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

destroying hundreds of homes and buildings and filling the flood plains of the Toutle and Cowlitz Rivers with thick mud deposits. The mountain continued to erupt throughout the day, sending plumes of ash as high as 62,000 ft (18,897 m) into the atmosphere. The eruption spread pyroclastic ash 150 to 200 mi (242 to 322 km) eastward, covering parts of eastern Washington with 2 to 3 in. (5 to 8 cm) of ash. The ash continued across the United States and eventually circumnavigated the world.

Continuing seismic activity (including harmonic tremors), steam and gas venting, dome formation, periodic major eruptions, and pyroclastic flows keep residents, officials, and scientists speculating about what Mount St. Helens may do in the future. Expectations are that Mount St. Helens may continue erupting for the next two decades.

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Characterization of Uranium Ores from House-Seale Deposit, Catahoula Formation, Texas Coastal Plain

Sandstones and mudstones of the House-Seale deposit, Live Oak County, Texas, contain up to 8,000 ppm uranium as U_3O_8; however, no uranium minerals have been detected in the ore. Autoradiography of slabbed rocks and thin sections show that uranium is inhomogeneously distributed throughout the ore on both a macroscopic and microscopic scale. Thin-section petrography, scanning electron microscopy, and electron microprobe examination of these enriched regions proves that uranium is associated with platy, layered grain-coating material and clayey matrix between grains. Selective dissolution analysis indicates that 61 to 64% of total uranium is held on ion exchange sites and 36 to 39% is associated with amorphous aluminosilicate material. No significant uranium concentrations are found in amorphous iron or manganese oxides or hydroxides, nor is uranium present in other minerals.

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Abnormal Formation Pressures: Recognition, Distribution, and Implications for Geophysical Prospecting, Brazoria County, Texas

The Frio and Anahuac Formations in east-central Brazoria County, Texas, were deposited in deltaic to prodeltaic environments during the active and waning stages of growth of a piercement-style salt diapir, Danbury dome. Growth faulting is prominent in the area and abnormal pore fluid pressure is present in much of the section.

Borehole shut-in pressure measurements, drilling mud density records, and shale transit times are used to interpret distribution of subsurface pressures. Three pressure regimes are defined in terms of vertical pressure gradients: normal pressure (0.465 psi/ft), soft overpressure (0.465 to 0.70 psi/ft), and hard overpressure ($>$ 0.70 psi/ft). Distribution of these pressure regimes is controlled by the distribution of sands in the sedimentary section, and the extent of flow continuity within them. Flow continuity can be cut off by stratigraphic pinch-out or by faulting.

Comparisons of stratigraphic thicknesses measured in boreholes with those derived from seismic reflection data show significant mis-ties if a single velocity function is used for time-depth conversion throughout the area. These mis-ties result from lateral variations in acoustic velocity which can be related to the distribution of normally and abnormally pressured zones in the subsurface.

Abnormally pressured zones have lower acoustic velocities than the normally pressured zones above and below them. Where these abnormal zones exist and dip significantly, lateral velocity variations should be expected.

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Source-Rock Potential of Austin Chalk, Upper Cretaceous, Southeastern Texas

The Austin Chalk is an impure "onshore" chalk deposited marginal to the Gulf of Mexico during the Late Cretaceous. The chalk is a reservoir, producing petroleum from the matrix and from fractures in the rock. In addition, the lower part of the Austin Chalk contains 0.5 to 3.5% organic matter, with some localized zones containing 20% organic matter.

The organic-rich chalks occur principally in deeper (greater than 5,000 ft or 1,524 m), basinward cores, whereas the organic-poor chalks occur in shallow cores on the San Marcos platform. The organic matter is similar in the chalk and in the underlying Eagle Ford Formation, although there is typically more organic matter in the shales of the Eagle Ford Formation. The kerogen is amorphous, sapropelic (Type II) kerogen that yields large amounts of saturated and aromatic hydrocarbons upon burial. Although hydrocarbon generation commences at about 2,000 ft (610 m) burial, the peak zone of petroleum formation is between 6,000 and 8,000 ft (1,828 and 2,438 m). At these depths, mature petroleum occurs in the matrix and in fractures in the chalk, whereas at greater depths gas is forming.

The hydrocarbons in the chalk include those formed in place and those formed elsewhere (probably the Eagle Ford Formation) which have migrated into the chalk. Due to increasing generation and migration of hydrocarbons with depth, the petroleum becomes lighter and enriched in saturated and total hydrocarbons with depth. At less than 3,000 ft (914 m), the petroleum is commonly heavy and depleted in saturated and total hydrocarbons, due to biodegradation or to the immaturity of the autochthonous oils.

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Diagenesis and Secondary Porosity in Vicksburg Sandstones, McAllen Ranch Field, Hidalgo County, Texas

Lower Vicksburg sandstones (Oligocene) at McAllen Ranch field in Hidalgo County, Texas, consist of thin sandstones interbedded with shales. The sands were deposited by turbidity currents as channel and overbank deposits. The sandstones produce gas from depths of 9,300 to 15,000 ft (2,800 to 4,500 m). Depositional patterns were controlled by a diapiric shale uplift and related faults. Petrographic analyses show that primary porosity was reduced during early diagenesis owing to calcite cementation. However, dissolution of calcite cement, feldspar, and volcanic rock fragments, which occurred after deep burial, led to secondary porosity development. Dissolution is evidenced by the formation of intergranular porosity, oversized pores, grain molds, and by microporosity within individual grains. Dissolution was followed by precipitation of quartz overgrowths, formation of authigenic clay minerals (kaolinite, chlorite, illite, smectite, and vermiculite), and by precipitation of iron-rich calcite cement. Scanning electron microscopy confirms that clay minerals are primarily authigenic and uniformly distributed. Chlorite grain coatings