**AAPG HEDBERG CONFERENCE**
***"Microbial Carbonate Reservoir Characterization"***
**June 4-8, 2012 – Houston, Texas**

# Workflow for Reservoir Characterization, Formation Evaluation, and 3D Geologic Modeling of the Upper Jurassic Smackover Microbial Carbonate Reservoir Facies at Little Cedar Creek Field, Northeastern Gulf of Mexico

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Little Cedar Creek Field is a mature oil field located in southeastern Conecuh County, Alabama, in the northeastern Gulf of Mexico. As of March 2011, 12.7 MMSTB of oil and 12,430.6 MMSCF of natural gas have been produced from the field area. The main reservoirs are microbial carbonate facies and associated higher energy nearshore facies of the Upper Jurassic Smackover Formation that overlie conglomerate and sandstone facies of the Norphlet Formation and underlie the argillaceous, anhydritic-carbonaceous facies of the Haynesville Formation. These carbonate reservoirs are composed of vuggy boundstone and moldic grainstone, and the petroleum trap is stratigraphic being controlled primarily by changes in depositional facies. The Buckner Anhydrite is not a top seal in this field, but rather the argillaceous beds of the Haynesville Formation serve as the top seal rock.

The workflow being developed is for fields producing from microbial carbonate and associated reservoirs and consists of geological characterization, formation evaluation, and 3D geologic modeling. The following workflow is used to develop a 3D geologic model for the carbonate reservoirs. Step I involves core description and thin section analysis to divide and characterize the different Smackover facies in the field area into 7 units, beginning from the base of the Smackover: 1) transgressive lime mudstone and dolomudstone, 2) microbial (thrombolite) boundstone), 3) microbially-influenced packstone to mudstone, 4) subtidal wackestone and lime mudstone, 5) peloid-ooid nearshore/shoal grainstone, 6) tidal channel rudstone and floatstone, and 7) peritidal wackestone and lime mudstone. The main reservoir facies are the microbial boundstone characterized by vuggy porosity and nearshore/shoal grainstone characterized by moldic porosity. Step II is well log correlation and formation evaluation of 116 wells. Calculation of the correct effective porosity values and initial fluid saturations are critical at this stage. Step III is building the 3D structural and stratigraphic framework that will be populated with facies and petrophysical parameters. Multiple approaches for modeling the complex porosity and permeability inherent to the boundstone and grainstone reservoirs are used to improve the final model. These approaches include conventional object based modeling and geostatistical distribution of values based on vertical proportion maps of the facies and using training images derived from the detailed reservoir characterization. Other approaches include the use of MICP data to determine the pore network parameters and to model petrophysical rock types (PRT's). The use of PRT's improves the prediction of the porosity-permeability relationships in microbial carbonate and associated reservoirs. Step IV is using the developed static model as the foundation for calculating volumetric data, such as STOOIP calculation, and in dynamic simulation modeling to maximize recovery, reduce risk, and enhance investment in the field area. Overall, the integration of reservoir characterization, formation evaluation, and 3D geologic modeling provides a sound framework in the establishment of a field/reservoir-wide development plan for optimal primary and enhanced recovery for these Upper Jurassic microbial carbonate and associated reservoirs. Such a reservoir-wide development plan has broad application to other fields producing from microbial carbonate reservoirs.


AAPG Search and Discovery Article #90153©2012 AAPG Hedberg Conference Microbial Carbonate Reservoir Characterization, Houston, Texas, 3-8 June 2012.