eation) and detailed, site-specific studies (to identify potential test-well sites).

The Tertiary strata of the Texas Gulf Coast comprise a number of terrigenous depositional wedges which dip and thicken into the gulf basin. Some of the wedges, Wilcox, Vicksburg, and Frio, thicken abruptly in a downdip direction as a result of contemporaneous movement along growth faults which developed near the ancient shorelines. Thick sections of sand and mud accumulated on the down side of these growth faults; expulsion of water from these downfaulted sediments was impeded by the faults and, with increased burial and overburden, high fluid pressures characteristic of this geopressured zone developed. The lack of water circulation in these geopressured reservoirs resulted in the increase in the temperature gradient from approximately 1°F/100 ft (1.9°C/100 m) in the hydrostatic zone to 2°F/100 ft (3.7°C/100 m) in the geopressured zone.

The regional studies, followed by detailed local investigations, were pursued to delineate prospective areas for production of geopressured energy. A prospective area must meet the following minimum requirements: (1) reservoir volume of 3 cu mi (12.5 cu km), (2) minimum permeability of 20 md, and (3) fluid temperatures of 300°F (149°C). Several geothermal fairways were identified in the Frio Formation and Wilcox Group as a result of these studies. Only the Brazoria fairway, however, meets all of the specifications for a geothermal prospect in the Frio. The DeWitt fairway best meets the requirements in the Wilcox.

In the Brazoria fairway, located in Brazoria and Galveston Counties, Texas, several hundred feet of deltaic sandstones have fluid temperatures greater than 300°F (149°C). Permeabilities within these reservoirs are greater than 20 md; this high permeability is related to secondary leached porosity, which developed in the moderate to deep subsurface. The geothermal test well (Department of Energy and General Crude Oil 2 Pleasant Bayou) is located within the Austin Bayou prospect, Brazoria fairway. The reservoir consists of 250 to 300 ft (75 to 90 m) of sandstone with core permeabilities between 40 and 60 md and fluid temperatures from 300 to 350°F (149 to 177°C). The sandstone-shale section within the Austin Bayou area is represented by seven progradational sequences. Each sequence is characterized by low-porosity prodelta and distal delta-front shale and sandstone at the base grading to porous distributary-mouth bar and delta-plain sandstone and shale at the top. The older and deeper depositional sequences represent only the distal part of the lobate delta, and the later events represent the entire deltaic complex. The 2 Pleasant Bayou well has been completed to total depth of 16,500 ft (5,029 m) and testing will begin during the last half of 1979.

A proposed well in the DeWitt fairway, DeWitt County, Texas, will test the deep sandstone reservoirs in the lower part of the Wilcox Group. More than 300 ft (90 m) of deltaic sandstone is present within a fault block 3 mi (5 km) wide and 15 mi (24 km) long.

The Pleasant Bayou geopressured geothermal test well is expected to provide the first reliable data concerning many aspects of producing energy from the water in the geopressured zone. However, this single well will not answer all of the questions nor prove or dis-

prove the feasibility; several additional wells are planned for both Texas and Louisiana.

BUFFLER, RICHARD T., Univ. Texas Marine Science Inst., Galveston, Tex.

Geologic History of Deep Gulf of Mexico Basin

New multifold seismic reflection lines (approximately 15,000 nmi; 27,780 km) and ocean-bottom seismometer (OBS) refraction lines collected by The University of Texas Marine Science Institute, Galveston Geophysical Laboratory, in the deep Gulf of Mexico basin and its adjacent margins show a sedimentary section up to 10 km thick overlying an acoustic basement. The thick section is divided into two major depositional sequences separated by a prominent gulf-wide unconformity, tentatively assigned a middle Cretaceous (Cenomanian) age on the basis of seismic ties with core holes and comparison with global sea-level cycle charts.

Below the middle Cretaceous unconformity, the early geologic history of the gulf basin is complex. A rifted, block-faulted, and attenuated continental crust is inferred to underlie the deep gulf just north and west of the Campeche Scarp and eastward into the Straits of Florida area. A thick salt basin overlies this continental crust in the area north and west of the Campeche Scarp, where it forms a band of salt structure 50 to 100 km wide (Sigsbee salt dome province). Early deformation of the salt and the overlying thick Jurassic sedimentary section suggests a period of gravity sliding associated with early rapid subsidence of the basin.

Refraction data indicate that an oceanic crustal layer underlies the rest of the deep gulf basin. A Late Jurassic (post-salt) period of rapid seafloor spreading or oceanization probably provided a mechanism (thermal cooling) for the rapid Late Jurassic-Cretaceous subsidence.

A younger undeformed sequence of rocks onlaps and fills in on top of the oceanic crust, the outer basement high, and the early salt structures in the central deep gulf. This sequence represents the deeper water, off-bank equivalent of the Late Jurassic-middle Cretaceous carbonate banks, shelves, and platforms that built up around the gulf basin as it subsided. The sequence thickens eastward to over 3 km beneath the Florida Scarp and Straits of Florida. Relief developed on these carbonate banks by middle Cretaceous time formed the proto-Florida and Campeche Straits. Location of the carbonate banks appears to be, at least in part, controlled by basement structure. Along the Florida and Campeche Scarps, there was a major middle Cretaceous shift from shallow- to deep-water sedimentation as the outer banks subsided.

The post-middle Cretaceous section in the deep Gulf is divided into five depositional sequences or seismic units, defined by major unconformities along the base of the northwestern Campeche Scarp and tentatively correlated with global unconformities and sea-level changes as follows: early Tertiary, middle Oligocene, late Miocene, and the Pliocene-Pleistocene boundary. The main source of sediment supply to the basin was on the west in Late Cretaceous-early Tertiary time, but shifted more to the north during the late Tertiary and culminated in deposition of the huge Pleistocene Mississippi fan.

The Oligocene-Miocene section along the deep western gulf apparently was deposited as part of an older deep-sea fan complex with a western source. The lower part of the fan sequence (Oligocene-middle Miocene) is characterized by strong, discontinuous reflectors and is interpreted as relatively coarse-grained material deposited in a channelized midfan environment. The upper Miocene part of the fan consists of fine-grained laminites and is characterized by prograding clinoforms, deposited as lobes seaward of a midfan zone of bypass.

The overall upper Tertiary fining-upward sequence in the western gulf and the gradual cessation of turbidites from a western source probably were due to the late Tertiary development of the Mexican Ridges foldbelt. This foldbelt apparently formed, or is still forming, owing to large-scale downslope gravity sliding of a more competent Tertiary section over incompetent, possibly geopressured, shales.

The northern margin of the deep Gulf is defined by the Sigsbee Scarp, which represents the southern extent of a zone of salt deformation along the entire Texas-Louisiana slope. The western scarp bulges southward and is characterized by salt wedges thrust 10 to 15 km seaward over Pleistocene rise sediments. East of the bulge area the scarp is formed by the seawardmost series of vertical salt ridges that have uplifted and deformed Pleistocene sediments. The salt deformation along the scarp probably is continuing today as a result of both downslope gravity forces and massive sediment loading in a large Pliocene-Pleistocene depocenter farther upslope.

GORDY, PETER L., Shell Canada Resources Ltd., Calgary, Alta.

Hydrocarbon Accumulations in Overthrust Belt of Alberta

Estimated proved and probable ultimate reserves of marketable natural gas in Alberta are 80.5 Tcf of which approximately 10.5 Tcf are in Paleozoic carbonate reservoirs that have been involved in thrust faulting in the Foothills belt of Alberta. Interpretation of exploration data in this belt has contributed significantly to our understanding of the geology of the southern Canadian Rocky Mountains as a whole.

The Foothills belt is the easternmost of four major physiographic and structural divisions of the southern Canadian Rocky Mountains between the interior plains and the Rocky Mountain trench. The eastern boundary of the Foothills belt is marked by a zone of underthrusting, referred to as the triangle zone. The western boundary is defined by the surface trace of major thrusts which bring Paleozoic or older strata to the surface.

The Precambrian basement dips regionally to the west and is not involved in thrusting. The basement is overlain by a westward-thickening prism of Paleozoic sedimentary deposits which contain important reservoirs in Upper Devonian and Mississippian carbonate rocks. Approximately 8% of the reserves are in the Upper Devonian and 87% in the Mississippian. There is close correlation between reserves found and facies trends within the Mississippian Rundle Group. A widespread organic-rich source rock, the Exshaw Formation, provided the major charge for both Mississippian and Devonian reservoirs. Jurassic marine shales overlie the Mississippian in the southern part of the belt and form an effective seal and possible source rock. In the northern part of the belt, the Mississippian is overlain by Triassic sedimentary rocks in which reservoirs are present. The overlying Cretaceous and Tertiary section consists of clastic deposits, both marine and nonmarine in origin. Cretaceous sandstones generally lack reservoir qualities and less than 5% of the reserves found to date are in the Cretaceous.

The Foothills belt is divided longitudinally into two zones, an eastern or outer Foothills belt, and a western or inner Foothills belt. The outer Foothills are characterized by closely spaced listric thrust faults that repeat the Mesozoic section. Some of the thrusts cut deep enough to carry a single or multiple thrust slices of Mississippian carbonate rocks. Trap capacity is governed by horizontal displacement, vertical uplift, convergences of allochthonous and autochthonous structural strike, and probable seal quality of the thrust planes. Approximately 18 significant gas-bearing structures containing 5 Tcf marketable reserves have been discovered. Jumpingpound and Jumpingpound West are typical fields in this belt.

The surface geology of the inner Foothills is characterized by outcrops of Paleozoic carbonate rocks and relatively undeformed Mesozoic strata. The thrusts in this zone usually have large displacements, measured in tens of miles and commonly involve most of the Paleozoic section. Usually two or more thrust sheets are stacked in a general anticlinal form and provide multiple objectives. To date, 14 gas-bearing structures have been discovered in this zone containing approximately 5.5 Tcf of gas. The gas-bearing structures in the Waterton-Carbondale and Moose Mountain Panther River areas are typical. Previous interpretations which attempt to relate the gas-bearing structures of the Foothills belt to faulted stratigraphic traps or ancestral folds seem untenable. The gas-bearing post-lower Paleocene structures probably are related to the time of maturation of the major source rock and the west-to-east deformation of the southern Canadian Rocky Mountains. Despite the large areas of the Alberta Foothills belt in which exploration is restricted, it is estimated that 6 to 15 Tcf of gas may still be found.

HORNE, JOHN C., Carolina Coal Group, Columbia, S.C.

Application of Depositional Models in Coal Exploration and Mine Planning

Geologic studies have shown that many parameters of coal beds (thickness, continuity, roof and floor rock, sulfur and trace-element content, and ash) can be attributed to the depositional environment in which the peat beds formed and to the tectonic setting at the time of deposition. With an understanding of the depositional setting of the coal seam and contemporaneous tectonic influences, the characteristics and variability of many of these parameters can be predicted.

On a regional scale, depositional models can be used to predict the trends of coal bodies. At the lease-tract level, coal thickness variations are closely related to the preexisting depositional topography. In addition, the