MAP 1-1

SAMPLING LOCATIONS

BY

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1987

EXPLANATION

Introduction

Chesapeake Bay Earth Science Atlases 1 and 2 represent the fourth in a series of map atlases depicting physical and chemical characteristics of the bottom sediments of Chesapeake Bay. These atlases are a product of a major research effort by the States of Maryland and Virginia in cooperation with the Chesapeake Bay Program of the Environmental Protection Agency to map the distribution of sediments, to identify the sites of deposition and erosion of such sediments, and to map the distribution of carbon and sulfur in the sediments.

The Maryland Geological Survey and the Virginia Institute of Marine Science conducted companion programs in each of their respective states to provide detailed information about the sediments of the Bay. This research effort is the first attempt to provide such information on a Bay-wide basis. Past studies of the Bay sediments have been either very localized and site specific (Kofoed and Gorsline, 1966; Biggs, 1967; Palmer, 1972; Shideler, 1975) or reconnaissance in nature (Ryan, 1953).

Acknowledgements

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The success of such a scientific endeavor could not have been accomplished without the dedicated professional services of the geologists and staff of the entire Maryland Geological Survey, and without the superb and encouraging leadership of Dr. Kenneth N. Weaver and Dr. Emery T. Cleaves. Collection of samples was accomplished on the Research Vessels Monitor and Discovery. The captain, Gerald Cox, and the first mate, James Robare, deserve credit for a well maintained safe research vessel from which the sediment sampling was performed. We also extend our gratitude and appreciation to the many people whose invaluable comments and suggestions helped initiate this project and contributed to completion of these Atlases. A very special thanks goes out to the draftsperson whose excellent work has provided a clear and legible product, Cindy Lang-Bachur.

Physiographic and Geologic Setting

The Chesapeake Bay is located in the Embayed Section of the Atlantic Coastal Plain Province. The Bay is an estuary formed by the post Wisconsin sea level rise which drowned the lower valley of the Susquehanna River. Prior to submergence, the Susquehanna River had developed an extensive drainage network in unconsolidated to weakly consolidated sediments of Cretaceous, Tertiary, and Quaternary age. The sedimentary units become progressively younger southward along the Bay axis from the Cretaceous Potomac Group in the Upper Bay to the Quaternary sediments along the Lower Eastern Shore.

As shown in these Atlases, the western shore differs markedly from that of the eastern shore. Along the western side (Baltimore and Harford Counties), the coast is a low-lying, irregular shoreline with numerous tidal creeks, inlets and fringing marshes. Several major river systems dissect the interior into a rolling topography. The drowned mouths of these rivers segment the shoreline into sections with irregular, low banks. The terrain is underlain by Quaternary sediments of the Talbot Formation (Glaser, 1976). The Talbot Formation is a graded sequence with an upper silt-clay unit. Glaser (1976) has described the Talbot Formation as a fluvial sequence deposited during interglacial conditions, probably Sangamonian or older.

Along the eastern shore, wave-cut cliffs as high as 80 feet border most of Atlas 1 and the northern section of Atlas 2. Low-lying banks dominate the southern section of Atlas 2. Two major rivers dissect the shoreline, the Sassafras River in Atlas 1 and the Chester River in Atlas 2. Numerous tidal creeks and marshes are present along the shoreline.

The sediments are Cretaceous and Tertiary in age capped by Quaternary sediment. The Cretaceous formations crop out along the high cliffs at the head of the Bay and along the cliffs of the Sassafras River. The Potomac Group, of continental origin, is exposed at the head of the Bay with the Magothy and Matawan Formations exposed along the Sassafras River. Quaternary sediments crop out in the low banks of Atlas 2.

SAMPLING LOCATIONS

The design plan for collection of bottom sediments is based on a uniform grid for systematic Bay-wide sampling. The grid concept of sampling offers a more efficient strategy for spatial correlation than most other sampling systems (McCammon, 1975). The grid is based on the Universal Tranverse Mercator Projection with one kilometer grid lines generated from a known point at 76°00W, 38°00N. Where the grid projection lines intersect the mean high water line along the Bay shoreline, the grid system was expanded to one kilometer (shore parallel) by 300 meters (shore normal) to a water depth of 3 meters.

Location, in the field, was determined by the use of a Teledyne-Hastings Raydist navigational system. Accuracy of the system is ±0.5 meters. The sampling locations were pre-plotted, based on the grid design, and converted to the Raydist coordinate system. This coordinate system provided the basis for actual field locations. Nearshore, where the grid system was expanded to one kilometer by 300 meters, location was determined by shore based triangulation methods.

Our initial 1 kilometer interval sampling grid was based on the radio-navigation lanes of the Raydist Navigational system. In the upper section of this map, this is readily apparent in the skewed and curved sampling pattern. Improvements in our navigational system made possible greater conformity to the UTM grid. This can be seen in the lower section of the map where the sample locations are more orthogonal.

A total of 776 sediment samples were collected and analyzed for textural parameters, as well as water, carbon, and sulfur content. The data are plotted on a series of overlays using the base map of the sample locations as reference.

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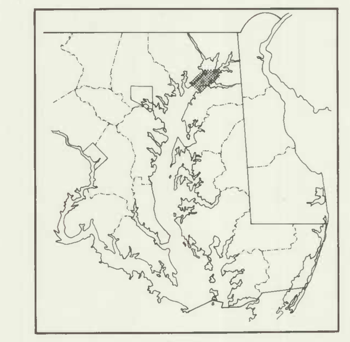
CHESAPEAKE BAY
EARTH SCIENCE ATLAS NO. 1

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



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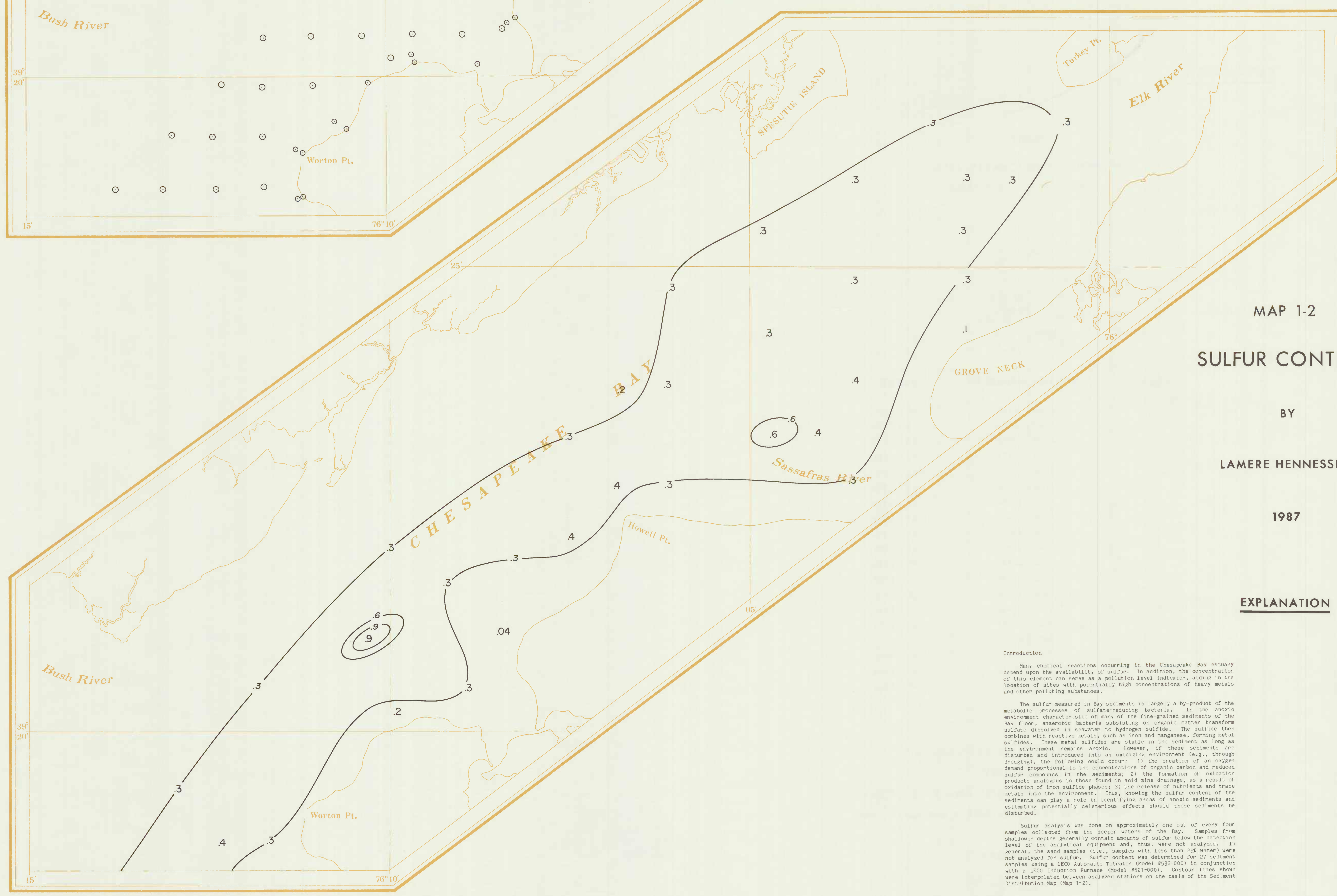

MAP 1-2

SULFUR CONTENT

BY

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1987

EXPLANATION

Introduction

Many chemical reactions occurring in the Chesapeake Bay estuary depend upon the availability of sulfur. In addition, the concentration of this element can serve as a pollution level indicator, aiding in the location of sites with potentially high concentrations of heavy metals and other polluting substances.

The sulfur measured in Bay sediments is largely a by-product of the metabolic processes of sulfate-reducing bacteria. In the anoxic environment characteristic of many of the fine-grained sediments of the Bay floor, anaerobic bacteria subsisting on organic matter transform sulfate dissolved in seawater to hydrogen sulfide. The sulfide then combines with reactive metals, such as iron and manganese, forming metal sulfides. These metal sulfides are stable in the sediment as long as the environment remains anoxic. However, if these sediments are disturbed and introduced into an oxidizing environment (e.g., through dredging), the following could occur: 1) the creation of an oxygen demand proportional to the concentrations of organic carbon and reduced sulfur 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 into the environment. Thus, knowing the sulfur content of the sediments can play a role in identifying areas of anoxic sediments and estimating potentially deleterious effects should these sediments be disturbed.

Sulfur analysis was done on approximately one out of every four samples collected from the deeper waters of the Bay. Samples from shallower depths generally contain amounts of sulfur below the detection level of the analytical equipment and, thus, were not analyzed. In general, the sand samples (i.e., samples with less than 25% water) were not analyzed for sulfur. Sulfur content was determined for 27 sediment samples using a LECO Automatic Titrator (Model #532-000) in conjunction with a LECO Induction Furnace (Model #521-000). Contour lines shown were interpolated between analyzed stations on the basis of the Sediment Distribution Map (Map 1-2).

Distribution

Dry weight percent sulfur in this section of the Bay averages 0.32%, ranging from less than 0.10% in the coarsest-grained sediments to 0.92% in the finer-grained ones (Table 1). Sulfur content is uniformly low throughout the area, except for two isolated pockets with anomalously high sulfur concentrations. Both of these coincide with spoil disposal areas. Consistently low values of sulfur across sediment types other than sands are attributable to the diminishing concentrations of sulfate in the overlying water column as seawater is diluted by freshwater. Bacterially-mediated sulfate reduction is independent of sulfate concentration at concentrations greater than 10 millimoles (mM) (Postgate, 1951). Below that limit, the growth of sulfate-reducing bacteria and, in turn, the rate at which sulfate is converted to sulfide, are controlled by sulfate concentration. The salinity corresponding to a concentration of 10 mM sulfate is approximately 13 ppt. Average salinity of bottom water measured at the southern boundary of the mapped area varies seasonally between 4-8 ppt (Pritchard, 1971). Thus, the reduction of sulfate to sulfide in these sediments is sulfate-limited.

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

TYPE	RANGE % S	MEAN % S	NUMBER
SAND	0.04-0.06	0.05	2
SILTY SAND	0.27-0.35	0.31	2
CLAYEY SAND	-	-	-
(SANDS)	(0.04-0.35)	(0.18)	(4)
SILT	-	-	-
SANDY SILT	-	-	-
CLAYEY SILT	0.24-0.92	0.38	11
(SILTS)	(0.24-0.92)	(0.38)	(11)
CLAY	-	-	-
SANDY CLAY	-	-	-
SILTY CLAY	-	-	-
(CLAYS)	-	-	-
SAND/SILT/CLAY	0.18-0.62	0.30	12
TOTAL	0.04-0.92	0.32	27

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LEGEND

SULFUR VALUE % DRY WEIGHT

CONTOUR INTERVAL 0.3%