CHESAPEAKE BAY
EARTH SCIENCE ATLAS NO. 3

MAP 3–6

SULFUR CONTENT

BY

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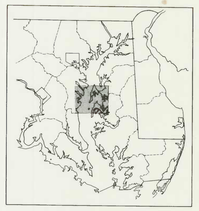
KENNETH N. WEAVER, Director

UNITED STATES - EAST COAST
MARYLAND

CHESAPEAKE BAY
EASTERN BAY AND SOUTH RIVER

Mercator Projection
Scale 1:40,000 at Lat. 38°52'
North American 1927 Datum



EXPLANATION

CONTOUR INTERVAL
0.3% BY WEIGHT

SULFUR 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 substances may be 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 eaten by the next higher level consumer for 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 sulfate.

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, the sulfides will react with the oxygen and could result in the depletion of an oxygen demand proportional to the environmental impact of the reduced compounds in the sediments; 2) the formation of intermediate 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. Reading the sulfur content of the surface sediments 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 material. This form of carbon is relatively inert and biologically unavailable; it 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 5-6% total carbon values.

The amount of total carbon in any particular sediment sample is largely controlled by the amount of organic carbon present. Mineralic carbon usually 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 down-bay reflects the fact that the bay water is higher in salinity, i.e. each of the sulfates found in the sediments comes from the sea 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. Deep water areas are depositional environments in which the sediments were 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 the sediments are not disturbed by bottom currents. 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 these sediments are undisturbed, organic carbon is not recycled because then aerobic decomposition, carbon material is preserved in the 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. Nine samples from shallower depths were also analyzed. However, these samples contained sources 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 samples. If the water content was less than 25% the sample was analyzed. 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 analyzed. Carbon was analyzed using a total carbon apparatus (Model 523 Geometric Analyzer (Model 573-100) and a Leco Induction Furnace (Model 523-300). Sulfur was analyzed using a Leco Induction Furnace (Model 523-300) and a Leco Automatic Titrator (Model #532-000).

Table 1 shows the values for sulfur 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 and range of sulfur values are shown. The average mean value for all samples is 0.597 and ranges from a low of 0.133 for all sands to a high of 0.852 percent for silts. The value for all clays is slightly lower at 0.775 percent.

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

TYPE	RANGE %S	MEAN %S	NUMBER
SAND	0.010-0.320	0.090	35
SILTY SAND	0.135-0.390	0.259	3
CLAYEY SAND	0.190-0.845	0.531	6
(SAND)	(0.010-0.869)	(0.133)	(46)
SILT	-	-	-
SANDY SILT	-	-	-
CLAYEY SILT	0.180-1.780	0.852	11
(SILTS)	(0.180-1.780)	(0.852)	(11)
CLAY	0.668-1.010	0.828	11
SANDY CLAY	-	-	-
SILTY CLAY	0.200-1.764	0.769	102
(CLAYS)	(0.220-1.764)	(0.775)	(113)
SAND/SILT/CLAY	0.254-1.170	0.522	16

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