Geologic History of Deep Gulf of Mexico Based on Regional Multifold Seismic Lines

Four annotated regional multifold seismic lines across the deep Gulf of Mexico illustrate details of many of the major geologic features. The thick sedimentary section (up to 9 to 10 km) underlying the deep gulf is subdivided into six major sequences or units whose boundaries are major unconformities along the southern margin of the basin, tentatively dated as middle Cenomanian, early Tertiary, middle Oligocene, late Miocene, and the Pliocene-Pleistocene boundary. These units provide a framework for analyzing and discussing the stratigraphy, structure, and geologic history of the deep gulf. A northeast-southwest line 1,000 mi (1,600 km) long from the Florida Escarpment to the Mexican Shelf shows the following major geologic features: (1) the Mexican Ridges foldbelt as a decollement and possible large gravity slides; (2) details of salt deformation in the Campeche-Sigsbee salt dome province; (3) a smooth subsalt basement reflector that possibly represents a major unconformity on top of an attenuated continental crust; (4) an irregular acoustic basement beneath the central Gulf of Mexico that possibly represents some type of oceanic crust; (5) a cross section of the thick Pleistocene Mississippi fan; and (6) a thick Jurassic to Lower Cretaceous sedimentary section thickening beneath the northern Florida Escarpment. Some of the geologic features seen along three north-south seismic depth sections include: (1) unusual salt or shale wedges beneath the upper Mississippi fan; (2) evidence for Jurassic sedimentation and early salt deformation in a basin just northwest of the Campeche Escarpment; and (3) details of the basement structure and the overlying Jurassic to Lower Cretaceous sedimentary sequences in the deep gulf between the northeastern Campeche Escarpment and the Florida Escarpment.

WRIGHTSON, C. B., C. M. GOLD, and H. A. K. CHARLESWORTH, Univ. Alberta, Edmonton, Alta.

Structure-Contour Maps Computer Constructed from Orientational, Stratigraphic, and Positional Outcrop Data

The manual of computer-based methods currently employed in exploration to produce structure-contour maps of coal seams requires numerous drill holes to provide the necessary three-dimensional control. The following method, illustrated by maps of coal seams from the Rocky Mountain foothills of Alberta, uses only orientational, stratigraphic, and positional data from outcrops. It has four steps: (1) establishment of structural domains within which the coal is approximately cylindrically folded; (2) construction of the coal seam's profile in each domain; (3) projection of each profile parallel with its fold axis in order to generate the coordinates of a set of points on the seam in each domain; (4) computer contouring of the resulting elevations. The first and fourth steps use known procedures. The second step can be carried out graphically using a computer plot showing the geographic location, stratigraphic position, and bedding trace of each outcrop projected onto a plane normal to the fold axis. Alternatively, where the stratigraphic positions of the outcrops are known precisely enough and the structure is not too complex, the computer can be instructed to interpolate the coal seam between the various projected outcrops. The third step involves using the appropriate digitized profile and fold axis to predict the coal seam's depth beneath each outcrop and saving these values for the contouring stage.

WYATT, DANNY J., Exxon Co., U.S.A., Lafayette, La.

Carbonate Mud Mounds from Lower Ordovician Wah Wah Limestone, Ibex Area, Western Millard County, Utah

Four carbonate lenses in the upper Wah Wah Limestone, western Utah, were core drilled. Thin sections and peels show that the lenses are mud mounds consisting primarily of micrite matrix, with some bioclastic debris, and minor (< 1%) intraclasts, pellets, iron minerals, and calcite fillings. Bioclastic debris consists of sponges, echinoderms, shell fragments (brachiopods and trilobites), and an encrusting problematic organism. Porosity is less than 1%; dolomitization averages less than 10%. The lenses are extremely burrowed. These fragments were transported to the buildups by currents which varied from fairly low energy to moderately high energy. The absence of frame-building organisms in growth position indicates that these buildups are mud mounds rather than reefs. Formation of the mud mounds could have resulted from sediment trapping by some organism, from sediment heaping by currents, or by a combination of both processes. The mud mounds are similar to those of other geologic periods. The mud mounds, although similar to reefs in external appearance, could have significance in that they serve as examples of what reefs are not. They also demonstrate that not all reeflike carbonate bodies offer potential for petroleum. Analysis of the interiors of carbonate lenses is required to distinguish reefs from mud mounds.

YOUNG, KEITH, Univ. Texas, Austin, Tex.

Immanitas Bed, Paso del Rio, Colima, Mexico

Immanitas is a rudist bivalve genus of the family Caprinidae described by Palmer in 1925. With one possible exception described by Coogan from the subsurface of south Texas, the genus has been reported from only one locality—at Paso del Rio, which is the old ford on the Rio Armería, just below the village of Periquillos, Colima, Mexico.

The *Immanitas* bed itself is a single carbonate cycle starting at the base with about 2 m of wackestone, overlain by packstone and perhaps grainstone for a total thickness of 4 m. In the packstone and grainstone the clasts are nearly all rudists, of which there are many giant specimens of species of *Immanitas*.

The single cycle represents a shoal area in a thick sequence of volcaniclastic rocks, at least part of which are marine. On the high-energy side of the shoal area, to the east, the carbonate bed gives way to dirty quartzarenite. Toward the low-energy side, on the west, the shoal grades laterally into black, thin-bedded (8 to 12 cycles per meter), carbonate mudstone.

Part of the length of the boundary between the *Immanitas* bed and the overlying volcaniclastic rocks has been intruded by diorite. This intrusion resulted in the neomorphism of even the mudstone fillings in the rudists to coarse-grained equant calcite. For this reason, the extent of packstone versus grainstone is difficult to ascertain.

ZARILLO, GARY A., Univ. Georgia, Athens, Ga.

Energy Dissipation over Salt Marsh and Its Effect on Estuarine Sediment Transport and Tidal Dynamics

Sand transport in a salt marsh estuary near Sapelo Island, Georgia, is in a net seaward direction. Bed forms migrate seaward at rates that vary with both their wave height and the tidal amplitude, and they maintain an ebb orientation through both the ebb and flood portions of the tidal cycle. Analysis of the energy flux through the estuary delineates the close interrelation between sand transport and hydrodynamics. The average rate of tidal-energy dissipation over the entire estuary–salt marsh system was determined from the difference in energy flux at the seaward and headward ends of the estuary. Estimates of the energy-dissipation rate within the estuary proper were obtained from measurements of bottom shear stress recorded at intervals over a tidal cycle. Comparison of these energy-dissipation rates indicates that the rate of energy loss in the total estuary–salt marsh system is several orders of magnitude larger than within the estuary proper. Most of the tidal energy loss is due to frictional dissipation around the *Spartina* grass in the marsh.

An important result of this is the "storage" of water at high tide in the marsh creating a large phase lag in the ebb flow between the headward and seaward ends of the estuary. The resulting large ebb-water slope (pressure gradient) induces ebb currents and bottom frictional forces which dominate over the flood phase. This result is directly reflected in the ebb-dominated bed-form geometry and sand transport.

ZIEGLER, PETER A., Shell Internationale Petroleum Maatschappij B.V., The Hague, Netherlands

North Sea Exploration

The North Sea covers parts of the intracratonic Northwest European basin. Exploration efforts in onshore parts of this basin peaked in the 1950s and 1960s and resulted in the proving of ultimate recoverable reserves of 2.4×10^9 bbl of oil and 110 Tcf of gas.

Exploration in the North Sea began in the early 1960s. Ultimate technically recoverable reserves in established offshore accumulations are estimated to amount to 24×10^9 bbl of oil and 90 Tcf of gas.

The gas province of the southern North Sea forms a direct extension of the onshore Permian gas play. Onshore oil plays do not extend into the offshore.

The prolific oil and gas province of the central and northern North Sea is closely tied to the Mesozoic North Sea rift. Reservoirs range in age from Devonian to early Tertiary. Upper Jurassic kerogenous shales are the principal source rocks; in large parts of the Viking and Central grabens the source shales reached maturity during the Tertiary by which time the North Sea rift had become inactive and was replaced by regional subsidence which led to the development of the Cenozoic North Sea basin.

Most of the hydrocarbon reserves in the Viking and Central grabens is contained in structural traps. High reserve concentrations in relatively small areas are related to the availability of abundant, mature source rocks, the blanket development of reservoirs, and the close spacing of trap-providing structures. Many of the known oil accumulations are contained in overpressured reservoirs. Long-range migration is apparently of little significance in the oil habitat of the North Sea.