CHESAPEAKE BAY EARTH SCIENCE ATLAS NO. 3

MAP 3–4

TOTAL CARBON CONTENT

BY

DARLENE V. WELLS, RENEE H. GELBLAT, AND ROBERT D. CONKWRIGHT

1980

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

EXPLANATION

CONTOUR INTERVAL
1% BY WEIGHT

TOTAL CARBON CONTENT

Introduction

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

Carbon is the primary food source for organisms in the Chesapeake Bay. Carbon as organic materials or living organisms is taken from the water column and sediment by organisms for utilization as food. In the presence of oxygen, the carbon is "burned" to provide energy. Unless there is a constant supply, this process eventually depletes the environment of oxygen. The environment becomes anoxic and an alternative oxidizing substance is used. In the Bay environment this substance is sulfur, in the form of sulfates.

In the anoxic environment sulfates are reduced to sulfides by anaerobic bacteria releasing energy for their use. The sulfides then combine with reactive metals such as iron and manganese, forming metal sulfides. These metal sulfides remain in the sediment where they are stable as long as the environment remains anoxic. However, if these sediments are disturbed and introduced to an oxidizing environment (e.g., through dredging), the following could occur: 1) the creation of an oxygen demand proportional to the concentration 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 iron sulfide phases; 3) the release of nutrients and trace metals to the environment. Knowing the organic carbon and sulfur content of the sediments can play a key role in identifying areas of anoxic sediments and estimating the 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 not viewed as organic because they cannot be utilized as an energy or food source by organisms. They do, however, contribute to the total carbon content of the sediments and because they are produced by the activities of organisms they give an indication of the biological productivity in different portions of the Bay.

Distribution

In general, content of total carbon increases with water depth. Values range from less than 1% near the shore (less than 20 ft in depth), to about 4% in the deeper water areas. There are also some isolated areas of 5-8% total carbon values.

The amount of total carbon in any particular sediment sample is largely controlled by the amount of organic carbon in that sample; mineralic carbon contributes little to the total carbon of the sediments in this area. For this reason the pattern of organic carbon distribution is similar to the pattern for total carbon, but for any sampling location the concentration of organic carbon is less than that of total carbon.

The distribution of sulfur is also similar to that of both organic and total carbon except for the slight increase down-Bay. This increase in sulfur content can be explained, in part, by two factors: the down-Bay increase in salinity, i.e. much of the sulfate found in the sediments comes from the ses water component of estuarine waters, and the down-Bay shift to finer-grained sediments.

Areas of high carbon and sulfur content tend to correspond to areas of deep water and fine-grained sediment. The nearshore and beach areas are high energy, wave dominated zones in which constant reworking of the sediments results in the removal of the finer-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 the deep areas tend to be 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 materials is a much slower process than aerobic decomposition, carbon material is preserved in these sediments. As sulfates are reduced to sulfides and combine with reactive metals the sulfur is retained in the sediment in the same areas.

Carbon and sulfur analysis was done on one out of every four samples collected from the deeper waters of the Bay. Some samples from shallower depths were also analyzed. However, these samples contained amounts of carbon and sulfur below the detection level of the analytical equipment and sample analysis was discontinued. In general, the sand samples (i.e. samples with less than 25% water) from which the finer grained materials have been removed were not analyzed for carbon and sulfur.

In selecting samples for carbon and sulfur analysis, every fourth sample was considered. The potential sites were then compared with the respective water content of the sample. Sand samples were replaced with a nearby acceptable sample. If a large area of the map was excluded on the basis of water content, the 25% limit was reduced. Samples with a water content as low as nineteen percent were used. Carbon analysis (total and organic) was performed using a Leco Gasometric Analyzer (Model 572-100) and a Leco Induction Furnace (Model 521-000).

Table 1 shows the values for total carbon as percent of dry sample weight determined for the various sediment size classes listed on the left. The number of samples analyzed for each size class, and the mean, minimum, maximum and range in total carbon values are shown. Note that the mean value for all samples is 2.217 percent and that an increase in the mean value is observed as the sediments become finer, from 0.468 percent for all sands through 2.318 percent for silts to 3.183 percent for clayey sediments. The sand-silt-clay admixture has a mean value of 1.966 percent which is close to the value for the silt class.

Table 1. Percent Total Carbon measured in the different sediment size classifications.

TYPE	RANGE % C_T	MEAN % C_T	NUMBER
SAND	0.000-3.280	0.347	92
SILTY SAND	0.418-1.310	0.826	7
CLAYEY SAND	0.860-2.162	1.422	9
(SANDS)	(0.000-3.280)	(0.468)	(108)
SILT	-	-	0
SANDY SILT	0.664-0.751	0.707	2
CLAYEY SILT	1.190-3.420	2.548	14
(SILTS)	(0.664-3.420)	(2.318)	(16)
CLAY	2.865-6.524	3.433	38
SANDY CLAY	-	-	0
SILTY CLAY	1.153-7.740	3.124	162
(CLAYS)	(1.153-7.740)	(3.183)	(200)
SAND/SILT/CLAY	0.779-3.480	1.966	23

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
HYDROGRAPHIC CHART 12270

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