sediments decreased with distance from the deltas. At any depositional moment, three gradational facies (sand, sand-shale, and shale) were being developed in bands mainly parallel with the shoreline. This depositional pattern persisted through the late Miocene and Pliocene so that in the total geometry of this net-regressive sedimentary wedge, the facies may be grossly viewed as having developed a sand, a sand-shale, and a shale *magnafacies.*

The sand magnafacies has been productive. However, the majority of hydrocarbons have been found in the inner- and middle-neritic zones of the sand-shale magnafacies in structural traps formed by salt diapirs and growth faulting. The gulfward limits of their exploitation can be determined reasonably from present data and should be confined largely to water depths up to 600 ft. Any significant discoveries are likely to be in the offshore. Louisiana is approaching maturity in its development of these facies but there is room for limited extension. Offshore Texas is largely unexplored but results of drilling through 1969 appear to have been disappointing. The volumes of sediments in the sand and sand-shale magnafacies remaining to be exploited are estimated as follows:

Pliocene	*cu mi*	*Reservoir Rocks*
Texas	3,000	30%
Louisiana	14,000	20%
Upper Miocene		
Texas	13,000	30%
Louisiana	16,000	20%

A possible future source exists in the shale magnafacies, where turbidite sands can reasonably be expected on the updip flanks of salt structures and in the lows between them. The search for reservoirs of this type, particularly in the younger sections, will involve operations beyond the edge of the continental shelf in water exceeding 600 ft in depth. Exploration in the older sections can be accomplished in shallower waters, but will require increasingly deeper drilling. Turbidite exploration demands a considerable sophistication of seismic techniques and the best efforts of geologists, paleontologists, and geophysicists. No reasonable estimate of favorable sediment volume in the shale magnafacies can be made at this time.

Present economics barely have justified the oil industry's endeavor in the prime sand and sand-shale magnafacies in water less than 600 ft deep. The same economics hardly can be expected to support operations beyond the edge of the continental shelf, particularly in the face of deteriorating or conjectural objectives. Increased incentives are necessary to encourage the costly risk-taking that will be required to find and develop any future trends in the upper Miocene and Pliocene shale magnafacies. Instead, it appears that current political attacks on existing incentives will be successful to some degree, and incentives will be lessened. Without substantial compensating factors, economic considerations may jeopardize all future explorations in the Gulf.

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Origins of Abnormal Fluid Pressures

This paper was prepared by the Houston Geological Society Abnormal Pressure Study Group Subcommittee on Origins, to serve petroleum geologists who may be responsible for planning and executing drilling programs.

The normal compactional process produces a stress system in sedimentary rock. A stress system is in equilibrium when the overburden pressure on a given rock equals the sum of the fluid pressure and the grain pressure within the rock. Processes which impose changes in the stress system may generate abnormal pressures, and there are several different modes of origin. Abnormal pressures may be generated if changes in overburden pressure result from vertical compression, horizontal compression, or uplift. Abnormal pressures also may result if changes in fluid pressure result from fluid density contrast or recharge, or if mechanical or physical processes (such as faulting, adsorption, osmosis, or diagenesis) inhibit the expulsion of fluid from compacting rocks.

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Application of Paleobathymetry in Exploration

Ecological studies of living Foraminifera provide an accurate framework for paleobathymetric interpretations. Exploration for hydrocarbons can be improved greatly if these interpretations, together with standard stratigraphic and structural methods, are used by the geologists.

Paleobathymetry can be used in (1) interpreting the geologic history of an area, (2) demonstrating sea-floor topography and establishing the time of growth and burial of topographic highs, (3) determining the presence of faults and unconformities, and the amount of uplift or subsidence, (4) correlations, and (5) determining the interrelations among sand deposition, abnormal pressure, and accumulation of hydrocarbons. These relations can be derived by plotting paleobathymetric data on cross sections and constructing bathymetric, tectonic, structural, and isopach maps.

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Future Petroleum Provinces of United States Western Gulf Basin—Lower Miocene-Oligocene

Future lower Miocene-Oligocene discoveries will be found under conditions similar to those controlling present production. Reservoirs are typically sandstone, and traps are usually structural, associated with salt domes, fault closures, anticlines, or residual highs. Depositional environment is critical for accumulation of hydrocarbons, the ideal habitat being a thick section of deltaic or shallow-neritic sandstone interbedded with marine shale. This relation limits the extent of production downdip where deeper shale replaces sandstone.

The lower Miocene section appears to be prospective both downdip from and on strike with the present producing trend over a 9,600 sq mi (24,900 sq km) area in Louisiana and Texas. The prospective area contains 9,200 cu mi (38,300 cu km) of sedimentary rock and lies largely on the sparsely drilled continental shelf offshore from southwestern Louisiana and south Texas. This future province may be divided into two parts: a probable producing area of 4,700 sq mi (12,200 sq km) containing 4,800 cu mi (20,000 cu km) of sediments, and a possible producing area of 4,900 sq mi (12,700 sq km) containing 4,400 cu mi (18,300 cu