packstones, mollusk and echinoid mudstones, and orbitolinid packstones and grainstones make up this sequence. The producible reservoir beds are curiously correlative only to the orbitolinid facies, despite the fact that log analyses and standard core analyses do not discriminate between facies with regard to reservoir properties.

Petrographic studies and special core analyses have identified a unique style of diagenetic recrystallization which yields water-free gas production from high-water saturation reservoirs. However, in updip parts of the field where porosity and permeability have been enhanced by solution diagenesis, both gas and water are produced in subeconomic proportions.

The complex association of a discretely layered reservoir, which demonstrates untraditional fluid dynamics within layers, is further complicated by a dual system of vertical fractures. This fracture system, which is probably a function of gulfward subsidence coincident with drape across the Hancock ridge, has been demonstrated to be an important factor controlling the prolonged and prolific production at Waveland field.

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Late Jurassic Reefs of Smackover Formation—Preliminary Report

Algal and coral reefs are recognized in conventional cores of the upper Smackover Formation from southwestern Arkansas eastward into the panhandle of Florida. Although only one known reef has produced commercial hydrocarbons, attractive porosities and permeabilities (mean ϕ of 15%, mean K of 20 md) result from freshwater leaching, fracturing, or dolomitization. In addition, the reefs may have provided a positive structural aspect to localized areas during later Smackover deposition and diagenesis.

Smackover reefs formed in the Late Jurassic during periods of maximum marine transgression (good circulation, clear water, normal marine salinity) in three major paleogeographic settings: (1) the margins of Paleozoic highs protruding into the Smackover basin, i.e., Vocation field in Alabama; (2) upthrown basement fault blocks, i.e., Melvin field in Alabama; and (3) the seaward edges of upthrown salt-cored fault blocks, i.e., Walker Creek field in Arkansas, Hico Knowles and North Haynesville fields in Louisiana, and West Paulding field in Mississippi. The buildups are commonly elongate, 3 to 40 m thick and generally cover an area of several square kilometers. The reefs appear higher (younger) in the stratigraphic section downdip. Also, the reefs are younger and have a more diverse biota in Arkansas and Louisiana than they do in Alabama and Florida.

Smackover reefs in Alabama and Florida were constructed by algae. Vertical relief on the reef surface during growth may have been a few meters. Similar reefs in southern Arkansas and northern Louisiana exhibit a vertical zonation suggesting an evolving reef community. These buildups are *Tubiphytes*-stromatolitic algal boundstones containing scattered corals toward the base; diversity increases upward with the addition of abundant corals (*Actinastrea, Complexastrea, Thamnasteria,* and others), sponges, skeletal algae, and byrozoans. The reefs are commonly underlain and overlain by subtidal peloidal lime packstones containing oncolites and scattered fossils, and they can develop in close proximity to subtidal quartz sands.

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Deep-Water Reservoir Sandstones of Texas Gulf Coast

Core studies have revealed that many downdip sandstones in the Texas Gulf Coast are turbidites. These sandstones are found in several distinct depositional settings, and each is characterized by different reservoir morphologies. Submarine fans are present in the upper Wilcox at Katy field, and bed associations observed in cores show stacked-channel, middle-fan, and outer-fan facies. Fans also are represented in the upper Wilcox at Northeast Thompsonville field. Constructional channel-fill sandstones are found in the lower Vicksburg at McAllen Ranch field. Submarine canyons in the outer shelf are shale filled and form truncation traps at Yoakum and Valentine fields. Channel sandstones within canyon fill are reservoirs in Oligocene Hackberry fields. Channel sandstones on unstable slopes are found in the Upper Cretaceous Woodbine in Seven Oaks field, and in a slumped, lower Wilcox section at South Hallettsville field. In both areas, slope instability was controlled by Lower Cretaceous carbonate-shelf margins. Turbidite deposition was controlled by growth faults in Frio sandstones at Nine Mile Point field and by a shale diapir in lower Vicksburg sandstones at McAllen Ranch field.

Recognition of turbidite reservoirs, and their different modes of occurrence, is important in exploration. Abundant evidence for turbidity current transport indicates that even the deepest parts of the Gulf Coast basin may contain reservoir sandstones.

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Petrographic Analysis of Pettet Porosity in Kerlin Oil Field, Columbia County, Arkansas

The Kerlin field in southwest Arkansas produces from secondary moldic porosity in the Pettet "A" zone of the Lower Cretaceous Sligo Formation. Three associated lithic units were delineated on the basis of a petrographic analysis of cores from approximately 20 wells. The three lithofacies identified are: oolite-skeletal grainstone, oolite-skeletal packstone, and the skeletal-packstone facies. The depositional model delineated by the facies distribution indicates an elongate offshore shoaling complex. The oolite-skeletal grainstone facies represents the shoal and the oolite-skeletal packstone facies represents the fringing spillover facies. The shoaling complex migrated over a basic substrate of the skeletal-packstone facies.

Production from the Kerlin field is from approximately 5 to 10 ft (1.5 to 3 m) of porosity in the oolite-skeletal grainstone facies. However, the adjacent oolite-skeletal packstone facies is nonproductive. Secondary moldic porosity in the oolite-skeletal grainstone facies is the basic porosity type and averages 13% in the producing horizon. Porosity was formed in the productive grainstone facies by selective dissolution of the aragonite shell fragments in the vadose and freshwater phreatic zones. Depositional interparticle porosity, which accounts for only a minor percentage of the total field porosity, was reduced by cementation. Present average permeability in the Pettet zone is 7.78 md.

Original permeability in the nonproductive oolite-skeletal packstone facies was reduced by the increased carbonate-mud content which inhibited the dissolutioning of aragonite skeletal material. Thus, moldic porosity was poorly developed in this facies.

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Walker Creek Revisited: Reinterpretation of Diagenesis of Smackover Formation, Walker Creek Field, Arkansas

Recent petrographic, trace element, isotopic, and fluid inclusion work has necessitated a major revision of the diagenetic model for the Smackover Formation at Walker Creek field, southern Arkansas. Prior studies concluded that all diagenetic changes occurred within a few tens of feet of the earth's surface. This investigation has shown that near surface diagenesis is confined to very minor marine cementation. The equant calcspar and baroque dolomite cementation occurred much later at temperatures between 60 and 120°C during the initial stages of hydrocarbon migration in the deep subsurface.

Earlier workers also concluded that the equant cementation is unrelated to depositional facies. They attributed the layered permeable and impermeable zones to permeability preservation in a meteoric vadose zone and occlusion in a meteoric phreatic zone. Because the equant cement is of a late origin, it can no longer be attributed to a meteoric zone.

The equant cement does occur in all depositional facies, but the effect of this cement upon the permeability of the rock is related to the original depositional facies. Permeability has been preserved in the coarser grained ooid and ooid-intraclast grainstones. This may be related to the size of the pore throats; cementation could block the pore throats completely in the finer grained material only. The coarser rock remained permeable and was made more permeable by late stage dissolution.

This new-found relation of permeability and original depositional facies has several implications regarding future hydrocarbon exploration in the southern Arkansas-northern Lousiana area.

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Stratigraphic, Sedimentologic, and Diagenetic Framework for Jurassic Cotton Valley Terryville Massive Sandstone Complex, Northern Louisiana

With deregulation and the subsequent rise in gas prices and development of modern evaluation and completion techniques, the "tight gas sands" of the Cotton Valley Terryville massive sandstone complex have become an intriguing play. This study establishes a generalized stratigraphic framework which allows regional correlation of individual productive horizons in the Terryville from east Texas to east Louisiana. It also proposes a sedimentologic sequence for deposition and a diagenetic sequence for reservoir rock modification.

The Terryville is an extensive complex of marine-dominated, massively bedded, predominantly fine-grained, quartz sandstones. It lies stratigraphically between the underlying Bossier shale and the overlying Knowles limestone and downdip from the time-equivalent Hico shale and Schuler Formation.

A series of four prograding marine-dominated, coalescing, deltaic complexes are proposed as the depositional systems for placing the Terryville sands on the stable Jurassic shelf. In this model, fluctuating sea levels and longshore drift spread the sands over a belt 40 to 50-mi (64 to 80 km) wide.

Burial diagenesis modified the porosity and, in the southeastern part of the area, created overpressuring in the Terryville sandstones. Subsequent structural movement in certain areas created large fractured reservoirs. Production from the tight gas sands is controlled by distinctive sedimentary and diagenetic effects which divide the area into two subareas: the normally pressured and the overpressured Terryville. Utilization of these concepts should result in a higher degree of success in economically developing the tight gas sands of the Cotton Valley Terryville.

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Structural Control of Lower Vicksburg (Oligocene) Turbidite Channel Sandstones, McAllen Ranch Field, Texas

Lower Vicksburg sandstones at McAllen Ranch field produce gas from depths of 9,300 to 15,000 ft (2,800 to 4,500 m). The sandstones have an ordered sequence of sedimentary structures and a systematic variation in composition and texture, which indicate deposition of the sands by turbidity flow. Structure at McAllen Ranch is a large, asymmetrical, southeast-plunging, anticlinal nose bounded on the west by a major growth fault. This structure is cut by numerous, smaller, growth and antithetic faults. To the west of the field is a Jackson shale uplift. Structural movement was active during deposition and controlled depositional patterns and facies distribution of the sandstones.

Three distinct facies were determined from examination of cores. Facies 1 has thick, stacked sequences of massive and laminated sandstones with very little shale. Facies 2 sandstones are separated by thin siltstones and shales and are thinner than the sandstones in facies 1. Facies 3 has considerably more silt and shale than either facies 1 or 2. Facies and net sand isopach maps for an upper sandstone, the "M," and a lower sandstone, the "V," indicate that these sandstones were deposited in turbidite channel environments.

The Jackson shale uplift west of the field controlled deposition of the "V' sandstone. The "V" sandstone was deposited in strike-trending channels that were diverted around the shale uplift. Anomalous thinning of the sandstone down the center of the field indicates the early presence of an axial, structural high. Deposition of the "M" sandstone was controlled by the axial high and by faulting. Two major, dip-trending channels were formed on either flank of the structure. Minor, strike-trending channels were developed later along the downthrown side of faults.

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Eruption of Mount St. Helens

Numerous small seismic events on March 20, 1980, indicated the reawakening of Mount St. Helens in southwest Washington State following a 125-year dormancy. A phreatic eruption one week later began a 62-day period of steam and ash venting, and periodic snow and ash avalanches. In early April, a bulge was detected growing about 5 ft (1.5 m) per day on the north side of the mountain. By mid-May, the bulge had swollen an estimated 250 ft (76 m) from the original mountainside. Residents of the valley below were warned of possible debris and mudflows caused by failure of the bulging mountain flank.

At 8:32 a.m. Sunday morning, May 18, 1980, a 5.0-magnitude earthquake caused the bulging north flank of Mount St. Helens to slide into the valley below, uncovering a gas-charged magma chamber. The resulting catastrophic explosion ripped away the remaining north flank and destroyed approximately 125-sq mi (325 sq km) of conifer forest in a 130° arc north of the mountain. The debris flow that resulted from the failure of the bulging north flank flowed down the North Fork of the Toutle River filling the valley with hundreds of feet of debris. Subsequent mudflows continued down the valley, ultimately emptying into the Columbia River after