MAP 1-5

CARBON CONTENT (ORGANIC AND TOTAL)

BY

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EXPLANATION

Introduction

Many chemical reactions occurring in the Chesapeake Bay estuary depend upon the availability of organic carbon. In addition, the concentration of this element serves as a pollution level indicator and aids in the location of sites with potentially high concentrations of heavy metals and/or other polluting substances.

Carbon is the primary food source for organisms in the Chesapeake Bay. Carbon, whether in the form of organic matter or living organisms, is extracted from the water column and sediment by organisms and, in the presence of oxygen, is 'burned' to provide energy. Unless oxygen is constantly replenished, it is eventually depleted by the consumers. The environment then becomes anoxic, and the consumption of organic carbon decreases dramatically. Many of the fine-grained sediments of the Bay bottom become anoxic within a few centimeters of the sediment surface. Within these anoxic sediments, reduced metals, such as iron and manganese, combine with reduced sulfur species to form metal sulfides. These are generally stable in sediment as long as the environment remains anoxic. However, if these sediments are disturbed and introduced into an oxidizing environment, the following could occur: 1) the creation of an oxygen demand proportional to the concentrations of organic carbon and reduced compounds in the sediment; 2) the formation of oxidation products analogous to those found in acid mine drainage, as a result of oxidation of the iron sulfide phases; or 3) the release of nutrients and trace metals into the environment. Knowing the organic carbon content of the sediments can play a key role in identifying areas of anoxic sediments and estimating potentially deleterious effects should these sediments be disturbed.

Carbon is also present in the sediments as mineralic skeletal parts, such as shell, teeth, and bones. These materials are viewed as inorganic because they cannot be utilized as an energy or food source by organisms, nor do they affect the potential oxygen demand of anoxic sediments. Although they do contribute to the total amount of carbon present in the sediment, their contribution is negligible. The amount of total carbon in any particular sediment sample is largely controlled by the amount of organic carbon in that sample. For this reason, the remainder of the discussion concerns the organic carbon distribution in the sediments, and the contour lines of equal carbon content shown on the map refer to organic carbon.

Carbon analysis was done on approximately one out of every four samples collected from the deeper water of the Bay. Sediments consisting predominantly of sand, which generally occur in shallower water, contain amounts of organic carbon close to or below the detection level of the analytical equipment. Therefore, these samples were not analyzed for their carbon content. Both total and organic carbon content were determined for 27 samples using a LECO Gasometric Analyzer (Model #572-100) in conjunction with a LECO Induction Furnace (Model #521-000).

Distribution

Areas of high organic carbon content tend to correspond to areas of deep water and fine-grained sediment. Nearshore and beach areas are high energy, wave-dominated zones in which constant reworking of the sediments results in the removal of the fine-grained materials, including the organics. In addition, high energy conditions stir up the bottom, aerating the sediments and preventing anoxic conditions from developing. In contrast, deep areas tend to be low energy environments in which fine-grained materials, including organics, accumulate. Anoxic conditions develop in these materials because their fine-grained nature inhibits the passage of oxygen into the sediment from the overlying water. Because anaerobic decomposition of organic materials is a much slower process than aerobic decomposition, organic carbon material is preserved in these sediments.

Dry weight percent organic carbon in this section of the Bay averages 5.21%, ranging from 0.61% to 10.47% (Table 1). The highest concentrations of organic carbon known to occur in the Maryland portion of Chesapeake Bay are found here, within a lobe of relatively coarse sediments deposited immediately downbay of the mouth of the Susquehanna River. The exceptionally high carbon content of these sediments is related to the terrigenous origin of the carbon, which includes particulate coal and plant debris. Coal from mining operations in northeastern Pennsylvania is transported to the head of the Bay by the Susquehanna (Ryan, 1953; Folger, 1972; Williams and Reed, 1972; Palmer, 1975). Most of the sediment load of the river is deposited within this region. The proportion of sedimentary carbon derived from terrigenous sources steadily decreases from the head of the Bay, with primary productivity contributing progressively more of the carbon incorporated into the sediments. As the nature of the carbon changes, the common association of organic carbon with fine-grained sediments is better established.

Table 1. Dry weight percent organic carbon measured in the different sediment size classifications

TYPE	RANGE % C	MEAN % C	NUMBER
SAND	0.61-0.98	0.80	2
SILTY SAND	4.15-10.13	7.14	2
CLAYEY SAND (SANDS)	(0.61-10.13)	(3.97)	(4)
SILT	-	-	-
SANDY SILT	-	-	-
CLAYEY SILT (SILTS)	3.34-6.46 (3.34-6.46)	4.58 (4.58)	11 (11)
CLAY	-	-	-
SANDY CLAY	-	-	-
SILTY CLAY (CLAYS)	-	-	-
SAND-SILT-CLAY	1.71-10.47	6.19	12
TOTAL	0.61-10.47	5.21	27

References

Folger, D.W., 1972, Characteristics of Estuarine Sediments of the United States: U.S. Geol. Survey Prof. Paper 742, 94 p.

Palmer, H.D., 1975, Bottom sediments, in Munson, T.O., ed., Upper Bay Survey: Annapolis, Md., Westinghouse Electric Corp., vol. II, p. 4-1 to 4-31.

Ryan, J.D., 1953, The sediments of Chesapeake Bay: State of Maryland, Dept. of Geology, Mines and Water Resources, Bull. 12, 120 p.

Williams, K.F., and Reed, L.A., 1972, Appraisal of stream sedimentation in the Susquehanna River basin: U.S. Geol. Survey Water Supply Paper 1532-H, 24 p.

LEGEND

1.5 - ORGANIC CARBON % DRY WEIGHT

(1.7) - TOTAL CARBON % DRY WEIGHT

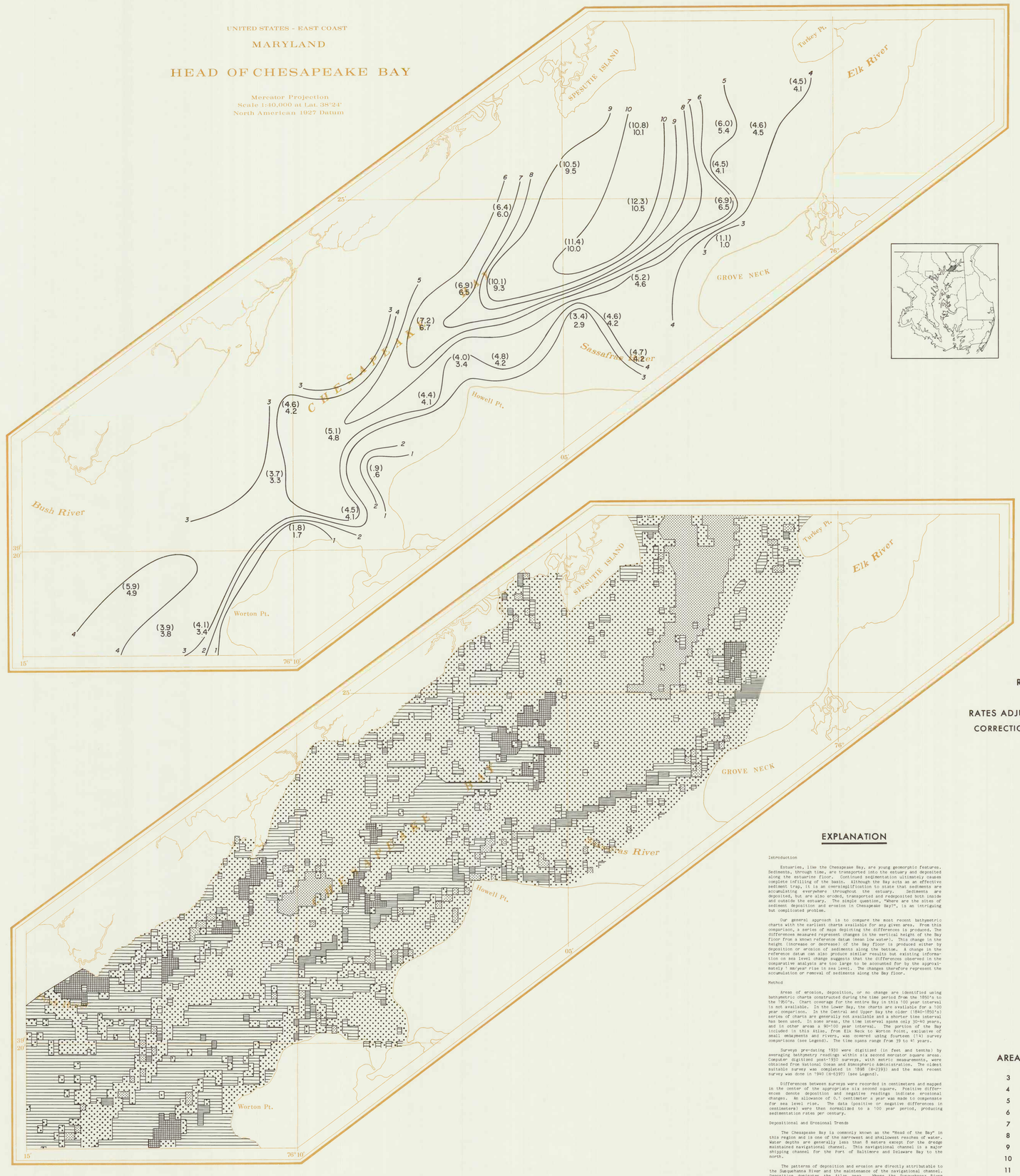
CONTOUR INTERVAL 1% ORGANIC CARBON

UNITED STATES - EAST COAST

MARYLAND

HEAD OF CHESAPEAKE BAY

Mercator Projection
Scale 1:40,000 at Lat. 38°24'
North American 1927 Datum



CHESAPEAKE BAY
EARTH SCIENCE ATLAS NO. 1

STATE OF MARYLAND
DEPARTMENT OF NATURAL RESOURCES
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HYDROGRAPHIC CHART 12264

MAP 1-6

PATTERNS OF EROSION AND DEPOSITION

BY

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1987

LEGEND

RATES OF EROSION AND DEPOSITION
METER/CENTURY
RATES ADJUSTED FOR SEA LEVEL RISE AND TIME INTERVAL
CORRECTION FACTOR FOR SEA LEVEL RISE 1 millimeter/year

METER / CENTURY

- > +2.2
- +2.2 to +0.2
- −0.2 to −0.4
- −0.4 to −2.4
- > −2.4

EXPLANATION

Introduction

Estuaries, like the Chesapeake Bay, are young geomorphic features. Sediments, through time, are transported into the estuary and deposited along the estuarine floor. Continued sedimentation ultimately causes complete infilling of the basin. Although the Bay acts as an effective sediment trap, it is an oversimplification to state that sediments are accumulating everywhere throughout the estuary. Sediments are deposited, but are also eroded, transported and redeposited both inside and outside the estuary. The simple question, "Where are the sites of sediment deposition and erosion in Chesapeake Bay?", is an intriguing but complicated problem.

Our general approach is to compare the most recent bathymetric charts with the earliest charts available for any given area. From this comparison, a series of maps depicting the differences is produced. The differences measured represent changes in the vertical height of the Bay floor from a known reference datum (mean low water). This change in the height (increase or decrease) of the bay floor is produced either by deposition or erosion of sediments along the bottom. A change in the reference datum can also produce similar results but existing information on sea level change suggests that the differences observed in the comparative analysis are too large to be accounted for by the approximately 1 mm/year rise in sea level. The changes therefore represent the accumulation or removal of sediments along the Bay floor.

Method

Areas of erosion, deposition, or no change are identified using bathymetric charts constructed during the time period from the 1850's to the 1960's. Chart coverage for the entire Bay in this 100 year interval is not available. In the Lower Bay, the charts are available for a 100 year comparison. In the Central and Upper Bay the older (1840-1850's) series of charts are generally not available and a shorter time interval has been used. In some areas, the time interval spans only 30-40 years, and in other areas a 90-100 year interval. The portion of the Bay included in this Atlas, from Elk Neck to Worton Point, exclusive of small embayments and rivers, was covered using fourteen (14) survey comparisons (see Legend). The time spans range from 39 to 4 years.

Surveys pre-dating 1930 were digitized (in feet and tenths) by averaging bathymetry readings within six second mercator square areas. Computer digitized post-1930 surveys, with metric measurements, were obtained from National Ocean and Atmospheric Administration. The oldest suitable survey was completed in 1898 (H-2393) and the most recent survey was done in 1940 (H-6397) (see Legend).

Differences between surveys were recorded in centimeters and mapped in the center of the appropriate six second square. Positive differences denote deposition and negative readings indicate erosional changes. An allowance of 0.1 centimeter a year was made to compensate for sea level rise. The data (positive or negative differences in centimeters) were then normalized to a 100 year period, producing sedimentation rates per century.

Depositional and Erosional Trends

The Chesapeake Bay is commonly known as the "Head of the Bay" in this region and is one of the narrowest and shallowest reaches of water. Water depths are generally less than 8 meters except for the dredge maintained navigational channel. This navigational channel is a major shipping channel for the Port of Baltimore and Delaware Bay to the north.

The patterns of deposition and erosion are directly attributable to the Susquehanna River and the maintenance of the navigational channel. Deposition dominates the Atlas area. Where the Susquehanna River encroaches into the Bay, the patterns are depositional with high deposition in water depths greater than 4 meters and low deposition in the nearshore, shallow areas. The only erosional patterns are confined to the navigational channel through periodic maintenance dredging. Southward to Howell Point, the pattern of low deposition dominates the entire area, particularly in water depths greater than 4 meters. South of Howell Point, a low depositional pattern is flanked by patterns of low erosion. The general pattern for Atlas #1 is high deposition in the northern section decreasing to low deposition flanked by low erosion. The overall pattern reflects the high deposition of the Susquehanna River sediments in the north decreasing southward.

HYDROGRAPHIC CHARTS USED
FOR BATHYMETRIC COMPARISON

AREA	SURVEY NUMBER	DATES
3	2432 - 6365	1899 - 1938
4	2432 - 6368	1899 - 1938
5	2432 - 6363	1899 - 1938
6	2393 - 6365	1898 - 1938
7	2393 - 6368	1898 - 1938
8	2393 - 6363	1898 - 1938
9	2393 - 6366	1898 - 1938
10	2393 - 6371	1898 - 1938
11	2393 - 6370	1898 - 1938
12	2393 - 6367	1898 - 1940
13	2393 - 6368	1898 - 1938
14	2399 - 6367	1898 - 1938
17	2399 - 6375	1898 - 1938
18	2399 - 6372	1898 - 1938