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REPORT TITLE: Reefs and Banks of the Northwestern Gulf of Mexico: Their Geological, Biological, and Physical Dymanics, Executive Summary and Final Report

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BACKGROUND: Investigators from Texas A&M University have conducted biological, geological, and physical oceanographic studies of the submarine banks of the Texas-Louisiana Outer Continental Shelf (OCS) since 1974. The U.S. Department of the Interior provided much of the funding for these studies which were concerned with potential environmental disturbances related to petroleum exploration and development in the vicinity of the submarine banks. This report summarizes the submarine bank studies conducted from 1974 to 1981 on the northwestern Gulf of Mexico OCS.

OBJECTIVE: To synthesize the biological, geological, and physical characterizations of reefs and banks existing on the northwestern Gulf of Mexico OCS in an ecological context.

DESCRIPTION: This report summarizes all available information, primarily Texas A&M University studies, pertaining to the offshore banks of the Texas-Louisiana shelf. In 1974, the first study was conducted to assemble baseline biological and geological data from 17 banks. The banks were mapped using precision navigation, precision depthrecorder, and side-scan sonar. Submersible dives, aboard the DRV DIAPHUS, were made to photodocument (35 mm and videotape) the seafloor near six of the banks. In addition, surficial sediments were sampled using grabs and corers. A second investigation began in 1976 to extend the mapping efforts on three more banks and to conduct submersible work on four additional banks. These studies included post-drilling assessments at four of the seven banks. In 1977, eight more banks were mapped using surface and subsurface geophysical data. Biological monitoring was initiated on the living coral reefs of East Flower Garden Bank. Studies were performed on the nepheloid layer present at several banks, and the brine seep at East Flower Garden Bank. During 1978 to 1980, several technological changes were made in the instrumentation used for hydrographic studies of the nepheloid layer. Deployment of current meter moorings and additional hydrographic instrument near the Flower Garden Banks provided measurements of turbidity, current velocities, temperature, and salinity. Seafloor roughness maps and structure/isopach maps were prepared for several banks. Biological monitoring at the Flower Garden Banks continued, including experimentally designed quantitative studies. From 1979 to 1981, hydrological and biological monitoring of the Flower Garden Banks were extended. In addition, side-scan sonar, subbottom profiler, and sedimentological data were obtained for the banks. These investigations determined relationships between biotic assemblages and sediment facies. Comparative studies on coral ecology were continued at the Flower Garden Banks.

SIGNIFICANT CONCLUSIONS: Topographic features on the Texas-Louisiana shelf are the result of intruding salt domes on the northwestern shelf and relict carbonate reefs on the south Texas OCS. Geological groupings of the Texas-Louisiana banks included mid-shelf bedrock banks and outershelf bedrock banks with carbonate reef caps. Seven characteristic benthic biotic zones were identified on each bank. Biotic zones were dependent on depth, salinity, substrate, turbidity, and temperature. The East and West Flower Garden Banks harbored dense biological communities including tropical coral reefs which were biogeographically similar to Bermuda and the Florida Middle Ground. Fish and invertebrate assemblages on all banks included a mixture of tropical and warm temperate species; many tropical organims were probably near their environmental stress limits. Water and sediment dynamics indicated that currents flow around topographic banks rather than up slope, thus precluding transport of bottom sediments to the bank crests.

STUDY RESULTS: The Gulf of Mexico basin originated through tectonic activity during the Jurassic period. Subsequent (since the Cretaceous) sedimentation and subsidence produced the present day basin configuration. The western Gulf OCS, from the Mississippi Delta to the Campeche Canyon, is under the influence of deltaic sedimentation, especially from the Mississippi River. Silts, clays and freshwater that come into this area cause appreciable water column turbidity and salinity fluctuations. The West Florida Shelf and the Yucatan Shelf are broad, shallow carbonate features with little or no continental sediment influx. Predominant circulation patterns in the Gulf of Mexico are anticyclonic and are responsible for transporting Caribbean biotal propagules into the Gulf OCS areas.

A series of topographically distinct submarine banks rise from the seafloor on the Texas-Louisiana shelf in two general areas, reflecting geologic origin. Several banks occur on the south Texas OCS, all of which are relict carbonate reefs. Banks located on the northwestern Texas-Louisiana shelf are caused by subsurface salt diapirs. The East and West Flower Garden Banks (27°55' to 27°52'N Lat and 93°36' to 93°49'W Long) are the best known of the diapiric banks in the northwestern Gulf of Mexico. Located at the OCS edge, with high vertical relief and surrounding depths of 100 to 180 m, they are exposed almost continually to tropical-subtropical, clear, oceanic water. Salinities average over 36 ppt, but are occasionally as low as 32 ppt at the surface and 34 ppt at the bank tops. Above 25 m depth, water temperatures may vary annually from approximately 18 to 32°C. Excellent water clarity and light penetration promote significant community developments of corals and coralline algae. Fluvial sands and muds commonly occur on the open shelf surrounding the banks. Normal shelf sediments do not occur at depths shallower than 75 to 80 m. Above 75 m, sediments are coarse-grained biogenic carbonate sands and gravels. A series of brine seeps and a brine lake are present, indicating the removal of large amounts of subsurface salt. The living coral reefs on the crests of the Flower Garden Banks exhibit low coral diversity but high population levels and accretionary growth rates. The most abundant hermatypic coral above 36 m depth is *Montastrea annularis*, while *Stephanocoenia michelini* and *Millepora alcicornis* are most abundant on deeper reefs (36 to 52 m).

Depth related biotic zones are recognized for all Texas-Louisiana banks: (1) Zones of major reef-building activity and primary production (*Diploria-Montastrea-Porites* Zone, *Madracis* Zone and Leafy Algae Zone, *Stephanocoenia-Millepora* Zone, and Algal-Sponge Zone); (2) Zone of minor reef-building activity (*Millepora*-Sponge Zone); (3) Transitional Zone wherein reef-building activity may range from minor to negligible (Antipatharian Zone); and (4) Zone of no reef-building activity (Nepheloid Zone). Following this classification scheme, geologically similar banks may be divided into five environmental groups: (1) South Texas mid-shelf relict Pleistocene carbonate reefs bearing turbidity tolerant Antipatharian Zones and Nepheloid Zones (surrounding depths of 60 to 80 m); (2) North Texas-Louisiana midshelf Tertiary outcrop banks bearing clear water, *Millepora*-Sponge Zones and turbid water tolerant Nepheloid Zones (surrounding depths of 50 to 62 m; crests 18 to 40 m); (3) North Texas-Louisiana mid-shelf banks bearing turbidity tolerant assemblages approximating the Antipatharian Zone (surrounding depths of 65 to 78; crests 52 to 66 m); (4) North Texas-Louisiana shelf-edge carbonate banks bearing clear water coral reefs and Algal Sponge Zones, transitional assemblages approximating the Antipatharian Zone, and Nepheloid Zone (surrounding depths of 84 to 200 m; crests 15 to 75 m); and (5) Eastern Louisiana shelf-edge carbonate banks bearing poorly developed elements of the Algal-Sponge Zone, transitional Antipatharian Zone, and Nepheloid Zone (surrounding depths of 100 to 110 m; crests 67 to 73 m).

A conceptual ecosystem model was developed for East Flower Garden Bank using available data. Conspicuous deficiencies needed for model input included nutrient suspended matter, phytoplankton, and zooplankton levels, and seasonal dynamics in primary productivity, respiration, growth, and fecal production.

STUDY PRODUCT: Rezak, R., T. J. Bright, and D. W. McGrail. 1983. Reefs and Banks of the Northwestern Gulf of Mexico: Their Geological, Biological, and Physical Dynamics. Northern Gulf of Mexico Topographic Features Monitoring and Data Synthesis. A final report by Texas A&M University, Department of Oceanography for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Office, Metairie, LA. (Executive Summary) - NTIS No. PB84-113380; (Final Report) - NTIS No. PB84-113372. Contract No. AA851-CT1-55.

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