UNITED STATES DEPARTMENT OF INTERIOR
U.S.GEOLOGICAL SURVEY

SUMMARY OF GEOCHEMICAL COASTAL ZONE RESEARCH OF THE SOUTHEASTERN, UNITED STATES

by

Charles W. Holmes
U.S.Geological Survey
MS 972, Denver Federal Center
Denver, CO., 80225

Open-File Report

92-357

This report is preliminary and
has not been edited or reviewed
for conformity with Geological
Survey standards or nomenclature

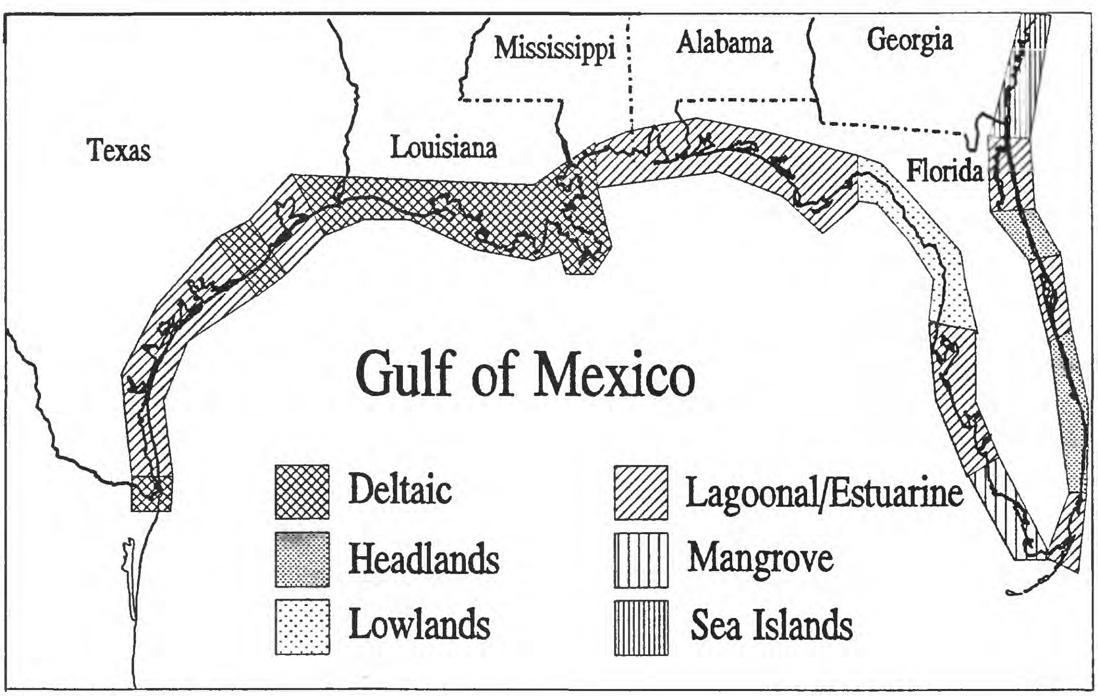
TABLE OF CONTENTS

List of figures

INTRODUCTION

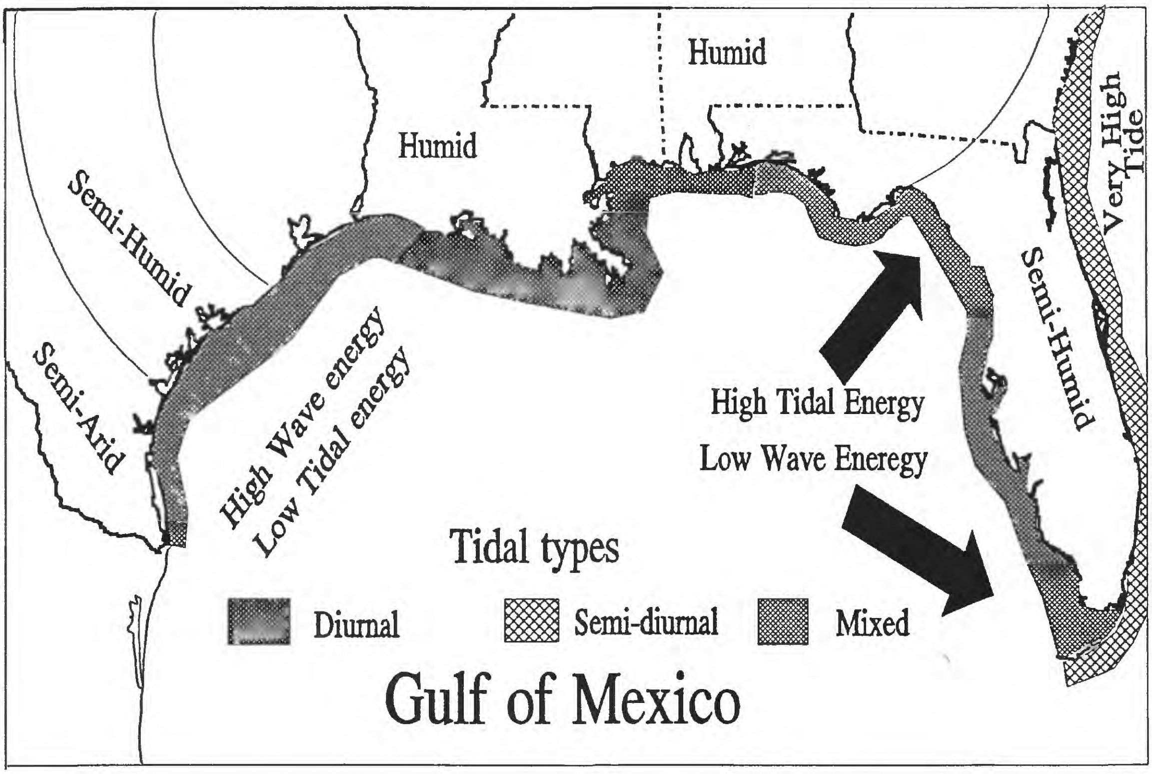
Assessing the enrichment or depletion of chemical elements in coastal regions requires consideration of geologic, mineralogic, hydrologic and biologic processes. These processes are controlled by the climatic, the geologic, and/or the geomorphic setting of the region. The coastal zone of Southeastern United Stated contains a variety of geomorphic features from the arid tidal flats of South Texas to the tropical mangrove coastline of south Florida (Fig.1). This region is also effected by a broad spectrum of wind and tidal energy; from the high wind-low tidal regime of the western Gulf to the low wind-high tidal regime of the Georgia sea islands, plus an occasional tropical storm (Fig. 2). The combination of geomorphic form and climatic regime plays a significant role on the geochemistry of any particular region. The rocks that are drained by the rivers entering the coastal zone, also, play

Figure 1 -- Distribution of geomorphic features in the coastal zone of the southeastern United States.



a significant geochemical role; the carbonate-phosphatic rocks of south Florida produce a different chemistry than the siliclastic rocks of south Texas.

Figure 2 -- Coastal climatic zones for the southeastern United States.



This report presents the status and availability of background data, a summary of knowledge on the distribution of chemical constituents, a bibliography of investigations for the costal regions in the southeastern United States, and the availability of material for continued study. The following is a summary of geochemical knowledge that demonstrates the disparity of information in the southeastern costal zone.

WESTERN GULF OF MEXICO

Texas coastal zone -- The geochemistry of the Texas coastal zone has been examined by many investigators beginning with those associated with API Project 51 (Shepard and others, 1960). From the early 1960's, the students and faculty of the University of Texas Marine Laboratory preformed coastal zone topical studies. The unpublished results of these studies are on file in the library at Port Aranasas, Texas.

Beginning in the early 1970's until the closing of the laboratory in 1985, regional geochemical studies were preformed by personnel of the U.S.Geological Survey Facility in Corpus Christi, Texas. The largest coastal project of this office began in 1975 in cooperation with the Bureau of Economic Geologic at the University of Texas, Austin, Texas. This study yielded 6672 samples at a spacing of approximately one mile (1.67 km.). These samples were analyzed for total organic carbon (6377), for major and trace metal concentrations (2104) and for size distribution (2750). The data from this program is reported in a series of publications by the Bureau of Economic Geology, the University of Texas, Austin (Submerged Lands of Texas Series). The results of this investigation with smaller regional studies (Holmes, 1974, Berryhill and Trippet, 1981, Hill, 1979, Sims, 1975, and Elias, 1973 and others) have produced a large amount of geochemical information for the Texas coastal zone.

Presently, there are two major programs underway to monitor environmental degradation; the National Oceanic and Atmospheric Agency's (NOAA) Status and Trends/Mussel watch program and Environmental Protection Agency's (EPA) Environmental Monitoring and Assessment Program (EPMAP). These and continuing works by cooperative investigators at Texas A. and M. University, Galveston and at the University of Texas Marine Laboratory, Port Aransas will provide more information that will be added to the regional data. Other site specific chemical data are in the files of the U.S.Army Corp. of Engineers and the Texas Water Quality Board (U.S.Army Corp. of Engineers in Corpus Christi and Galveston and the Texas Water Quality Board in their headquarters in Austin, Texas).

Rio Grande and Laguna Madre -- The southern border of the Texas Coastal zone is the Rio Grande delta. This feature is presently being destroyed, in part due to the cessation of sediment supply and in part high wave and tidal energy. Thus the coastal zone surrounding the mouth of the river and extending north into the Laguna Madre is dominated by sands and sandy-muds. Chemical data from the area indicate higher than background concentrations of chromium and manganese that are attributed to heavy mineral concentrations (White and others, 1986; Holmes, 1969). Within semi-arid Laguna Madre, the climate and physical processes have combined to form a marine sabkha. The sabkha chemistry of this region has been studied by Amdurer (1978), Gudramovics (1981) and Long and others (1985). Amdurer(1978) and Gudramovics (1981) concentrated on major element chemistry and proved that the area is consistent with sabkha hydrology. Long and others (1985) examined the trace element chemistry of the deposits. They concluded that trace metals appeared to be concentrated by fluids flowing through cyanobacterial layers. This conclusion is consistent with the unpublished data of Holmes, (1970) who found high concentrations of molybdenum in algal mats of the northern tidal flats in Laguna Madre.

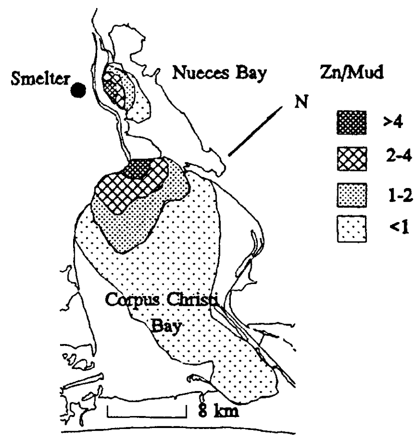
The only bay/estuary in the Laguna Madre region is Baffin Bay. Because this bay is cut off from the open marine environment, it lacks normal estuarine circulation. As it lies in a semi-arid zone of the coast, the waters are often hypersaline. The combination of the hypersalinity and high energy leads to the production of oolites, that are found in abundance at the mouth of the bay. Because of the unique character of the bay, it serves as a natural laboratory for the University of Texas Marine Laboratory at Port Aransas and is the focus for many investigations into the organic and inorganic processes.

Central Bays -- From Corpus Christi north to the Texas-Louisiana border, a series of lagoons exist inside an almost continuous barrier island. Despite the proximity to Laguna Madre, these lagoons are different as they lie within a more humid climate zone. Most of these bays and lagoons are fed by rivers that produce waters lower in salinity than the open Gulf. Unlike the sandy floor of Laguna Madre, the sediments of the bays are muds with coarser material confined to the rims. Within all the bays there are many oyster reefs that act as minitraps for sediment.

These bays are shallow, averaging about 3 meters. The rates of sedimentation in these bays average about 32cm/100 years, with highest rates near the deltas. The infilling of the bays is, however, inhibited by the climatic dynamics of the region. This section of the Gulf of Mexico has strong shifts in wind energy. These strong wind shifts occur from late September till late April. When a front approaches the coastline, strong southeasterly winds are produced. The turbulence created by this wind suspends much of the sediment. As the front passes the coastline, the wind shift to a northern direction flushing the bays, carrying the suspended material onto the shelf. Because, anthropogenic material is flushed with the suspended material. Concentrations of lead and barium on the south Texas shelf is the result of this process (Holmes and Martin, 1977).

Trace element concentrations in the bays and the offshore areas (table 1) show only a few areas with significant enrichment of metals (White and others, 1989). In Corpus Christi Bay, elevated barium concentrations are the result of the extensive drilling (Over 500 wells) The zinc is derived from the harbor (Fig. 3) (Holmes, 1974, Holmes and others, 1974, and White and others, 1983). Except the Houston Ship channel, Matagorda/Lavaca Bay complex and Sabine lake, there is no other body of water that has significantly elevated concentration of chemical elements.

Figure 3 -- Zinc/mud ratio in Corpus Christi Bay, Texas. From White and others, 1983.

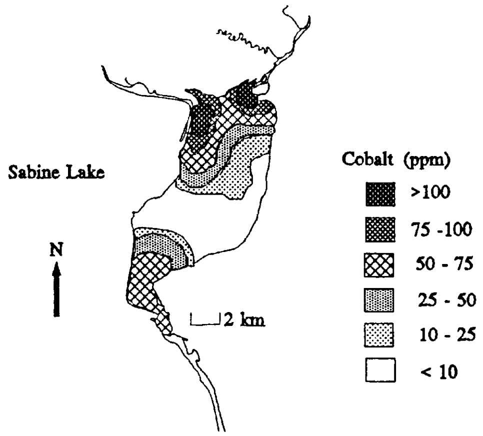


The elevated zinc and related elements in Corpus Christi Bay and mercury in Matagorda/Lavaca Bay are the direct result of industrial input; a zinc smelter in Corpus Christi Harbor and an aluminum refinery on Lavaca Bay. In both cases these facilities are located on channels that acts as a conduit for fresh marine waters. For Corpus Christi, the channel-bay interaction is seasonal. During the summer, the harbor water becomes anoxic and metals such as zinc react with the increased H_2S, precipitating sulfides. With the onset of winter and the passage of northers oceanographic conditions are changed. A strong flow of bottom water is set up, bringing "fresh" marine waters into the ship channel. This flow is strong enough to cause turbulence, suspending contaminated bottom sediment. As result some precipitated sulfides are dissolved. The metals released complex with chlorine and are transported to the bay via the surface return flow. At the mouth of the harbor, the enriched waters are mixed with turbid bay waters and the metals are adsorbed on suspended sediment and deposited near the mouth of the channel.

In Matagorda/Lavaca bay complex the distribution of mercury is believed to be linked to water flow in the ship channel also. Here, there is no indication of a seasonality. With this exception, the processes of precipitation, stirring by tidal currents, transport as chloride complexes and redeposition on suspended sediment are similar (Holmes, 1977).

The high metal concentrations within the Houston Ship channel and Galveston bays are the direct results of effluent from the area's industrial complex. The cause of the high cobalt in Sabine lake is presently unknown (Fig. 4). This area has been resampled and there is no basic change in metal distribution (White and others, 1987).

Figure 4 -- Cobalt concentration in bottom sediments of Sabine Lake, Texas.



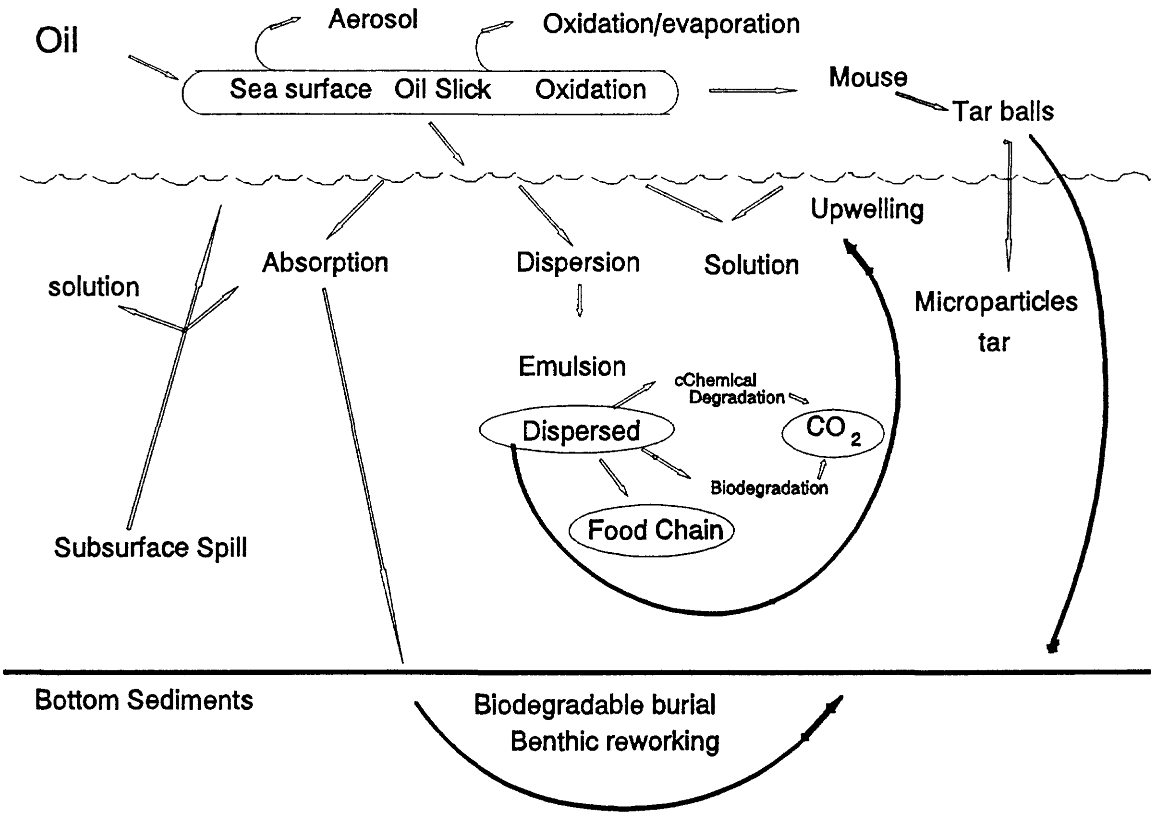
There has been no concentrated effort to determine the background levels of organic constituents comparable to the trace metal programs. There has been much work on the distribution of selected organic components by the University of Texas Marine Science laboratory and researchers at Texas A. and M. University(mostly deep water). Currently, there are two programs that may supply some insights to the distribution of organic material in the Texas Coastal Zone; the National Status and Trends Program (NOAA) and the Environmental Monitoring and Assessment Program (EPA). As these programs are in the initial stages and it is hoped that they will provided information of the distribution and processes that affect the distribution of organic materials. Fig 5 diagrammatically presents what is known about the effects of oil spilled into marine systems.

NORTHERN GULF OF MEXICO

Northwestern Coastal Zone -- From Sabine lake to the mouth of the Mississippi River, little information on the distribution of chemical constituents is available. Because of the lack of major industrialization, biological resources (major shrimp grounds lie further offshore and oyster reefs are far from the industrial sites) and urbanization, there is apparently no urgent reason to have chemical information for this area.

This region, an area of low tidal and wind energy (excepting tropical storms) is part of the Mississippi delta plain and is undergoing subsidence and erosion. Currently, there is a major effort underway to understand the geologic framework of this region, but there are no comparable chemical investigations, save the Status and Trends Program and the Environmental Assessment Program (EPA). One study underway in the area is a project sponsored by the Climate Program of the U.S.G.S. This study is focusing on the role of saline encroachment on the production of methane. This study may provide some information on geochemical processes in the region and may provide background information for further studies.

Figure 5 -- Fate of oil in the marine environement. Graph from Preston, 1988.



Delta of the Mississippi River -- The Mississippi River is the most significant river entering the Gulf of Mexico. As it drains the industrialized central part of the country, it has the potential to be a major source of pollution of the Gulf Coast Zone and the Gulf of Mexico. The present mouth of the river at the shelf edge, with the major currents sweeping effluent further seaward along the shelf edge, Thus the effect on any contaminant carried by the river on the coastal zone is unknown.

There have been a few investigations on the disposition of contaminants from the river. Available data has been summarized by Trefry (1977) and suggest that the suspended material carries >90% of the heavy metal load of the river. Selective leaching experiment data from the suspended material showed that hydrous oxides and aluminosilicate lattices are the primary phases of the particulate material. During the low flow stages of the river, there was an increase of organic material with an associated decrease in particulate iron and aluminum but an increase in manganese, zinc, copper and cadmium. The increase sedimentation rates and seasonal biological activity produce a reflux of manganese from the sediment to the overlying waters. This reintroduction of manganese is caused by the interaction of chemical and biological activity: sequestration of elements during the winter when biological activity is slowed and release during the summer when biological activity in increased.

Northeastern Gulf of Mexico -- From the mouth of the Mississippi River to the Big Bend region of Florida is a series of lagoons/ bays, the largest of which is Mississippi Sound. There has been a series of studies within this region by the Ocean Springs Laboratory of the University of Southern Mississippi and other Universities of the Mississippi Sea Grant Consortium. The results of these studies have been summarized (table 2) by Isphording and others (1986). Comparison of this data with that from the Texas Gulf Coast is difficult because important information is missing: the distribution of samples and number of samples from each region. Isphording and others (1986) have suggested, based on metal levels, in the Mississippi Sound area that Mobile Bay is highly impacted, Apalachicola bay as moderately impacted, and Perdido and Pensacola Bays are the least affected. This is somewhat of an enigma, since Apalachicola Bay is the least urbanized or industrialized of the bay systems.

EASTERN GULF OF MEXICO

Geochemical data from the coastal zone of the eastern Gulf of Mexico is very sparse. Except for studies in Tampa Bay and Charlotte Harbor, the remaining Florida coast is poorly known. Even in Tampa Bay and Charlotte Harbor, the level of studies and information, at this time, does not approach the quantity of data and information in the coastal zone of the western Gulf.

Tampa Bay -- The chemical data from Tampa Bay has been summarized by Doyle and others, (1985, 1989). Data is being collected by the National Status and Trends Program, but this is being collected at suspected contaminated sites throughout the bay. This program and the EMAP (Environmental Monitoring Assessment Program) investigation by the Environmental Protection Agency will provided some information on the health of the bay, but this information will be limited to those areas sampled. In fact only the northern part of the Tampa Bay region is included in the EPA program.

Charlotte Harbor -- Chemical data for this region is less than for Tampa Bay. Froehlich and others (1985) studied the distribution of arsenic, barium, germanium, tin and nutrient biochemistry in the bay. This bay was chosen because in drains the phosphate mining region of south Florida. They found a very productive diatom bloom present at the mouth of the Peace river. This "front" is responsible for the complete removal of the fluvial fluxes of nitrate, silica, and inorganic germanium. The bloom had only a slight effect on the distribution of arsenic. The barium was highest in the region of mid-salinity concentrations that was attributed to releases from phosphate clay slime. Information of other chemical constituents apparently is non-existent.

Florida-Georgia coastal Zone -- Extensive data reported to have been compiled by the State of Florida have not yet been published and were unavailable as of this writing. There have been topical studies made in Biscayne Bay region and in the Jacksonville region by the Corp of Engineers. In addition some coastal zone chemical studies have been carried out by members of the Harbor Branch Foundation in the St. John River, by students at Florida Atlantic University, and students at the University of Miami. But the information from these investigations have no yet found its way into the literature. In the Sea-Island region of southeastern Georgia, students and the faculty at the Sidaway Institute have investigated trace metal transport from the fresh to marine systems, but there is very little systematic investigations such as the Western Gulf available.

References Cited

Amdurer, M 1978, Geochemistry, hydrology, and mineralogy of the Laguna Madre Flats, South Texas. M.S.Thesis, University of Texas, Austin, Texas.(Unpublished).

Berryhill, H.L.Jr., and Trippet, A.R., 1981, Map showing trace-metal content and texture of surfacial bottom sediment in the Corpus Christi 1 o x2 o quadrangle: U.S.Geological Survey Miscellaneous Investigations Series, Map 1-1287-B, 1p.

Doyle, L.J., Van Fleet, E.S., Sackett, W.M., Blake, N.J., and Brooks, G.R., 1985, Hydrocarbon levels in Tampa Bay, Final Report to Florida Department of Natural Resources, St. Petersburg, Florida, University of South Florida, 193p.

Doyle, L.J., Brooks, G.R., Fanning, K.A., Van Fleet, E.S., Byrne, R.H., and Blake, N.J., 1989, A characterization of Tampa Bay sediments. St. Petersburg, Fla, University of South Florida, Center for Nearshore Marine Science, 99p.

Elias, R.W., 1973, The role of sea grasses and benthic algae in the biogeochemistry of trace metals in Texas estuaries, Ph.D. Dissertation, University of Texas, Austin, Texas, 274 p.

Froehlich, P.N., Kaul, L.W., Byrd, J.T., Andreas, M.O., and Roe, K.K., 1985, Arsenic, barium, germanium,tin,dimethylsulfide and nutrient biogeochemistry in Charlotte Harbor, Florida, A phosphorus-enriched estuary, Estuarine,Coastal and Shelf Science, v.20, pp. 239-264.

Geoscience Inc., 1983, A report of the collection and analysis of sediment and water samples, Pascagoula Harbor and Mississippi Sound: U.S.Army Corp. of Engineers Contract No. DACW01-83-C-0027, 77p.

Gudramovics, R., 1981, A geochemical and hydrological investigation of a modern coastal marine sabkha, M.S. Thesis, Michigan State University, East Lansing, Michigan, 107p.

Hill, G.W., 1979, Correlation of trace elements concentrations in marine benthonic polychaetes with their host sediments, U.S.Geological Survey Open File Report 79-393,10p.

Holmes, C.W., 1986, Trace metal seasonal variations in Texas marine sediments, Marine Chemistry, v.20, pp. 13-27.

Holmes, C.W., 1977, Effects of dredge channels on trace-metal migration in an estuary, Journal of Geological Research, U.S.Geological Survey, v.5, p. 243-251.

Holmes, C.W., 1974, Maps showing the distribution of selected elements in surface-bottom sediments of Corpus Christi and Baffin Bays, Texas, U.S.Geological Survey Miscellaneous Field Studies 571, 2p.

Holmes, C.W., 1969, Geochemical exploration in the Gulf of Mexico, Ocean Industry, v.4, p. 49-52.

Holmes, C.W., Slade, E.A., and McLerran, C.J., 1974, Migration and redistribution of zinc and cadmium in marine estuarine system, Environmental Science and technology, v.8,pp. 255-259.

Isphording, W.C., 1985, Sediment, dispersal and partitioning of trace metals in Coastal-Alabama estuarine sediments: Final Technical Report, MASGP-83-035, Grant NO. NA81AA-D-00050, 29p.

Isphording, W.C., Stringfellow, J.A. and Flowers, G.C., 1985, Sedimentary and geochemical systems in transitional marine sediments in the northeastern Gulf of Mexico, Transaction of the Gulf Coast Association of Geological Societies, v. 35, 397-408.

Long, D.T., Lyons, W.B., and Gaudett, H.E., 1985, Trace -metal concentrations in modern marine sabkhas, Chemical Geology, v.53, pp.185-189.

Lytle, T.F. and Lytle, J.S., 1982, Heavy metals in oysters and clams in St.Louis Bay, Mississippi: Bulletin of Environmental Contamination and Toxicology, v. 29, pp. 50 - 57.

O'Brien, P.A., 1980, The geochemistry of trace metals in the bottom sediments of Mississippi Sound: M.S. Masters Thesis, The University of Mississippi, Oxford, Mississippi, 67 p.

Olinger, W.,Rogers,R.,Fore,P.,Todd, R., Mullins, B., Bisterfield, F. and Wise, L., 1975, Environmental and recovery studies of Escambia Bay and the Pensacola Bays systems, Florida: U.S. Environmental Protection Agency, EPA 904/9-76-016, Atlanta, GA, 438p.

Preston, M.R., 1988, Marine pollution <u>in</u> Riley, J.P. (ed) Chemical Oceanography, v.9, Acdemic Press, pp. 53-176.

Reynolds, W.R. and Thompson, D.A., 1976, Occurrence and distribution of clay minerals and trace metals in the bottom sediment of Biloxi Bay, Mississippi: Water Resources Institute, Mississippi State University, Oxford, MS. 41 p.

Shepard, F.P., Phleger, F.B., and van Andel, T.H., 1960, Recent sediments, northwest Gulf of Mexico, American Association of Petroleum Geologist, Tulsa, OK. 394 p.

Sims, R.R., 1975, Selected chemistry of primary producers, primary consumers and suspended matter from Corpus Christi Bay and the northwest Gulf of Mexico, M.S. Thesis, Texas A and M University, College Station, Texas, 65p.

White, W.A., Calnan T.R., Morton, R.A., Kimble, R.S., Littleton, T.G., McGowen, J.H., Nance, H.S., and Schmedes, K.E., 1983, Submerged lands of Texas, Corpus Christi Area: sediments, geochemistry, benthic macroinvertebrates, and associated wetlands, Bureau of Economic Geology, The University of Texas, Austin, Texas, 154p.

White, W.A., Calnan T.R., Morton, R.A., Kimble, R.S., Littleton, T.G., McGowen, J.H., Nance, H.S., and Schmedes, K.E., 1985, Submerged lands of Texas, Galveston-Houston Area: sediments, geochemistry, benthic macroinvertebrates, and associated wetlands, Bureau of Economic Geology, The University of Texas, Austin, Texas, 145p.

White, W.A., Calnan T.R., Morton, R.A., Kimble, R.S., Littleton, T.G., McGowen, J.H., Nance, H.S., and Schmedes, K.E., 1986, Submerged lands of Texas, Brownsville-Harlingen Area:sediments,geochemistry, benthic macroinvertebrates, and associated wetlands, Bureau of Economic Geology, The University of Texas, Austin, Texas, 138p.

White, W.A., Calnan T.R., Morton, R.A., Kimble, R.S., Littleton, T.G., McGowen, J.H., and Nance, H.S., 1987, Submerged lands of Texas, Beamount-Port Arthur Area:sediments,geochemistry, benthic macroinvertebrates, and associated wetlands, Bureau of Economic Geology, The University of Texas, Austin, Texas, 110p.

Appendix I

The following bibliography is a compilation of major investigations on the geochemistry of the coastal zone in the southeastern United States.

Amduer, M., 1977, Geochemistry, hydrology, and mineralogy of noncarbonate coastal sabkha, Laguna Madre, Texas: American Association of Petroleum Geologists Bulletin 61, no. 5, p. 760.

Andren, A.W., 1973a, The geochemistry of mercury in three estuaries from the Gulf of Mexico: Tallahassee, Florida State University, Ph.D. thesis, 176 p.

____1973b, The geochemistry of mercury in three estuaries from the Gulf of Mexico: Dissertation Abstracts International, v. 34, no. 4, p. 1657B.

Andren, A.W., and Harriss, R.C., 1973, Methylmercury in estuarine sediments: Nature 245, no. 5423, p. 256-257.

Bales, J.D. and Holley, E.R., 1987, Analysis of estuarine tracer gas transport and desorption: in Ragan, R.M. (ed) Proceedings of the 1987 National Conference on Hydraulic Engineering, American Society of Civil Engineers, p. 974-979.

Barnard, L.A., 1982, Marine manganese accretions; nodule-micronodule comparisons among major ocean basins: College Station, Texas A&M University, Ph.D. thesis, 291 p.

Baron, J.A., Thibodeaux, L.J., Reible, D.D., Templet, P.H., and Henry, C.B., Jr., 1990, Laboratory simulation of diffusion in contaminated marine sediments: Estuaries, v. 13, no. 1, p. 81-88.

Baskaran, M., Coleman, C., Benoit, G., and Santschi, P.H., 1990, Natural radionuclides in Texas estuaries, AGU 1990 ocean sciences meeting: EOS, American Geophysical Union Transactions, v. 71, no. 2, p. 71.

Benoit, G., Coleman, C., Cantu, A., Griffin, L., and Santschi, P.H., 1990, Trace metals in Texas estuaries, AGU 1990 ocean sciences meeting: EOS, American Geophysical Union Transactions, v. 71, no. 2, p. 112.

Berryhill, H.L., Jr., Shidler, G.L., Holmes, C.W., Barnes, S.S., Hill, G.W., Martin, E.A., and Pyle, C.A., 1978, Environmental studies, South Texas outer continental shelf, 1976; Geology: National Technical Information Service, 652 p.

Berryhill, H.L., Jr., Shidler, G.L., Holmes, C.W., Hill, G.W., Barnes, S.S., and Martin, R.G., Jr., 1976, Environmental studies, South Texas outer continental shelf, 1975; Geology, pt. I, Geologic description and interpretation; pt. II, Inventory of data archived and analyzed: National Technical Information Service, 353 p.

Berryhill, H.L., Jr., and Trippet, A.R., 1981a, Map showing trace-metal content and texture of surficial bottom sediments in the Corpus Christi 1° X 2° quadrangle, Texas: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-1287-B.

____1981b, Map showing trace-metal content and texture of surficial bottom sediments in the Beeville 1° X 2° quadrangle, Texas: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-1288-B.

Bilyard, G.R., 1987, The value of benthic infauna in marine pollution monitoring studies: Marine Pollution Bulletin 18, p. 581-585.

Botello, A.V., Mandelli, E.F., Macko, S., and Parker, P.L., 1980, Organic carbon isotope ratios of Recent sediments from coastal lagoons of the Gulf of Mexico, Mexico: Geochimica et Cosmochimica Acta 44, no. 3, p. 557-560.

Boyle, E.A., Reaid, D.F., Huested, S.S., and Hering, J., 1984, Trace metals and radium in the Gulf of Mexico; an evaluation of river and continental shelf sources: Earth and Planetary Science Letters, v. 69, no. 1, p. 69-87.

Brannon, D.P., and Irish, G.J., 1985, Satellite remote sensing and geographic information systems applied to biogeochemical flux estimates: Estuaries, v. 8 (2BO), p. 7a.

Breland, J.A., II, 1980, Chemical and physical characteristics of a saline geothermal submarine spring off Florida's southwest coast: St. Petersburg, University of South Florida, MS thesis.

Brooks, J.M., 1975, Sources, sinks, concentrations and sub-lethal effects of light aliphatic and aromatic hydrocarbons in the Gulf of Mexico: College Station, Texas A&M University, Ph.D. thesis, 362 p.

Broutman, M.A., and Leonard, D.L., 1988, The quality of shellfish growing waters in the Gulf of Mexico: National Oceanographic and Atmospheric Agency, Rockville, Md.

Brown, L., Sacks, I.S., Tera-Fouad, Klein, J., and Middleton, R., 1981, Beryllium-10 in continental sediments: Earth and Planetary Science Letters, v. 55, no. 3, p. 370-376.

Burnett, W.C., Cowart, J.B., and Deetae, Suchint, 1990, Radium in the Suwannee River and estuary; spring and river input to the Gulf of Mexico: Biogeochemistry, v. 10, no. 3, p. 237-255.

Canfield, D.E., and Berner, R.A., 1987, Dissolution and pyritization of magnetite in anoxic marine sediments: Geochimica et Cosmochimica Acta 51, no. 3, p. 645-659.

Capuzzo, J.M., Moore, M.N., and Widdows, J., 1988, Effects of toxic elements in the marine environment: predictions of impacts from laboratory studies: Aquatic Toxicology, v. 11, p. 19-28.

Cardoso, J.B., and Clarke, O.M., Jr., 1985, Use of Alabama peat as an adsorbent for heavy metals: MRI (Alabama) Technical Report Series, 10 p.

Caughey, M.E., 1988, Biogeochemistry of organic matter deposition and diagenesis in Bering-Chukchi and Gulf of Mexico sediments: Austin, University of Texas, Ph.D. thesis, 162 p.

Commeau, R.F., Paull, C.K., Commeau, J.A., and Poppe, L.J., 1987, Chemistry and mineralogy of pyrite-enriched sediments at a passive margin sulfide brine seep; abyssal Gulf of Mexico: Earth and Planetary Science Letters, v. 82, no. 1-2, p. 62-74.

Custodi, G.L., 1971, A survey of mercury in the Gulf of Mexico: College Station, Texas A&M University, MS thesis.

Davis, D.R., 1968, The measurement and evaluation of certain trace metal concentrations in the nearshore environment of the northwest Gulf of Mexico and Galveston Bay: College Station, Texas A&M University, Ph.D. thesis, 80 p.

Deleon, I.R., Overton, E.B., and Laseter, J.L., 1982, The role of analytical chemistry in a toxic substance spill into the aquatic environment, in Albaiges, J., ed., Analytical techniques in environmental chemistry 2, Proceedings of the second international congress: CSIC, Institute of Bio-Org. Chemistry, Barcelona, Spain, p. 1-17.

Ehrhardt, M.G., 1971, The detection of petroleum hydrocarbons in shellfish by methods of oil analysis: Geological Society of America, v. 3, no. 7, p. 554.

Elder, J.F., and Dresler, P.V., 1988, Accumulation and bioconcentration of polycyclic aromatic hydrocarbons in a nearshore estuarine environment near a Pensacola (Florida) creosote contamination site: Environmental Pollution (1987), v. 49, no. 2, p. 117-132.

Fanning, K.A., 1978, Dissolved silica and the American Mediterranean, in Stewart, H. B., Jr., ed., CICAR II; Symposium on progress in marine research in the Caribbean and adjacent regions: U.N. Food and Agriculture Organization, Rome, Italy, FAO Fisheries Report, no. 2, p. 297-298.

Fanning, K.A., Breland, J.A., II, and Byrne, R.H., 1982; Radium-226 and radon-222 in the coastal waters of West Florida; high concentrations and atmospheric degassing: Science, v. 215, no. 4533, p. 667-670.

Fanning, K.A., and Pilson, M.E.Q., 1973, The lack of inorganic removal of dissolved silica during river-ocean mixing: Geochimica et Cosmochimica Acta 37, no. 11, p. 2405-2415.

Feldhausen, P.H., Palmer, H.D., Johnson, D., and Trefry, J.H., 1982, Weak acid trace metal fraction in eastern Gulf of Mexico bottom sediments: International Congress on Sedimentology 11, p. 140.

Fenner, F.D., 1983, The distribution and geochemistry of iridium in river suspended material and marine sediments: College Station, Texas A&M University, MS thesis, 63 p.

Fernandez, M., 1990, Surface water hydrology and salinity of the Anclote River estuary, Florida, U.S.Geological Survey water Resources Investigation 89-4046, 34p.

Fisher, J.C., 1988, Hydrologic data for the Salt Bayou estuary near Sabine Pass, Texas, October 1984 to March 1986: U.S.Geological Survey Open File Report 88-0499, 128p.

Fisher, J.C., 1983, Chemical and physical characteristics of water in estuaries of Texas, October 1976-September 1978: Texas Department of Water Resources Report 282, 215 p.

Fisher, J.C. and Grozier, R.U., 1985, Chemical and physical characteristics of water in estuarines of Texas, October 1978 -September 1983: U.S.Geological Survey Open File Report 85-0408, 243 p.

Fox, L.E., Sager, S.L., and Wofsy, S.C., 1985, Factors controlling the concentrations of soluble phosphorus in the Mississippi Estuary: Limnology and Oceanography, v. 30, no. 4, p. 826-832.

Fraser, T.H., 1986, Long term water quality characteristics of Charolett Harbor, Florida: U.S.Geological Survey Water Resources Investigations 88-4180, 213 p.

Froelich, P.N., Kaul, L.W., Byrd, J.T., Andreae, J.T., and Roe, K.K., 1985, Arsenic, barium, germanium, tin, dimethylsulfide and nutrient biogeochemistry in Charlotte Harbor, Florida--a phosphorus-enriched estuary: Estuarine, Coastal and Shelf Science, v. 20, no. 3, p. 239-264.

Fry, B., Scalan, R.S., and Parker, P.L., 1977, Stable carbon isotope evidence for two sources of organic matter in coastal sediments, seagrasses and plankton: Geochimica et Cosmochimica Acta 41, no. 12, p. 1875-1877.

Gambrell, R.P., Khalid, R.A., and Patrick, W.H., Jr., 1980, Chemical availability of mercury, lead, and zinc in Mobile Bay sediment suspensions as affected by pH and oxidation-reduction conditions: Environmental Science and Technology, v. 14, no. 4, p. 431-436.

Gilio, J.L., and Segar, D.A., 1976, Biogeochemistry of trace elements in Card Sound, Florida, in Thorhaug, A., and Volder, A., eds., Biscayne Bay: past, present, future: Coral Gables, University of Miami, Sea Grant Special Report, no. 5.

Goldberg, E.D., Griffin, J.J., Hodge, V., Koide, M., and Windom, H.L., 1979, Pollution history of the Savannah River estuary: Environmental Science and Technology, v. 13, no. 5, p. 588-594.

Gormly, J.R., and Sackett, W.M., 1975, Anthropogenic alteration of sedimentary organic carbon: Geophysical Research Letters, v. 2, no. 4, p. 197-200.

Gu-Deyu, I.N., and Trefry, J.H., 1986, The chemistry of sediment interstitial water from the Indian River lagoon, Florida: Florida Scientist, v. 49, no. 1, p. 11-12.

Guerin, W.F., and Braman, R.S., 1985, Patterns of organic and inorganic sulfur transformations in sediments: Organic Geochemistry, v. 8, no. 4, p. 259-268.

Hahl, D.C., and Ratslaff, K.W., 1969, Chemical and physical characteristics of water in estuaries of Texas, Sept. 1967-Sept.1968: Texas Water Quality Board Rep. 117, 96 p.

Hahl, D.C., and Ratslaff, K.W., 1971, Chemical and physical characteristics of water in estuaries of Texas, Sept. 1968-Sept.1969: Texas Water Quality Board Rep. 144, 162 p.

Hahl, D.C., and Ratslaff, K.W., 1972, Chemical and physical characteristics of water in estuaries of Texas, Sept. 1969-Sept.1970 : Texas Water Quality Board Rep. 144, 162 p.

Hanson, P.J., 1982, Measurement of zinc complexation by marine humic material in seawater using a complexometric titration technique: EOS, American Geophysical Union Transactions, v. 63, no. 3, p. 111.

Hedges, J., 1974a, Lignin compounds as indicators of terrestrial organic matter in marine sediments: Austin, University of Texas, Ph.D. thesis, 148 p.

____1974b, Lignin compounds as indicators of terrestrial organic matter in marine sediments, in Geophysical Laboratory, biogeochemistry: Washington, Carnegie Institute Yearbook, no. 73, p. 581-590.

Hill, J.M. 1978, Landsat assessment of estuarine water quality with specific reference to coastal land use: Ph.D. Dissertation, Texas A. and M. University, College Station, Texas, 226p.

Hinga, K.R., 1988, Seasonal predictions for pollutant scavenging in two coastal environments using a model based upon thorium scavenging: Marine Environmental Research 26, p. 97-112.

Ho, C.L., Schweinsberg, E., and Reeves, L., 1970, A study of the chemistry of water and surface sediments in Barataria Bay, Louisiana: Abstracts of papers, Joint southeast-southwest regional (ACS) meeting, p. 90.

Hoering, T.C., 1974, The isotopic composition of the carbon and hydrogen in organic matter of Recent sediments, in Geophysical laboratory, biogeochemistry: Washington, Carnegie Institute Yearbook, no. 73.

Holmes, C.W., 1974, Maps showing distribution of selected elements in surface-bottom sediment of Corpus Christi and Baffin Bays, Texas: U.S. Geological Survey Miscellaneous Field Studies Map MF-0571.

____1977, Effects of dredged channels on trace-metal migration in an estuary: U.S. Geological Survey Journal of Research, v. 5, no. 2, p. 243-251.

Honeyman, B.D., and Santschi, P.H., 1988, Metals in aquatic systems: predicting their scavenging residence times from laboratory data remains changes: Environmental Science and Technology, v. 22, p. 862-871.

Huang, W.Y., 1975, Sterols as the source indicator of sedimentary organic matters: Bloomington, Indiana University, Ph.D. thesis, 104 p.

Huang, W.Y., and Meinschein, W.G., 1975, Sterols as source indicators of organic materials in sediments: Geological Society of America Abstracts with Programs, v. 7, no. 7, p. 1123.

____1976, Sterols as source indicators of organic materials in sediments: Geochimica et Cosmochimica Acta 40, no. 3, p. 323-330.

Huerta, D.M.A., 1989, Geochemistry of trace metals associated with sedimentary pyrite from anoxic marine environments: College Station, Texas A&M University, Ph.D. thesis, 321 p.

Huerta, D.M.A., and Morse, J.W., 1990, Geochemistry of trace metals associated with sedimentary pyrite from anoxic marine sediments: EOS, American Geophysical Union Transactions, v. 71, no. 2, p. 98.

Incze, M.L., and Roman, M.R., 1983, Carbon production and export from Biscayne Bay, Florida; II, Episodic export of organic carbon: Estuarine, Coastal and Shelf Science, v. 17, no. 1, p. 61-72.

Iricanin, N., Trefry, J.H., and Vetter, T.W., 1985, Seasonal variations of interstitial water Mn in Mississippi delta sediments: EOS, American Geophysical Union Transactions, v. 66, no. 18, p. 278.

Isphording, W.C., 1982, Misinterpretation of environmental monitoring data; a plague on mankind!: Gulf Coast Association of Geological Societies Transaction, no. 32, p. 399-411.

____1983, Chemistry and partitioning of heavy metals in Mobile Bay, Alabama: Coastal Sedimentology Symposium, v. 6, p. 184-200.

____1985a, A comparison of basin sedimentology and geochemistry for bays, estuaries and coastal lagoons in the northern Gulf of Mexico, in Tilford, N.R., ed., Site selection, characterization, and design exploration: Association of Engineering Geologists Annual Meeting, v. 28, p. 65.

Isphording, W.C., 1985b, A comparison of basin sedimentology and geochemistry for bays, estuaries and coastal lagoons in the northern Gulf of Mexico: Association of Engineering Geologists Annual Meeting, v. 28, p. 65.

Isphording, W.C., and Flowers, G.C., 1985, Use of heavy metal partitioning as an indicator of environmental hazards: EOS, American Geophysical Union Transactions, v. 66, no. 46, p. 940.

Isphording, W.C., Flowers, G.C., and Stringfellow, J.A., 1984, Comparison of heavy metal partitioning behavior from bays and estuaries of the northern Gulf Coast: EOS, American Geophysical Union Transactions, v. 65, no. 45, p. 953.

Isphording, W.C., Helton, R.E., Jr., and Blount, G., 1983, Heavy metal discharge and faunal contamination in Mobile Bay, Alabama: The Journal of the Alabama Academy of Science, v. 54, no. 3, p. 137.

Isphording, W.C., and Stringfellow, J.A., 1985, Geochemical comparison of bay and estuarine sediments of the northern Gulf of Mexico: Geological Society of America Abstracts with Programs, v. 17, no. 2, p. 96.

Isphording, W.C., Stringfellow, J.A., and Flowers, G.C., 1985, Sedimentary and geochemical systems in transitional marine sediments in the northeastern Gulf of Mexico: Gulf Coast Association of Geological Societies Transactions, v. 35, p. 397-408.

Jasper, J.P., and Hayes, J.M., 1990, A carbon isotope record of CO_2 levels during the late Quaternary: London, Nature, v. 347, no. 6292, p. 462-464.

Jones, D.K., 1960, Organic and inorganic carbon in Recent sediments of the open gulf, barrier island and bay environments, Mustang Island, Texas: Austin, University of Texas, MS thesis, 53p.

Judge, R.M., and Curtis, F.W., Jr., 1979, Heavy metal distribution in Biscayne Bay sediments: Florida Scientist, v. 42, no. 4, p. 242-247.

Keeney-Kennicutt, W.L., and Presley, B.J., 1986, The geochemistry of trace metals in the Brazos River estuary: Estuarine, Coastal and Shelf Science, Florida, v. 22, no. 4, p. 459-477.

Kennicutt, M.C., and Brooks, J.M., 1982, The concentrations, fate, and cycling of volatile organic compounds in estuarine systems: International symposium on utilization of coastal ecosystems; planning, pollution and productivity abstracts. Atlantica, v. 5, no. 2, p. 66. Brazil, Fundacao Universidade de Rio Grande, Rio Grande 96200, Brazil.

Kennicutt, M.C., II, Keeney-Kennicutt, W.L., Presley, B.J., and Fenner, F., 1983, The use of pyrolysis and barium distributions to assess the areal extent of drilling fluids in surficial marine sediments: Environmental Geology, v. 4, no. 3-4, p. 239-249.

Ketchum, B.H., 1974, Movement of heavy metals and organohalogens through the food chains and the affects on populations and communities, in McIntyre, A.D., and Milles, C.F., eds., Ecology and Toxicology Research: New York, Pflum Press, p. 285-300.

Kraemer, T.F., 1975, Geochemical investigation of Pleistocene sediments from the American Mediterranean: Coral Gables, University of Miami, Ph.D. thesis, 163 p.

Lind, W.B., 1983, Chemical and physical characteristics of water in estuaries of Texas, October 1975-September 1976: Texas Department of Water Resources Report 275, 203 p.

Lloyd, R.M., 1964, Variations in the oxygen and carbon isotope ratios of Florida Bay mollusks and their environmental significance: Journal of Geology, v. 72, no. 1, p. 84-111.

Long, D.L., Lyons, W.B., and Gaudette, H.E., 1985, Trace-metal concentrations in modern marine sabkhas: Chemical Geology, v. 53, no. 3-4, p. 185-189.

Lytle, J.S., and Lytle, T.F., 1977, Sediment hydrocarbons as environmental indicators in the Northeast Gulf of Mexico, in Wolfe, D.A., ed., Fate and effects of petroleum hydrocarbons in marine ecosystems and organisms: Oxford, England, Pergamon Press, p. 404-412.

Lytle, T.F., 1970, The contribution of blue-green algae and marsh plants to the trace metal content of near-shore sediments: Joint Southeast-southwest regional (ACS) Meeting, Abstracts of Papers, p. 91.

____1973, Organic geochemistry of a coastal environment: Geological Society of America Abstracts with Programs, v. 5, no. 7, p. 723-724.

____1980, Environmental baseline survey of St. Louis Bay 1978: Analytical Chemistry, sec. 2, v. 9, Gulf Coast Research Lab, Ocean Springs, Miss.

Lytle, T.F., and Lytle, J.S., 1976, Assessment of hydrocarbon pollutants in Gulf and estuarine environments: Mississippi Academy of Science 21 (supplement), p. 78.

____1982, Heavy metals in oysters and clams of St. Louis Bay: Environmental Control and Toxicology Bulletin 29, p. 50-57.

____1990, Contaminants in sediments from the central Gulf of Mexico: Estuaries, v. 13, no. 1, p. 98-111.

Maeda, M., and Windom, H.L., 1982, Behavior of uranium in two estuaries of the Southeastern United States: Marine Chemistry, v. 11, no. 5, p. 427-430.

Malatino, A.M., 1980, Chemical quality of bottom sediment samples from Mobile Bay, Alabama: Alabama Coastal Board G.S.A. Contract No. 80-3052, 22 p.

Mangini, M.E., and Sackett, W.M., 1983, The pathway of carbon in Bayboro Harbor, Tampa Bay, via stable carbon isotope compositions: EOS, American Geophysical Union Transactions, v. 64, no. 52, p. 1064.

Manker, J.P., Hill, A.R., and Johnston, C.S., 1982, Toxic metal concentrations and distribution in Tavernier and Tarpon Basin, Florida Bay: Georgia Journal of Science, v. 40, no. 1-2, p. 21.

Mankiewicz, P.J., 1981, Hydrocarbon composition of sediments, water, and fauna in selected areas of the Gulf of Mexico and southern California marine environment: Los Angeles, University of California, Ph.D. thesis, 350 p.

Martin, D.F., and Martin, B., 1973, Implications of metal-organic compounds in red tide outbreaks, in Trace metals and metal organic interactions in natural waters: Ann Arbor Science, Ann Harbor, Mich., illustration (including sketch map), p. 339-362.

McDonald, T.J., 1988, Volatile organic compounds in Gulf of Mexico sediments: College Station, Texas A&M University, Ph.D. thesis, 250 p.

McGowen, J.H., Byrne, J.R., and Wilkinson, B.H., 1979, Geochemistry of bottom sediments, Matagorda Bay system, Texas: Texas University, Bureau of Economic Geology Circular 79-2, 63 p.

McKee, B.A., Booth, Greg, and Swarzenski, Pete, 1990, The fate of particulates and particle-reactive constituents in the Mississippi River/ocean mixing zone: EOS, American Geophysical Union Transactions, v. 71, no. 2, p. 71.

McLerran, C.J., and Holmes, C.W., 1974, Deposition of zinc and cadmium by marine bacteria in estuarine sediments: Limnology and Oceanography, v. 19, no. 6, p. 988-1001.

McPherson, B.F. and Miller, R.F., 1990, Nutrient distribution and variability in the Charolett Harbor estuarine system: Water Resources Bulletin, v.26, p. 67-88.

Metz, Simone, 1986, Metal enrichment processes in the marine environment: Florida Institute of Technology, Ph.D. thesis, 157 p.

Metz, Simone, and Trefry, J.H., 1983, Trace metal leaching of sediments as a function of pH: EOS, American Geophysical Union Transactions, v. 64, no. 52, p. 1030.

Miller, R.L., Kraemer, T.F., and McPherson, B.F., 1990, Radium and radon in Charolett Harbor Estuary, Florida: Estuarine, Coastal and Shelf Science, v.31,p. 439-457

Moffett, J.W., and Zika, R.G., 1988, Measurement of copper(I) in surface waters of the subtropical Atlantic and Gulf of Mexico: Geochimica et Cosmochimica Acta, v. 52, no. 7, p. 1849-1857.

Mousseau, R.J., and Williams, J.C., 1979, Dissolved hydrocarbons in coastal waters of North America: American Association of Petroleum Geologists Bulletin 63, no. 4, p. 699.

Onuf, C., and Quammen, M.L., 1990, Seagrass status and trends in the Laguna Madre of Texas: U.S. Fish and Wildlife Service, Research Information Bulletin.

Ortner, P.B., Kreader, C., and Harvey, G.R., 1983, Interactive effects of metals and humus on marine phytoplankton carbon uptake: Nature 301, no. 5895, p. 57-59.

Palacas, J.G., Gerrild, P.M., Love, A.H., and Roberts, A.A., 1976, Baseline concentrations of hydrocarbons in barrier-island quartz sand, northeastern Gulf of Mexico: Geology, v. 4, no. 2, p. 81-84.

Palacas, J.G., Swanson, V.E., and Love, A.H., 1968, Organic geochemistry of Recent sediments in the Choctawhatchee bay area, Florida--a preliminary report: U.S. Geological Survey Professional Paper 600-C, p. C97-C106.

Parker, P.L., 1963, Biogeochemistry of the stable isotopes of carbon in a marine bay: Geological Society of America Special Paper 73, p. 213.

Petasne, R.G., and Zika, R.G., 1987, Fate of superoxide in coastal sea water: Nature 325, no. 6104, p. 516-518.

Piotrowicz, S.R., Harvey, G.R., Boran, D.A., Weisel, C.P., and Springer, Y.M., 1984, Cadmium, copper, and zinc interactions with marine humus as a function of ligand structure: Marine Chemistry, v. 14, no. 4, p. 333-346.

Piotrowicz, S.R., Harvey, G.R., Springer, Y.M., Courant, R.A., and Boran, D.A., 1983, Studies of cadmium, copper, and zinc interactions with marine fulvic and humic materials in seawater using anodic stripping voltammetry, in Wong, C.S., Boyle, E.A., Bruland, K.W., Burton, J.D., and Goldberg, E.D., eds., Trace metals in seawater: Institute of Ocean Science, Sidney, BC, Canada, NATO Conference Series IV, Marine Sciences, no. 9, p. 699-717.

Presley, B.J., and Boothe, P.N., 1987, Trace elements in Gulf of Mexico sediment and oysters from the NOAA Status and Trends Program, Abstracts of papers: American Chemical Society, 194th ACS National Meeting, p. 194.

Presley, B.J., and Van Fleet, E.S., 1990, Environmental chemistry, in Phillips, N.W., and Larson, K.S., eds., Synthesis of available biological, geological, chemical, socioeconomic, and cultural resource information for the South Florida area: Continental Shelf Associates, Jupiter, Fla., p. 41-73.

Pulich, W., Barnes, S., and Parker, P., 1976, Trace metal cycles in seagrass communities, in Wiley, M., ed., Estuarine processes, VI, Uses, stresses and adaptation to the estuary: New York, Academic Press, p. 493-506.

Rabalais, N.N., and Turner, R.E., 1990, Louisiana continental shelf sediments--pigments and biogenic silica: EOS, American Geophysical Union Transactions, v. 71, no. 2, p. 70.

Reynolds, W.R., and Thompson, D., 1974, Clay minerals conference, Abstracts with Programs, v. 23, p. 52.

Rice, C.A., and Martin, E.A., 1981, Distribution of arsenic and selenium and sedimentation rates in Baffin Bay, Laguna Salada, Alazan Bay and Cayo del Grullo, Texas: Estuaries, v. 4, no. 3, p. 249-250.

Roman, M.R., Reeve, M.R., and Frogatt, J.L., 1983, Carbon production and export from Biscayne Bay, Florida; I, Temporal patterns in primary production, seston and zooplankton: Estuarine, Coastal and Shelf Science, v. 17, no. 1, p. 45-59.

Rotter, R.J., 1985, Pb-210 and Pu-239, 240 in nearshore Gulf of Mexico sediments: College Station, Texas A&M University, MS thesis, 157 p.

Ryan, J.D., Lewis, F.G., III, and Schropp, S.J., 1989, Metal and nutrient concentrations in Florida Bay sediments, in Tilmant, J.T., ed., Symposium on Florida Bay, a subtropical lagoon: Marine Science Bulletin 44, no. 1, p. 523.

Sackett, W.M., Brooks, G., Conkright, M., Doyle, L.J., and Yarbro, L., 1986, Stable isotope compositions of sedimentary organic carbon in Tampa Bay: Applied Geochemistry, v. 1, no. 1, p. 131-137.

Sackett, W.M., and Brooks, J.M., 1975, Origin and distributions of low molecular weight hydrocarbons in Gulf of Mexico coastal waters: American Chemical Society, Symposium Series 18, Marine Chemistry in the Coastal Environment, p. 211-230.

Santschi, P.H., Baskaran, M., and Benoit, G., 1990, Coagulation control of radionuclide and trace metal removal from coastal waters: EOS, American Geophysical Union Transactions, v. 71, no. 2, p. 71.

Sauer, T.C., Jr., 1981, Organic changes in open ocean and coastal surface waters: Organic Geochemistry, v. 3, no. 3, p. 91-101.

Sauer, T.C., Jr., Durell, G.S., Brown, J.S., Redford, David, and Boehm, P.D., 1989, Concentrations of chlorinated pesticides and PCBs in microlayer and seawater samples collected in open-ocean waters off the U.S. East Coast and in the Gulf of Mexico: Marine Chemistry, v. 27, no. 3-4, p. 235-257.

Sauer, T.C., Jr., Sackett, W.M., and Jeffrey, L.M., 1978, Volatile liquid hydrocarbons in the surface coastal waters of the Gulf of Mexico: Marine Chemistry, v. 7, no. 1, p. 1-16.

Schropp, S.J., Lewis, F.G., Windom, H.L., Ryan, J.D., Calder, F.D., and Burney, L.C., 1990, Interpretation of metal concentrations in estuarine sediments of Florida using aluminum as a reference element: Estuaries, v. 13, no. 3, p. 227-235.

Scott, M.R., 1987, Geochemistry of uranium and thorium series nuclides and of plutonium in the Gulf of Mexico; final report: College Station, Texas A&M University, Department of Oceanography Report DOE/EV/0352-T1, 5 p.

Scott, M.R., and Salter, P.F., 1979, Accumulation of plutonium in the Gulf of Mexico: EOS, American Geophysical Union Transactions, v. 60, no. 18, p. 283.

____1980, Anomalous plutonium concentrations in nearshore marine sediments of the Gulf of Mexico: American Geophysical Union Transactions, v. 61, no. 32, p. 572.

Segar, D.A., Gilio, J.L., and Pellenbarg, R.E., 1973, Some aspects of the biogeochemical cycles of trace metals in a subtropical estuary including ecosystem compartment models, in Symposium on environmental biogeochemistry: Logan, Utah State University, National Science Foundation, Ecol. Cent., Geochem. Soc., Organic Geochemistry Division, abstracts, p. 19-20.

Segar, D.A., Pellenbarg, B., and Gilio, J., 1972, Observations on the distribution of Ag, Cu, Co, Ni, Cd, Zn, Pb, Fe, and V in a coastal ecosystem: EOS, American Geophysical Union Transactions, v. 53, no. 11, p. 1030.

Sengupta, S., 1985, Definition of major subenvironments in Florida Bay: Geological Society of America Abstracts with Programs, v. 17, no. 7, p. 712.

Shiller, A.M., and Boyle, E.A., 1983, Laboratory mixing and field studies of Mississippi Plume trace metals: EOS, American Geophysical Union Transactions, v. 63, no. 18, p. 246.

Shiller, A.M., Buesseler, K., and Boyle, E.A., 1982, Trace metals in the Mississippi Plume: EOS, American Geophysical Union Transactions, v. 63, no. 45, p. 1009.

Shultz, D.J., and Calder, J.A., 1976, Organic carbon (13)C/(12)C variations in estuarine sediments: Geochimica et Cosmochimica Acta 40, no. 4, p. 381-385.

Snowden, J.O., 1961, Geologic and chemical environment of Biloxi Bay, Mississippi: Columbia, University of Missouri, MS thesis.

Sorensen, C.E., 1983, Relationship of geochemical, biological, and sedimentological parameters in basins in Florida Bay, Florida: Geological Society of America Abstracts with Programs, v. 17, no. 1, p. 12.

____1985, A study of active processes affecting grain-size and chemical distribution in three selected basins of Florida Bay, Florida: Wichita, Kansas, Wichita State University, MS thesis, 146 p.

Spalding, R.F., 1972, The contemporary geochemistry of uranium in the Gulf of Mexico distributive province: College Station, Texas A&M University, Ph.D. thesis, 268 p.

Stoker, Y.E., Henderson, S.E., McPherson, B.F., 1989, Hydralic and salinity characteristics of the tidal reach of the Peace River, southwestern Florida, U.S. Geological Survey, Water Resources Investigations 88-4162, 37p.

Stoker, Y.E., 1986, Water quality of the Charlotte Harbor estuarine system, Florida, November 1982- through October 1984: U.S. Geological Survey Open File Report 85-0563, 213 p.

Stoker, Y.E. and Karavitis, G.A., 1983, Literature assessment of the Charlotte Harbor estuarine system and surrounding area, Southwest Florida; U.S.Geological Survey Open File Report 83-0127, 143p.

Swart, P.K., Berler, D., McNeill, D., Guzikowski, M., Harrison, S.A., and Dedick, E.T.I., 1989, Interstitial water geochemistry and carbonate diagenesis in the subsurface of a Holocene mud island in Florida Bay, in Tilmant, J.T., ed., Symposium on Florida Bay, a subtropical lagoon: Marine Science Bulletin 44, no. 1, p. 490-514.

Taylor, R.J., and Presley, B.J., 1987, Field, laboratory, and modelling studies of Mn(II) oxidation in estuarine sediment: American Chemical Society, Abstracts of Papers, 193rd National Meeting, Denver, Colo.

Terco Corp., 1979, Literature review of Mississippi sound and adjacent areas: final report: U.S. Army Corp of Engineers, Mobile District, Contract No. DANI-78-C-0244, 23 p.

Todd, J.F., 1984, The aquatic geochemistry of the particle-reactive radionuclides: Old Dominion University, Ph.D. thesis, 213 p.

Trefry, J.H., III, 1977, The transport of heavy metals by the Mississippi River and their fate in the Gulf of Mexico: College Station, Texas A&M University, Ph.D. thesis, 236 p.

Trefry, J.H., Feldhausen, P.H., and Doyle, L.J., 1979, Provenance and distribution of trace metals in eastern Gulf of Mexico sediments: Geological Society of America Abstracts with Programs, v. 11, no. 4, p. 215-216.

Trefry, J.H., and Metz, S., 1984, Selective leaching of trace metals from sediments as a function of pH: Analytical Chemistry, v. 56, no. 4, p. 745-749.

Trefry, J.H., Metz, S., and Trocine, R.P., 1983a, Geochemical cycles of cadmium and lead for the Mississippi River and Delta: EOS, American Geophysical Union Transactions, v. 64, no. 52, p. 1021.

____1983b, Decreased inputs of cadmium and lead to the Gulf of Mexico from the Mississippi River: EOS, American Geophysical Union Transactions, v. 64, no. 18, p.245.

Trefry, J.H., Metz, S., Trocine, R.P., and Nelsen, T.A., 1985, A decline in lead transport by the Mississippi River: Science, v. 230, no. 4724, p. 439-441.

Trefry, J.H., and Presley, B.J., 1976a, Heavy metals in sediments from San Antonio Bay and the Northwest Gulf of Mexico: Environmental Geology, v. 1, no. 5, p. 283-294.

____1976b, Heavy metals in sediments from San Antonio Bay: Environmental Geology, v. 1, p. 283-294.

Trefry, J.H., Presley, B.J., and Shokes, R.F., 1977, Manganese flux from nearshore sediments: EOS, American Geophysical Union

Trefry, J.H., Sadoughi, M., Sullivan, M.D., Steward, J.S., and Barber, S., 1983, Trace metals in the Indian River lagoon, Florida: the copper story: Florida Scientist, v. 46, no. 3-4, p. 415-427.

Trefry, J.H., Sims, R.R., Jr., and Presley, B.J., 1976, The effects of shell dredging on heavy metal concentrations in San Antonio Bay, in Bouma, A.H., ed., Shell dredging and its influence on Gulf Coast environments: Houston, Tex., Gulf Publishing Co., p. 161-184.

Trefry, J.H., and Trocine, R.P., 1984, The role of particulates in the chemistry and transport of trace metals in the Mississippi River: EOS, American Geophysical Union Transactions, v. 65, no. 45, p. 887.

Trocine, R.P., Trefry, J.H., and Bewig, R.B., 1985, Particulate metal cycles for the Mississippi River-Gulf of Mexico shelf system: EOS, American Geophysical Union Transactions, v. 64, no. 18, p. 244.

Ullman, W.J., and Aller, R.C., 1985, The geochemistry of iodine in near-shore carbonate sediments: Geochimica et Cosmochimica Acta, v. 49, no. 4, p. 967-978.

Van Fleet, E.S., Pierce, R.H., Brown, R.C., and Reinhardt, S.B., Sedimentary hydrocarbons from a subtropical marine estuary, in Schenk, P.A., deLeeuw, J.W., and Lijmbach, G.W.M., eds., Advances in Organic Geochemistry: Organic Geochemistry, v. 6, p. 249-257.

Walters, C.C., and Cassa, M.R., 1986, Regional organic geochemistry of offshore Louisiana, 1985: Association of Geological Societies Transactions off the Gulf Coast, v. 35, p. 277-286.

Ward, C.H., Bender, M.E., and Reished, D.J., 1979, The offshore ecology investigation: effects of oil drilling and production in a coastal environment: Houston, Tex., Rice University Studies, v. 65, no. 4-5, 589 p.

Wells, L., and Froelich, P.N., 1982, Estuarine nutrient geochemistry in Ochlockonee Bay, Florida: EOS, American Geophysical Union Transactions, v. 63, no. 3, p. 56.

Wells, M.C., Boothe, P.N., and Presley, B.J., 1988, Iridium in marine organisms: Geochimica et Cosmochimica Acta, v. 52, no. 6, p. 1737-1739.

Wheeler, R.B., Anderson, J.B., Schwarzer, R.R., and Hokanson, C.L., 1980, Sedimentary processes and trace metal contaminants in the Buccaneer oil/gas field, northwestern Gulf of Mexico: Environmental Geology, v. 3, no. 3, p. 163-175.

White, W.A., 1985, Textural and geochemical relationships in benthic sediments in three bay-estuary-lagoon systems in Texas: Proceedings, Offshore Technology Conference 17, v. 2, p. 67-74.

White, W.A., Calnan, T.R., Morton, R.A., Kimble, R.S., Littleton, T.G., McGowen, J.H., and Nance, H.S., 1987, Submerged lands of Texas, Beaumont-Port Arthur area: sediments, geochemistry, benthic macroenvironments and associated wetlands: Bureau of Economic Geology, Austin, Tex., 110 p.

____1988, Submerged lands of Texas, Bay City-Freeport area: sediments, geochemistry, benthic macroenvironments and associated wetlands: Bureau of Economic Geology, Austin, Tex., 130 p.

____1989a, Submerged lands of Texas, Kingsville area: sediments, geochemistry, benthic macroenvironments and associated wetlands: Bureau of Economic Geology, Austin, Tex., 138 p.

____1989b, Submerged lands of Texas, Port Lavaca area: sediments, geochemistry, benthic macroenvironments and associated wetlands: Bureau of Economic Geology, Austin, Tex., 165 p.

White, W.A., Calnan, T.R., Morton, R.A., Kimble, R.S., Littleton, T.G., McGowen, J.H., Nance, H.S., and Schmedes, K.E., 1983, Submerged lands of Texas, Corpus Christi area: sediments, geochemistry, benthic macroinvertebrates, and associated wetlands: Bureau of Economic Geology, Austin, Tex., 154 p.

____1985, Submerged lands of Texas, Galveston-Houston area: sediments, geochemistry, benthic macroenvironments and associated wetlands: Bureau of Economic Geology, Austin, Tex., 145 p.

____1986, Submerged lands of Texas, Brownsville-Harlingen area: sediments, geochemistry, benthic macroenvironments and associated wetlands: Bureau of Economic Geology, Austin, Tex., 138 p.

Windom, H.L., 1973, Investigation of the changes in heavy metal concentrations resulting from maintenance dredging of Mobile Bay Ship Channel: Mobile Bay, Alabama, Contract No. DACW01-73-C-0136, 46 p.

Windom, H.L., Smith, R.G., and Maeda, M., 1985, The geochemistry of lead in rivers, estuaries and the continental shelf of the southeastern United States: Marine Chemistry, v. 17, no. 1, p. 43-56.

Windom, H.L., Smith, R., Jr., Rawlinson, C., Hungspreugs, M., Dharmvanij, S., and Wattayakorn, G., 1988, Trace metal transport in a tropical estuary: Marine Chemistry, v. 24, no. 3-4, p. 293-305.

Wood, B.K., and Trefry, J.H., 1983, The distribution and provenance of trace elements in eastern Gulf of Mexico sediments: Gulf Coast Association of Geological Societies Transactions, v. 33, p. 455-456.

Appendix II

The following is a list of samples available for future study. The Texas samples are stores at the Bureau of Economic Geology facilities in Austin Texas; the Florida samples are stored in the core storage facility at Florida Sate University. The samples that have organic carbon data could valuable for studies of trace metals and organic constituents.

Region	Total	Bays	Shelf	Chem.	T.O.C	Text	Yr.
Brownsville,Tex	1193	617	576	457	1185	423	77
Kingsville,Tex	845	277	568	269	798	332	77
Corpus Christi, Tex.	876	498	378	235	852	543	76
Port Lavaca,Tex.	1051	507	463	350	925	463	77
Bay City-Freeport,Tex.	765	139	707	217	696	264	77
Galveston-Houston,Tex.	1368	696	672	395	1364	549	76
Beaumont-Pt.Arthur,Tex.	574	160	414	181	557	176	77
Total Texas	6672	2894	3778	2104	6377	2750	
Mobile Bay,AL	310	300	10	----	310	310	65
Perdido Bay, AL	146	146	----	----	---	146	67
Pensacola	315	315	----	----	---	315	66
Choctuahatchee	235	235	-----	----	---	235	63
St.Andrew's Bay	10	10	-----	----	10	10	64
St.Joseph's Bay	101	101	-----	----	101	101	60
Appalachicola	106	96	10	----	106	106	60
St.George Bay	176	176	-----	----	176	176	63
Tampa Bay, FL	773	773	-----	----	773	773	61
Charlottte Harbor, FL	215	215	-----	----	215	215	63
Gullivan Bay,FL	377	377	-----	----	377	377	60
Card Sound,FL	200	200	-----	----	---	200	65
Total AL/FL	2964	2944	20	----	2068	2964	---

Marine = samples taken offshore; Chem = number of samples with chemical data; Text = no of samples with textural data; TOC = number of samples with organic carbon data; yr = year collected.