ate grainstone cycles. The three reservoirs are offlapping and are separated from each other by clastic facies rich in terrigenous matter. The two oldest reservoirs were deposited as well-defined barrier-island complexes up to 4 mi (6.4 km) long and less than ½ mi (0.8 km) wide. The youngest reservoir is less well defined and was deposited primarily as coalescing bars which were only occasionally emergent. All carbonate facies were deposited as mud-free oolitic and rhodolitic grainstones. Most porosity occlusion was by early cementation in the meteoric phreatic and mixed phreatic zones, paralleling depositional strike.

Ten of the 13 producing wells and all four dry holes were conventionally cored. Thin sections were made at 1-ft (0.3 m) intervals from perm plugs, corresponding with measured values of porosity and permeability. Detailed petrographic correlation of wells allowed the individual reservoirs to be subdivided into distinct mappable units on the basis of a plot of the diameter of the largest coated grain ("clasticity index") in each thin section. Clasticity index provides a simple, rapid tool for precise well correlation within individual reservoirs; the correlation is not possible by conventional log methods.

Prior to the incorporation of petrographic analysis in the development drilling program, the field consisted of seven producing wells and three dry holes. Combining clasticity plots and other petrographic information with porosity isopach values enabled the field size to be almost doubled with the successful completion of the next six holes.

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Bayou Middle Fork Field, Claiborne Parish, Louisiana—Case History from Discovery to Waterflood

Bayou Middle Fork field, Claiborne Parish, Louisiana, is located in north-central Louisiana near the Arkansas-Louisiana border in an area known as the "State-Line trend" of the Upper Jurassic Smackover Formation. Smackover production in the area is associated with a complex fault system masked by approximately 10,000 ft (3,000 m) of younger sediments. A geophysical program combined with geologic studies indicated a faulted, deep-seated east-west-trending anticline. On the basis of this evidence, Cities Service Co. drilled a test well on the structure and discovered the Smackover reservoirs at Bayou Middle Fork field in March 1975.

Core and sample studies made as the field developed showed the Smackover at Bayou Middle Fork field to be a limestone composed mainly of oolites, hardened pellets, pisolites, oncolites, and micrite. This limestone has been divided into three units designated as the Smackover A, B, and C. The general environmental setting that produced these sediments varied from low- to high-energy conditions over a broad, shallow, gradually south-sloping marine shelf. This environmental setting underwent continual minor sea-level fluctuations and structural changes, producing an interfingering and mixing of the various carbonate sediments. One major change occurred as sea level completely receded. The shelf was exposed to supratidal conditions which resulted in the deposition of evaporitic and continental sediments. This regression ended Smackover "C" deposition and produced the Buckner "B" member of the stratigraphic section, which was followed by a partial transgression and subsequent regression resulting in the Smackover "B" and "A" being deposited in an offlap sequence. This second withdrawal of the sea ended Smackover deposition and again produced conditions for accumulation of supratidal and continental sediments.

Porosity preserved within the oolitic rocks is primary intergranular and has been enhanced by leaching of the oolites. Effective porosity varies from a low of 8% to a high of 23.7% and permeability ranges from less than 1 to 270 md. During early development of the field, the porosity and water values from log analysis indicated the possibility of substantial water production. However, as wells were completed, no water was produced; scanning electron microscope and petrographic work revealed the presence of microporosity containing irreducible water.

Smackover production at Bayou Middle Fork field is from three separate reservoirs, the Smackover "C," and upper and lower "A." The lower Smackover "A" reservoir, the largest of the three, contains volatile oil, that through primary production is produced by solution gas drive, with recovery of only 20% of the oil in place. To provide pressure maintenance, a water-drive system was chosen. It is estimated that an additional 20% of the oil in place will be produced by the waterflood program.

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Interpretive Well-Logging Concepts Solve South Texas Formation-Evaluation Problems

Proper selection and application of properly calibrated well logs provides valuable information for exploration, drilling, and reservoir engineering. Interpretive log-derived concepts allow determination of subsurface pressure, temperature, and salinity variations, define the type of depositional environment, and evaluate the production potential of clastic and carbonate reservoir rocks. Overpressure detection and pore-pressure evaluation are of further assistance. Gamma-ray spectral-logging techniques have located permeable and/or fractured reservoir intervals in the Cretaceous carbonate trend (Austin Chalk, Eagle Ford Shale, and Buda Limestone), to determine the source-rock potential of shales, and the type of clay minerals present. A new method allows a reliable log-derived estimate of the cation exchange capacity and hence improved water saturation estimates in shaly, hydrocarbon-bearing clastic reservoir rocks.

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Log Evaluation of "Tight Rocks" of South Texas

South Texas has several productive zones that can be described as "tight rocks"—the relatively low-porosity, low-permeability sandstones of lower Oligocene, Eocene, and Upper Cretaceous Gulfian Series. They include such important producing formation as "Deep