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KEY WORDS: Western Gulf; Matagorda Bay; Texas; geology; particulate matter; water column; benthos; stratigraphy; sediment; deposition; trace metals; geochemistry; shelf; transport; shipboard observations; plankton; foraminifera; seasonality; resuspension; grain size

BACKGROUND: The present study was a continuation of investigations begun in late 1974 as part of the Outer Continental Shelf (OCS) Environmental Studies Program. The program was designed to provide a quantification of sedimentary processes operative on the South Texas OCS that are of concern in establishing baseline conditions and in monitoring offshore petroleum operations.

OBJECTIVES: (1) To determine the amounts, composition, sources, and dispersal patterns for inorganic particulate matter suspended in the water column; (2) to determine the textural stratigraphy and sedimentary structures of shallow subbottom sediments; (3) to define animal-sediment relationships; (4) to measure rates of sedimentation; (5) to evaluate the relation of trace metal concentrations in bottom sediments to natural gas seepage; and (6) to describe the late Quaternary history and Holocene geology of the South Texas OCS.

DESCRIPTION: The project study area covers 19,250 km^2 of the South Texas coast and extended northward from the U.S.-Mexico International Boundary to the northern

end of Matagorda Island, Texas. The area extended seaward from the Federal-State Territorial Boundary to the outer edge of the continental shelf. Five cruises were made to the area during November 1975 and March and May 1976. These cruises sampled suspended sediments and transmissometry (Cruises 1, 3, 5), coring of benthic sediments (Cruise 2), and coring of benthic sediments for dating and analysis of trace metal concentrations around natural gas seeps (Cruise 4).

A standard gravity fall pipe was used to collect sediment cores for textural stratigraphy and sediment transport studies. A gravity corer was used for remaining core samples. Niskin casts were made to collect water samples at near surface, mid depth, and near bottom for extraction of suspended particulate matter. A Martek transmissometer was used to estimate particulate concentrations in the water column. Top to bottom profiles were made at each station for each of the three sampling seasons. Overall, a total of 668 samples or observations were collected.

SIGNIFICANT CONCLUSIONS: Work completed during this study confirms results obtained during 1975 and adds quantification for the suspended sediments on a seasonal basis. Water movement over the study area is dictated by two regimes: (1) fluvial water inflow to the inner and northern parts of the study region; and (2) encroachment of water from the deeper Gulf onto the outer part of the study region. Biological factors may be controlling distribution of trace metals in suspended and benthic sediments of the outer shelf. Increased amounts of trace metals in suspended sediments along the outer edge of the shelf where suspended inorganic particulates are low may be associated with plankton such as foraminifera. Another possibility for the increased trace metal concentrations may be contributions from seepage of natural gas although benthic sediments do not seem to have abnormally large concentrations of trace metals as a result of gas seepage.

STUDY RESULTS: Concentrations of suspended particulate matter was greatest along the inner shelf. Geographically, the highest amounts were recorded over the northern and inner central portions of the shelf and were larger in November than in May. Inlets located along the northern part of the study area were identified as the principal contributors for this material, while the Rio Grande River represents a subordinate source. Quartz and clay were the principal inorganic constituents of the suspended sediments. Montmorillonite was predominant over the northern part of the study region, with illite dominating over the southern part and in waters just above the seafloor on all parts of the shelf.

Two geographic patterns emerged for increased abundance of all trace metals except chromium. One pattern evident on the inner shelf related closely to the larger amounts of total suspended particulates normal to that area. The second pattern was found over the outer shelf where relative amounts of total suspended particulates were low and inorganic particulates were very low. The pattern on the inner shelf was probably related to large amounts of terrestrially derived particulates, as well as to large amounts of suspended biological components. Specific biological components and natural gas seepage may explain the increased trace metal concentrations noted over the outer shelf.

Three types of benthic sediments were found on the South Texas shelf: (1) relict deposits within the ancestral deltas of the Brazos-Colorado and Rio Grande Rivers; (2) palimpsest or retransported and redeposited sediments; and (3) modern deposits carried onto the shelf during the Holocene. Core analyses indicated that sand in quantities sufficient to form discrete layers have been carried repeatedly seaward beyond the middle shelf area. This transport could have occurred in the aftermath of hurricanes when ebbing floodtides carried large quantities of sediments from bays and barrier islands onto the shelf as turbidity flows.

Seasonal variation was evident in grain size distributions. The variation in sand/mud ratios was greatest along the inner shelf where water depths were shallowest. The highest variability was found among the sediments of the ancestral Rio Grande River delta. Trace metal content of the sediments also showed seasonal variability. A potential cause noted was the magnitude of infaunal activity from season to season. Study results indicated that there was a high degree of bioturbation and textural modification of the benthic sediments by infaunal activity. The most significant bioturbation was evident in those parts of the OCS floored by sediments that have larger amounts of silt and sand and less of the clayey sediments characteristic of the outer shelf.

Sedimentation rates over the shelf, as determined by ^{210}Pb dating, varied considerably and ranged from 0-9 mm per year. The highest rates were measured over the northern part of the shelf. Study results indicated that transport to this depocenter occurs as large amounts of suspended material are moved southwestward along the coast to the vicinity of Matagorda Bay where the material is entrained oblique to the coast by a combination of currents and wind stresses. The suspended material being transported from the high energy inner shelf is rapidly deposited when it reaches the relatively quieter central shelf. Gas detected in the sediments appeared to be representative of slow seepage of biogenic methane from depth (i.e., originating at some depth in the sediment). Correlation analysis indicated no relation between the distribution of gas and any of the trace metals. Increased amounts of trace metals in the sediments over a salt dome site were probably related to increased amounts of organic matter in the sediments rather than to gas seepage. However, it was suggested that increased amounts of trace metals in suspended sediments could reflect gas seepage into the water and subsequent accumulation by microorganisms.

The continental terrace off South Texas, though historically seismic, has been molded by tectonism. Control has been by structural movements including diapirism and sediment loading, as well as significant fluctuations in sea level caused by cyclic glaciation. Faulting has moved progressively seaward across the shelf since the late Pleistocene. Most recent faulting has been along the outermost part of the shelf and can be expected to continue along a diapiric ridge or anticline that lies seaward of the shelf edge. The main depocenter of sedimentation has shifted northward since the Holocene to its present location on the northern part of the OCS study area. The present depocenter reflects the location of sediment sources and the area's prevailing oceanographic processes.

STUDY PRODUCT: Berryhill, H. L., Jr., G. L. Shideler, C. W. Holmes, S. S. Barnes, G. W. Hill, E. A. Martin, and C. A. Pyle. 1976. Environmental Studies, South Texas Outer Continental Shelf, 1976: Geology. A final report by the U.S. Geological Survey for the U.S. Department of the Interior, Bureau of Land Management Gulf of Mexico OCS Office, New Orleans, LA. NTIS No. PB-277337. Contract No. AA550-MU6-24. 626 pp.

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