CHESAPEAKE BAY
EARTH SCIENCE ATLAS NO 2

MAP 2-4

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. Whether in the form of organic matter or living organisms, carbon 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 this process. 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, reactive metals, such as iron and manganese, combine with reduced sulfur species to form metal sulfides. These are stable in the 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 sediments; 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 shells, 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 present 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. Both total and organic carbon content were determined for 125 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 sediments. 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 protected from low energy environments in which fine-grained materials, including organics, accumulate. Anoxic conditions develop quickly 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 substances 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 2.85%, ranging from no detectable carbon to 5.70% (Table 1). A lobe of relatively high carbon concentrations occurs in channel deeps south and east of Pooles Island. This cluster of samples corresponds with the southernmost extent of the Bay's turbidity maximum - a zone of high suspended sediment concentrations within the upper 25-30 kilometers of the estuary (Schubel, 1971). The remainder of this section of the Bay is characterized by a comparatively uniform distribution of carbon, of about three percent. Carbon concentrations exceeding four percent are restricted to a small area immediately north of the Bay Bridge. These few high values are associated with areas of mixed sediments and a former dredge disposal site.

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

TYPE	RANGE % C	MEAN % C	NUMBER
SAND	0.00-2.01	0.52	18
SILTY SAND	0.93-1.34	1.14	3
CLAYEY SAND	0.95-2.39	1.68	6
(SANDS)	(0.00-2.39)	(0.85)	(27)
SILT	-	-	-
SANDY SILT	-	-	-
CLAYEY SILT	2.93-5.70	4.34	19
(SILTS)	(2.93-5.70)	(4.34)	(19)
CLAY	3.01	3.01	1
SANDY CLAY	-	-	-
SILTY CLAY	1.58-4.73	3.26	63
(CLAYS)	(1.58-4.73)	(3.26)	(64)
SAND/SILT/CLAY	1.69-4.65	2.83	15
TOTAL	0.00-5.70	2.85	125

References

Schubel, J.R., 1971, Sedimentation in the upper reaches of the Chesapeake Bay, in Schubel, J.R., ed., The Estuarine Environment: Washington, D.C., Amer. Geol. Inst., p. VII-1 to 31.

LEGEND

1.5 - ORGANIC CARBON % DRY WEIGHT
(1.7) - TOTAL CARBON % DRY WEIGHT
CONTOUR INTERVAL 1% ORGANIC CARBON

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