical components, interactions with the biota, or physical characteristics. For the Chesapeake Bay Program, sediments are defined, classified, and mapped according to: 1) the physical size of the individual sedimentary particles, 2) the water content, and 3) the carbon and sulfur content. In the atlas, each parameter is considered separately, thereby providing an overview of the variability observed in each selected component of the sediment system. The ability to compare and contrast sediments according to selected physical and chemical characteristics provides an important managerial and scientific tool useful for the reconstruction and interpretation of events within the estuarine environment.

Physically, the sediments are defined and classified by the relative proportions of SAND, SILT, or 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 from 0.004 millimeters to 0.0006 millimeters (8ϕ to 14ϕ). A minor amount of sediment contains particles greater than 2 millimeters, termed GRAVEL.

Using a classification scheme devised by Shepard (1954), the relative proportions of SAND, SILT, and CLAY define ten sediment categories (see legend). A sample plot (Figure 1) indicates that a wide variety of sediment types are found in the map area, but when taken as a whole, the sediments form a distinct trend across the diagram from SAND through SAND-SILT-CLAY to SILTY CLAY and CLAY. In the lower Bay the trend of sediment types is from SAND through SAND-SILT-CLAY to CLAYEY SILT (R. Byrne, pers. comm.). The upper Bay (map area) appears to be enriched in clay-sized particles in comparison to the lower Bay.

Distribution

The areal distribution of sediment types suggests that sediment type is related to basin geometry or the boundary conditions of the basin. In the central portion of the main Bay, the sediments are SILTY CLAYS and CLAYS. Away from the central portion and near the margins of the Bay, the sediments grade through SAND-SILT-CLAY to SAND near the shoreline. This cross-Bay change in sediment types reflects the energy conditions and processes operating in these zones. The SAND in the nearshore areas is a result of high-energy, wave dominated processes constantly reworking the sediments and selectively removing the finer-grained components. The central portion or channel area is a lower energy zone dominated by processes of estuarine tidal mixing and circulation. The lower energy processes allow the accumulation of finer-grained sediments, the SILTY CLAYS and CLAYEY SILTS.

In addition to a cross-Bay gradation in sediment type, there is a down-Bay change. In the northern section SILTY CLAYS are encountered. Proceeding southward, discontinuous patches of CLAY are evident, suggesting either an enrichment of clay-sized particles or selective removal of silt-sized particles. Field observations have identified these areas as "bedrock" exposures, probably of the Miocene Calvert Formation. Field observations have also identified "bedrock" exposures along the margins of Herring Bay.

In Eastern Bay the sediments are generally coarser-grained and more poorly sorted than those found in the main Bay. The SAND-SILT-CLAY admixture covers a relatively large area. The sediments found throughout Eastern Bay are derived in part from estuarine circulation and mixing processes, but mostly from erosion of shoreline sediments composed of interbedded sands and silt-clays of the Kent Island Formation and silt-clays of the Holocene marshes.

SEDIMENT SIZE ANALYSES

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. 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 analyses of the sand fraction (>0.063 millimeters) is with a Rapid Sediment Analyzer (RSA) (Halka, et al, 1981). The silt-clay fraction (<0.063 millimeters) is 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 are combined, defining a grain-size distribution ranging from coarse sand (2 millimeters) to very fine clay (0.00006 millimeters). From the combined grain-size distribution, statistical parameters such as mean grain size and standard deviation (sorting coefficient) are calculated. Percent SAND, SILT, and CLAY are also calculated and, based upon these percentages, the sediment is classified according to Shepard's (1954) classification.

Halka, J., R. Conkwright, R. Kerhin, and D. Wells, 1981, The design and calibration of a rapid sediment analyzer and techniques for interfacing to a dedicated computer system: Maryland Geol. Survey, Infor. Circ. (in press).

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

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

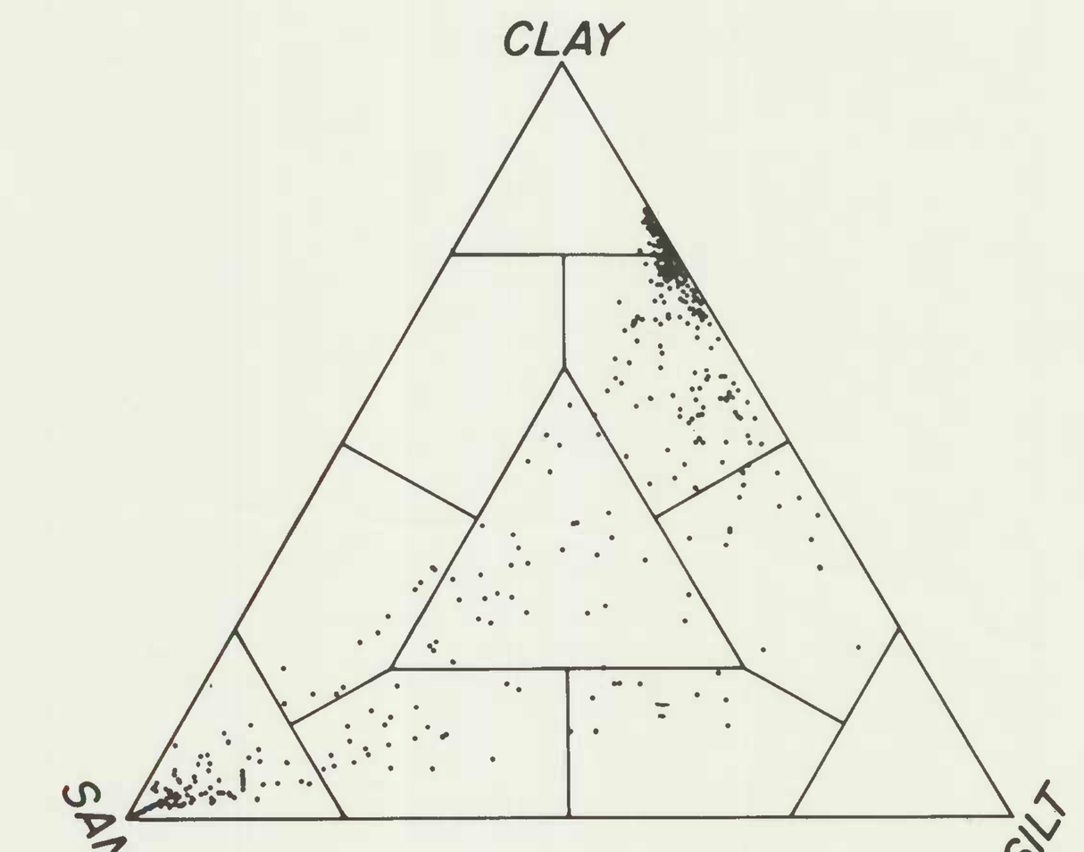


FIGURE 1

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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
HYDROGRAPHIC CHART 12270

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