freshwater phreatic diagenetic environments are not favorable. However, the marine phreatic diagenetic environment is favorable.

The transgressive-regressive couplets, which consist of numerous upward-shoaling cycles, provide for generation and accumulation of hydrocarbons. The transgressive cycles are generally favorable to preservation of organic matter, whereas the regressive cycles are favorable sites for development of porosity. Where the transgressive-regressive couplets are buried at a sufficient depth to bring about the thermal degradation of organic matter to petroleum, major accumulations of hydrocarbons occur.

The synchronous and post-sedimentary tectonic events also seem to have a positive influence on the source-rock potential of carbonates and evaporites. Rapidly subsiding shelves would place the organic-bearing carbonates below the destructive influence of the freshwater phreatic zones. Late structural movements could produce the microfracture systems which would form the avenues for petroleum migration from source to reservoir rocks.

Geochemical data on ancient rocks strongly suggest that sabkha evaporites should be seriously considered as a possible source rock for petroleum.

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Regional Stratigraphy of Upper Jurassic Smackover Carbonate Rocks of Southwest Alabama

Upper Jurassic Smackover deposition in southwest Alabama was primarily controlled by the Mississippi interior salt basin and the Manila and Conecuh embayments, and closely approximated carbonate sedimentation in the present Persian Gulf. These depositional sites are characterized by distinctive lithofacies and fossil assemblages. Early salt movement produced local variations in carbonate-sediment distribution, and pre-Jurassic paleo-highs, such as the Wiggins uplift and Conecuh arch, also modified carbonate sedimentation.

Throughout much of southwest Alabama, the Smackover Formation consists of a lower predominantly mudstone lithofacies which overlies the Norphlet sandstone and an upper lithofacies sequence dominated by grain-supported textures which is overlain by the Buckner anhydrite. Where present, the lower Smackover lithofacies include laminated mudstone and some peloidal wackestone, peloidal-oncolitic packstone, and dolomite. The upper lithofacies sequence consists of oolitic or oncolitic grainstone, peloidal or oncolitic wackestone to packstone, and some dolomite and mudstone.

Petroleum traps in southwest Alabama are principally combination traps involving favorable stratigraphy and salt anticlines, faulted salt anticlines, or extensional faults associated with salt movement. Reservoir rocks include grainstones; leached and dolomitized wackestones, packstones, and grainstones; and dolomite. Porosity is facies-selective and is developed chiefly in lithofacies of the upper Smackover. Porosity includes primary interparticulate, secondary grain moldic, intercrystalline dolomite, vuggy, and fracture. The algal mudstones that characterize the lower Smackover and are interbedded with upper Smackover lithologies throughout most of southwest Alabama make excellent petroleum source rocks.

The flanks of the Wiggins-Conecuh ridge and updip Smackover grainstones associated with salt structures are excellent areas for petroleum exploration in southwest Alabama. The key to successful prospecting is the delineation of traps associated with salt movement and recognition of either high to moderate energy lithofacies that have had their primary interparticulate porosity preserved or of lithofacies that have been dolomitized or leached with the development of intercrystalline dolomite or secondary grain moldic porosity.

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Geology of Gum Island North and French Island Areas, Jefferson County, Texas

The Gum Island North field is adjacent to a small topographic feature of the same name elevated over 5 ft (1.5 m) above tidal marsh about 13 mi (21 km) west of Port Arthur, Texas. French Island field along Taylors Bayou is 4 mi (6.4 km) due north of Gum Island. The two fields, discovered as a result of the same initial exploration effort, are combination stratigraphic and structural traps. The principal reservoirs are Oligocene middle Frio–Hackberry in age. They are localized as a result of rapid filling of downward troughs created by older growth-fault structural movement, principally of Vicksburg age, but persistent during lower and middle Frio. Pre-Hackberry structural maps, Hackberry sand-distribution maps, and structural and stratigraphic maps, both prior and subsequent to discovery, as well as seismic and subsurface cross sections, demonstrate the nature of the oil and gas traps, as well as the geologic history of the area.

At both French Island and Gum Island, an erosional surface of significant magnitude is at the base of the Hackberry. The resulting unconformity does not greatly affect Hackberry accumulation at French Island, but at Gum Island the stratigraphic position of the unconformity relative to older beds is not only indicative of strong structural uplift, but it also bears a direct relation to individual subsequently deposited Hackberry sand reservoirs.

Exploratory drilling prior to discovery is described, along with an exploration philosophy requiring knowledge of the geologic history and depositional patterns of the trend, detailed geologic analysis of drilling results, stratigraphic integration of paleontologic data, as well as detailed and imaginative geologic use of seismic data, all with a long-term will to persist.

Statistics concerning reserves of oil and gas discovered as a result of this exploration are not made a part of this report. However, the results are expected to be 150 to 250 Bcf of gas and 6 to 10 MM bbl of oil and condensate when ultimately developed. The topside numbers could easily double when additional expected local turbidite "potholes" are drilled.

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Depositional Systems in Nacatoch Sand (Upper Cretaceous), East Texas Basin and Southwest Arkansas

The Nacatoch Sand, the middle formation of the Navarro Group, consists of marine sandstones and mudstones derived largely from a source area to the north and northeast of the east Texas embayment. Terrigenous clastics were supplied to the Nacatoch basin by two major dispersal systems: (1) a bifurcating northwestern and northern system in southern Hunt and southern Delta Counties, and (2) a northeastern system originating in southwestern Arkansas.

Five facies are recognized in surface exposures of southwestern Arkansas: tidal flat, tidal channel, tidal inlet association, shoreface, and shelf facies. In northeast Texas, a deltaic sequence is recognized in south-central Hunt County, and shelf sandstones and mudstones are present in Navarro and Kaufman Counties.

Nacatoch sandstones in the East Texas basin are significant shallow oil and gas reservoirs. Production of hydrocarbons from the Nacatoch is restricted to the shelf-sand facies. Hydrocarbon occurrence is perhaps more a function of structural closure than depositional facies. Hydrocarbon production is associated with the Van salt dome in Van Zandt County and coincident with the Mexia fault system trend along the western margin of the basin.

MERRITT, LINDA C.

Diagenesis of Deltaic Sandstone: Olmos, San Miguel, and Upson Formations (Upper Cretaceous), Northern Rio Escondido Basin, Coahuila, Mexico

During the Late Cretaceous, the Rio Escondido basin was filled with deposits of lobate deltas that prograded eastward. Three distinct depositional environments can be recognized in the subsurface: delta plain (Olmos Formation), delta front (San Miguel Formation), and prodelta (Upson Formation).

The sandstone of the Rio Escondido basin is predominantly feldspathic litharenite. Major framework grains are quartz (23%), plagioclase feldspar (35%), and volcanic and sedimentary rock fragments (42%). Most of the matrix was formed by compaction of sedimentary and volcanic rock fragments during early burial. Porosity was reduced to 19% by compaction before cementation. Chlorite, the earliest cement, formed thin rims around framework grains and replaced feldspar rock fragments, and matrix. Minor thin quartz overgrowths precipitated next. Extensive calcite cement occluded most remaining porosity by filling intergranular pores and replacing framework grains (chiefly feldspar). Subsequently, widespread dissolution of calcite created 5 to 10% secondary porosity. Kaolinite precipitated next as a pore-filling cement and today is the chief occluder of secondary porosity. Ferroan dolomite replaced most remaining calcite; only remnant calcite is present in the sandstone today. Late-stage cements include local authigenic siderite and pyrite. A final dissolution event locally removed remaining calcite cement or framework grains (feldspar).

Essentially all porosity present in the sandstone today is of secondary and not primary origin. Macroporosity in the sandstone is 5.0% and permeability is 2.6 md. Kaolinite cement, volcanic rock fragments, and matrix contain an estimated 6.5% microporosity. Porosity distribution is patchy and cannot be correlated with depositional facies. Porosity and permeability values do not indicate good reservoir quality in the northern Rio Escondido basin sandstone.

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Future Petroleum Provinces of Gulf of Mexico Region

The Gulf of Mexico area is the fifth largest potential petroleum-producing region in the world, exceeded only by the Arabian (Persian) Gulf basin, the West Siberian basin, the Eastern Venezuela (Maturín) basin, and the Western Canada basin. The last two are larger than the Gulf of Mexico basin because of their enormous tar-sand deposits.

Within the United States, large areas of the west Florida shelf remain unexplored, specifically, the Paleocene and parts of the Mesozoic. In the upper Gulf Coast, the post-Ouachita Pennsylvanian and Permian rocks are promising. Jurassic objectives, particularly the Smackover, require intensive exploration in Texas. Additional Gulf Coast plays of the United States include: westward extension of the Tuscaloosa trend; development of the Austin Chalk play; the drilling of numerous structures still undrilled, in central Louisiana; development of Wilcox marine sandstone plays; and extensive drilling of the salt ridges and domes of the continental slope where large reserves of oil and gas can be expected. There are other plays, but those listed are the largest.

In Mexico, the Upper Jurassic-Lower Cretaceous gas reserves of the Sabinas basin are just being developed. Several score structures remain to be drilled and tested. In the Parras basin, gas should be found in formations ranging in age from Late Jurassic through the Late Cretaceous, possibly extending into the earliest Tertiary. Farther south, Upper Jurassic-middle Cretaceous plays are almost untested in the San José de las Rusias homocline, and the Arenque Jurassic reef play north of the Golden Lane still is undeveloped. A subthrust play extends from north of the Sabinas basin to the mountain front south of the Isthmus of Tehuantepec. Large subthrust fields should be expected, particularly between Monterey and the southwestern part of the Veracruz basin. The full extent of the Reforma-Campeche shelf play, onshore and offshore, still has not been determined. Southeast of the Reforma trend, the Upper Jurassic and Lower to middle Cretaceous of the Chapayal basin remain unexplored. Beneath the Reforma trend and the Chapayal basin is an extremely attractive section of Pennsylvanian and Permian with probable reef development, similar to that of west Texas. Some major Paleozoic structures have been found at depths of less than 3,000 m. Offshore, west of the Campeche shelf, a salt-dome province extends from the Isthmus of Tehuantepec northward to the Sigsbee Knolls, all of which may be prospective. Tertiary turbidites also may be objectives in the deep gulf. Certainly the Mexican Ridge province east of eastern Mexico offers attractive possibilities for future exploration.

Cuba is far less attractive because of its complex alpino-type geology. However, several large structures in Upper Jurassic and Lower Cretaceous carbonate rocks still remain to be drilled in northern and northwestern Pinar del Río province.