

of error in the interpretation of recent basin deposition. Visual and radiographical comparisons of samples from a piston corer with samples from a gravity corer used at the same stations confirms the existence of highly incompetent layers previously only suspected. The detection of these layers in a more consolidated sedimentary column, as well as undetected shortening of samples obtained by piston and gravity corers, is important if the sedimentary history and the engineering properties are to be examined.

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#### MAJOR TRANSITION ZONES OF GULF OF MEXICO: DeSOTO AND CAMPECHE CANYONS

Deep well information throughout the Gulf of Mexico coastal plain has indicated that the Gulf margins can be divided into two distinct provinces, the subsided southeastern section which is underlain by carbonate rocks and the northwestern section that is underlain mainly by terrigenous clastic rocks. In the latter area there is complicated surface and subsurface structure controlled mainly by the influence of upward salt migration. Recent geophysical studies in the offshore areas indicate that DeSoto Canyon is the transition zone between the terrigenous clastic and carbonate provinces in the northern Gulf and that the Campeche Canyon plays a similar role in the southwestern part of the basin. Most salt diapirs in the region lie west of a line connecting the two canyons, but recent work suggests the presence of some diapiric structures east of the line.

The geophysical data from the DeSoto Canyon indicate that erosion has played an important part in its development. Two mechanisms for the formation of the canyon are suggested: (1) the loop current of the eastern Gulf of Mexico and associated circulation in the northeastern Gulf have sufficient velocity along the bottom during specific periods of time to effect a scouring action and/or keep sediments in suspension; and (2) erosion by turbidity flows takes place during periods of low sea-level stands associated with glacial stages. The fact that the DeSoto Canyon extends across parts of two distinct geologic provinces, the northeast Florida platform and the Mississippi cone, adds credence to an hypothesis involving erosional rather than tectonic processes.

Although there are insufficient data available to determine the origin of the Campeche Canyon, it is suggested that, unlike the DeSoto Canyon, its topographic expression probably is more the result of adjacent salt tectonics than of erosion. Some workers suggested that an alignment from the DeSoto Canyon to Campeche Canyon may represent a fracture zone across the Gulf basin. The hypothesis that this alignment forms the southeastern boundary of the Gulf of Mexico salt province is contradicted by the presence of diapirs in northwestern Matanzas Province, Cuba, and by the discovery of some possible diapiric structures in the Florida Straits and Yucatan Channel.

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#### STABILITY AND GEOTECHNICAL CHARACTERISTICS OF MARINE SEDIMENTS, GULF OF MEXICO

Studies of shear strength and consolidation characteristics of marine sediments were made from the following four major provinces of the Gulf of Mexico:

Mississippi fan, Gulf abyssal plain, Texas-Louisiana continental slope, and Mexican continental slope. These studies indicate that the sediments in these regions, to a depth of 10 m below the sediment-water interface, are stable in their present environment.

Shear-strength *versus* normal-stress plots indicate that minimum average values of  $\phi$  (angle of internal friction) ranges from  $11^\circ$  for the Texas-Louisiana and Mexican continental slope sediments to  $10^\circ$  for the Mississippi fan and abyssal plain sediments. Average values of  $\phi$  ranged from a high of  $20^\circ$  for the Texas-Louisiana continental slope sediments to  $16^\circ$  for Mississippi fan and abyssal plain sediments.

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#### HABITAT OF OIL IN CARBONATE ROCKS

Entrapment of oil in carbonate reservoirs can be explained by analysis of (a) depositional environment, (b) diagenetic changes, (c) structural history, and (d) fluid mechanics.

Favorable reservoir rocks in carbonate environments include reefs, bioherms, oolite bars, and porous skeletal calcarenite. Production of organic material in such environments (with the exception of oolite bars) is prolific, but under normal conditions a major part of the organic soft parts are destroyed by bacteria scavengers and early diagenesis, whereas skeletal parts are preserved. Early diagenesis modifies the texture and the original porosity of carbonate deposits by recrystallization, solution, cementation, and replacement. Under favorable conditions, dolomitization enhances the reservoir characteristics of the carbonate sediment.

Hydrocarbons are found in cyclic carbonates which were deposited on unstable shelves and subjected to recurrent sea-level fluctuations with periodic influxes of terrigenous clastic material. Under a cyclic regime of sedimentation, a reservoir-type carbonate facies can be covered by sapropelic shale, evaporite, or basinal facies. This stratigraphic relation, in addition to providing an adequate seal, also can be suitable to preservation of organic soft parts within the reservoir facies. In the writer's opinion, cyclic sedimentation in carbonate rocks could explain *in situ* accumulation of hydrocarbons in carbonate rocks under certain favorable conditions.

The oil generated in carbonate rocks is subject to secondary migration as a result of structural deformation. An understanding of fluid mechanics is very useful for explanation of some peculiarities of oil distribution within the carbonate traps.

Tectonic setting of the carbonate shelf, relative to the stable nuclei and the mobile margins of the continents, has a profound influence on the type of trapping mechanisms likely to be found in the carbonate rocks.

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#### REINTEGRATION: SYNTHESIS EDP TECHNIQUES IN GEOLOGY

Information elements observed, defined, classified, and recorded by the variety of geological sciences are in focus with the aid of computer, mathematical, and information sciences. These information elements now can be tested for validity, reinforced in meaning, displayed for understanding, and combined semantically. Information elements normally kept segregated in specialty data files now can be integrated in new in-

terdisciplinary approaches. Linkages, mathematical models, graphic techniques, file management, and the functional orientation of the professional are important. It is necessary for the geological integrationist to reach conclusions vital to industry, government, and education.

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#### SALT TECTONICS AS RELATED TO SEVERAL SMACKOVER FIELDS ALONG NORTHEAST RIM OF GULF OF MEXICO BASIN

Recent exploration activity in the Smackover trend along the northeastern part of the Mississippi Salt basin has provided much new information for the interpretation of salt-formed structures. The study area is Clarke and Wayne Counties, Mississippi, and Choctaw County, Alabama. Improved seismic techniques and much new well control on the Louann Salt provide data to group structure types.

All structures studied are the result of salt flowage, and structural types are correlative primarily with amount of salt available to the structure from the mother salt bed.

Four principal categories are recognized in the area studied. These are, progressing from thinnest salt along the rim of the basin to thicker salt basinward:

1. *Periphery salt ridges*.—Around the periphery of the Mississippi Salt basin, the Louann Salt wedges out against an older Paleozoic shoreline. With subsidence of the basin after deposition of the salt, differential forces were created which caused flowage of the salt toward the wedgeout. This has produced a series of salt ridges along the updip limit of the salt. Stresses caused in overlying beds by this salt flowage resulted in a complex system of graben faulting in shallower beds. Such faults generally parallel the updip limit of the Louann Salt (the Pickens-Gilbertown-Pollard fault system). The salt thickness at the apex of peripheral salt structures ranges from approximately 500 to 2,000 ft. The Quitman field, Clarke County, Mississippi, and the Choctaw Ridge field, Choctaw County, Alabama, are examples of this type.

2. *Buried salt ridges*.—Downdip from the peripheral salt-ridge structures, the mother salt layer is relatively thin and salt supply to structures very limited. Salt flowage apparently took place soon after deposition of a moderate sedimentary overburden. Available salt was depleted during early structural growth so that there is very little structural growth indicated after Jurassic time. These structures appear as elongated ridges usually aligned parallel with regional strike. The salt thickness at the apex of these structures ranges from 500 to 2,500 ft. The Nancy field, Clarke County, Mississippi, is an example of this type.

3. *Intermediate salt structures*.—Basinward from the buried salt ridges, the mother layer is thicker, and the salt-formed structures have the appearance of an elongated deep-seated dome with a greater uplift. These structures are found directly downdip from the salt ridges and produced the traps at such fields as Cypress Creek. These structures show pronounced growth in older Mesozoic rocks and may produce an initial graben. In some places sufficient salt uplift took place after the graben was initiated to spread the graben faults apart (generally less than 0.75 mi), so that younger Jurassic beds were deposited over the salt within the graben, and pre-Haynesville (Late Jurassic) beds may be found only on the upthrown

sides of these original faults. Apparently there was not sufficient salt available to permit significant growth of these structures during Late Mesozoic and younger times. As a result, only slight indications of structure are observed in beds above the Jurassic. The salt thickness at the apex of the intermediate structures ranges from 2,500 ft to 5,000 ft.

4. *High-relief salt structures*.—Farther basinward, the mother salt layer is sufficiently thick to furnish large amounts of salt. Consequently, the salt uplifts attain very large size and may have grown throughout Mesozoic time. The long duration of growth produced steeply dipping and very complex structures in the early Mesozoic beds; some of them were breached by a major salt extrusion. In these high-relief structures, the initial graben which was formed during early Mesozoic time commonly spread apart from 0.75 to 1.5 mi, but spreading ceased before late Mesozoic time. Younger grabens which affect late Mesozoic and Cenozoic beds are developed within the older graben. Potential Jurassic traps are present on the flanks of the large salt uplift, and generally are controlled by the original graben faults. The Pool Creek field is an example of this type of structure. A salt thickness ranging from 5,000 to 15,000 ft or more may be expected on this type of structure.

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#### PELAHATCHIE FIELD—MISSISSIPPI GIANT?

Pelahatchie field in Rankin County, central Mississippi, was discovered in 1962 with the completion of a well in the Early Cretaceous Mooringsport Formation. This discovery led to further step-out drilling for Early Cretaceous objectives and resulted in the establishment of production in the Paluxy, Rodessa, Sligo, and Hosston. The Early Cretaceous reservoirs are undersaturated and appear to have tilted water tables with no significant closure. A deep Smackover (Late Jurassic) test at Pelahatchie field in search of  $H_2S$  gas resulted in the discovery of high-pressure, high-volume oil production from a basal Smackover sandstone after finding  $CO_2$  gas in the Buckner and upper Smackover.

The Pelahatchie structure appears to be quite large, with little or no fault complications. The highest development of structural closure is in the Late Jurassic Cotton Valley Formation and is very prominent in the older Smackover. This field should prove to be one of Mississippi's largest.

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NORPHLET SANDSTONE, PELAHATCHIE FIELD, RANKIN COUNTY, MISSISSIPPI

The Late Jurassic Norphlet sandstone first produced oil in the Gulf Coast in the Shell-Love *et al.* Unit 1 W. D. Rhodes *et al.*, Pelahatchie field, Rankin County, Mississippi, from a depth of approximately 17,000 ft. Cores from the discovery and confirmation wells show that halite constitutes about 20 percent by weight of the rock. Flushing of the core increased the porosity from about 8 to 27 percent and permeability from about 4 to about 3,900 md; grain density was increased from 2.52 g/cm<sup>3</sup> to 2.63 g/cm<sup>3</sup>. It is concluded that the halite was derived from the underlying Louann Salt and that the present porosity is a result of leaching by circulating groundwater.

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