Monday, January 23, 2006

Westchase Hilton • 9999 Westheimer
Social 5:30 p.m., Dinner 6:30 p.m.

Cost: $25 Preregistered members; $30 non-members & walk-ups

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by ***Ezat Heydari***
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A Microbial Smackover Formation and the Dual Reservoir-Seal System at the Little Cedar Creek Field in Conecuh County, Alabama

Little Cedar Creek Field appears to be the largest Smackover field discovered in the Northern Gulf Coast Province in the last three decades. At this time, the field demonstrates an oil column of at least 700 feet and extends along strike over 7 miles. Development drilling is ongoing.

From nearly 20 conventional cores taken throughout the field, it is apparent that two separate reservoirs exist in the Smackover: an upper ooid/peloid grainstone shoal facies and a lower microbiolite/thrombolite bindstone reef facies. These two reservoirs are underlain, separated and overlain by tight mid-ramp, lagoonal and tidal flat limestones, respectively.

Little Cedar Creek Field is also unique because both of its reservoirs are composed predominately of limestone, not dolomite

The lower, reefal reservoir is only partially dolomitized and characterized by porosities of 6% to 25% with permeabilities in excess of 1 Darcy. The thickness of this lower reservoir varies from 2 to 50 feet. The upper ooid shoal reservoir varies from 0 to 30 feet in thickness and is somewhat tighter, less permeable and only partially dolomitized. Each reservoir possesses its own distinct oil/water level and each reservoir pinches out in an updip direction.

Unlike virtually all other Smackover fields in the Eastern Gulf, Little Cedar Creek Field does not possess a Buckner anhydrite top seal immediately overlying the Smackover reservoir. Furthermore, Little Cedar Creek Field is also unique because both of its reservoirs are composed predominately of limestone, not dolomite, as is the case in most Smackover fields in the region.

The Smackover Formation is only 80 to 100 feet (24 to 30 m) thick and consists of seven distinct lithofacies at Little Cedar Creek Field. From the base to the top, the following lithofacies are recognized: (1) a laminated peloid wackestone (mid-ramp) which overlies the red conglomerates (alluvial fan) of the Norphlet Formation with a sharp contact; (2) a bioturbated, peloid packstone (mid-ramp); (3) a microbial bindstone (inner ramp); (4) a laminated peloid wackestone-packstone (inner ramp); (5) a bioturbated peloid packstone (lagoonal); and (6) a peloid-ooid grainstone (beach). These nearly pure carbonate lithofacies are overlain by a mixed regime of lime mudstones, red and green shales, sandstones and conglomerates (lithofacies 7) interpreted as Smackover mixed carbonate and siliciclastic tidal flat deposits. The sequence of lithofacies and their respective depositional environments indicate a shoaling-upward cycle that formed by southward progradation following the rapid transgression of the Smackover sea. Virtually every lithofacies of the Smackover Formation exhibits microbial features, making the entire thickness of the formation microbial in origin at this location. Such a situation was probably caused by harsh environmental conditions imposed by the geometry of the embayment and the ramp, low-energy conditions and poor seawater circulation.

The microbial bindstone and ooid grainstone lithofacies are highly porous and permeable, forming two distinct reservoirs at the Little Cedar Creek Field. The microbial bindstone reservoir consists primarily of pellets and peloids bound by microbially and abiotically precipitated cements. Framework and intergranular pores generate porosities of 6% to 25% and permeabilities as high as 1.5 Darcies. The microbial reef reservoir is overlain by the nonporous and nonpermeable bioturbated peloid packstone lithofacies (5 to 20 feet) forming the seal over this reservoir. The cause of the preservation of porosity in the microbial bindstone was marine cementation that prevented extensive burial compaction.

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The ooid grainstone reservoir is cross-laminated and has intergranular, moldic, vuggy and intercrystalline porosity types. The abundance of microbially coated grains and composite particles suggests a low-energy beach where microbial activities were an integral part of the environment. The ooid grainstone reservoir grades upward into nonporous and nonpermeable wackestone and packstone facies, and eventually to green and red shale and sandstone layers. The reason for the preservation of porosity in the ooid grainstone reservoir was early meteoric diagenesis, which produced moldic and intercrystalline pore spaces.

The Little Cedar Creek Field was discovered in 1994 when Hunt Oil Company drilled the #1 Cedar Creek Land & Timber 30-1. The Smackover Formation was perforated at a depth of 11,870–11,883 feet and tested at the rate of 108 barrels of oil per day. The original bottom hole pressure was 4300 psi, producing 46 degree API gravity oil. The Hunt well produced for several years, flowing at an average rate of 43 BOPD.

Midroc Operating Company offset the Hunt discovery in 2001 with the drilling of the #1 Cedar Creek Land & Timber 19-15. The Midroc well was completed at a rate of 250 BOPD from the same stratigraphic interval in the upper Smackover Formation. Since that time Midroc Operating Company has drilled 22 additional successful wells in an east-northeast direction from the original discovery. The average completion on the last 22 wells is 270 BOPD and roughly 250 MCFPD.

Such an important and unique discovery prompted us to conduct a comprehensive study of the Smackover at Little Cedar Creek Field to evaluate the conditions that led to the formation of such a major dual-reservoir system. The purposes of this investigation are the following: (1) to provide a detailed description of lithofacies of the Smackover Formation in the field, with particular attention given to the reservoir and seal lithofacies characteristics; (2) to interpret the depositional environments of the Smackover Formation in order to decipher conditions that led to deposition of this dual reservoir setting; and (3) to speculate on future exploration strategies for similar Smackover reservoirs. ■

Biographical Sketches

Lawrence R. Baria After receiving his BS and MS degrees from Northeast Louisiana University, where he studied stratigraphy and sandstone petrology, Larry Baria attended LSU to work on PhD studies in stratigraphy, carbonate and sulfate diagenesis. Early in his career he worked with Getty Oil Company's E&P Research Lab, specializing in Cretaceous and Jurassic stratrigraphy worldwide. Since 1980 he has been a consulting and exploration geologist active in the Central and Eastern Gulf Coast and the Middle East working primarily in the Smackover and other Mesozoic carbonates. His interests revolve around the relation between sedimentary petrology, the recognition of depositional environments and the interpretation of seismic stratigraphy as applied to oil and gas exploration.

Ezat Heydari finished his undergraduate studies in geology at the University of Tehran in Iran. His graduate education in geology includes a Master's degree from the Pennsylvanian State University and a PhD degree from Louisiana State University. He has worked as a research scientist at LSU and at the Mississippi Office of Geology. He is currently an Assistant Professor at Jackson State University. He has conducted research on sedimentology and diagenesis of Mesozoic formations of northern U.S. Gulf Coast and Permian and Triassic strata of Iran. His interests revolve around depositional environment, diagenesis and geochemistry of carbonate rocks to solve issues related to fluid-rock interactions and to the Earth's history.