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Integrated Geoscientific Study of Upper Jurassic Smackover Reef and Carbonate Shoal Reservoirs Associated with a Paleotopographic Basement Structure: Appleton Field, South Alabama

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In 1967, oil was discovered in the Upper Jurassic Smackover Formation in Toxey Field, Choctaw County, Alabama. This discovery was located on a Paleozoic basement high of the updip basement ridge play of the eastern Gulf Coastal Plain. Subsequent paleohigh discoveries followed, including Appleton Field, Escambia County, Alabama, in 1983.

Initially, petroleum explorationists drilled the crests of the basement highs; however, such a strategy resulted in the drilling of a series of dry holes because the Smackover Formation was either absent over these high-relief paleohighs or was represented by non-reservoir quality, intertidal to supratidal lithofacies. Therefore, although delineation of a paleotopographic anomaly through the use of seismic reflection data was fundamental to a successful exploration strategy, the selection of a drill site location off the structural crest but updip of the oil-water contact was also crucial to the drilling of a productive well. Unfortunately, at that time the resolution of the seismic data did not allow the definition of the Smackover reservoir lithofacies over these features.

Appleton Field was discovered through the use of 2-D seismic reflection data and with the drilling of the D. W. McMillan 2-14 well. The discovery well was drilled off the crest of a composite paleotopographic structure. The well penetrated Paleozoic basement rock at a depth of 12,786 ft (3,897m) in the northwestern part of the field. The Upper Jurassic Norphlet Formation is not present in this well or any of the wells drilled within the Appleton Field boundary indicating the Norphlet pinches out against this paleohigh. Buckner anhydrites were encountered in the discovery well and in all wells drilled in this field. The Buckner varies in thickness in the Appleton Field from 4 ft (1.2m) to 66 ft (20m). With the successful drilling of the discovery well and the D.W. McMillan Trust 11-1 confirmation well, the field was established in 1985 and developed on a 160-acre well spacing. After the drilling of two additional successful field development wells, the D. W. McMillan Trust 12-4 well and the W. B. Graham Heirs et al. 2-16 well, the field was unitized in 1988 with a total unitized area of 840 acres.

The Appleton field structure is a northwest-southeast trending paleotopographic ridge comprised of local paleohighs. The field produces from microbial reef boundstones and shoal grainstones and packstones of the Upper Jurassic Smackover Formation. Because Appleton Field is approaching abandonment due to reduced profitability, an integrated geoscientific study of the field structure and reservoir was undertaken to determine whether drilling additional wells in the field would extend the productive life of the reservoir. The conclusion from the integrated study, which included advanced carbonate reservoir characterization, 3-D geologic visualization modeling, seismic forward modeling, porosity distribution analysis, and field production analysis, was that a sidetrack well drilled on the western paleohigh should result in improved oil recovery from the field. The sidetrack well was drilled and penetrated porous Smackover reservoir near the crest of the western paleohigh. The well tested 136 barrels of oil per day.