

3-D Reservoir Characterization of the South Buckeye Field, Dundee Formation (Devonian), Michigan Basin, USA

Shawn M. McCloskey¹ and G. Michael Grammer²

¹Michigan Geological Repository for Research and Education, Western Michigan University, Kalamazoo, Michigan, shawn.m.mccloskey@wmich.edu

²Michigan Geological Repository for Research and Education, Western Michigan University, Kalamazoo, Michigan, michael.grammer@wmich.edu

Middle Devonian Dundee carbonates are prolific hydrocarbon reservoirs throughout the Michigan Basin that have produced in excess of 375 million barrels of oil from more than 100 fields. Carbonate systems are driven by dynamic processes that vary in time and space at nearly all scales, from the pore network to the regional sequence stratigraphic architecture. The internal variability and detailed facies geometry of the Dundee are not well understood. This high resolution reservoir characterization study defines the complex internal heterogeneities of the South Buckeye field by tying reservoir quality (i.e., porosity and permeability from whole core analyses) directly to seven primary depositional facies.

The fundamental goal of this study is to evaluate if the geographic distribution of patch reefs can be accurately modeled in Petrel based on core and log data without a tie to 3-D seismic by utilizing the application of geometrical data from multiple depositional analogs. Paleotopographic highs provided nucleation sites for the stromatoporoid patch reefs to grow, but within each of these reefs reservoir quality varies significantly. The internal architecture of the South Buckeye field and the distribution of patch reefs were defined through the integration of petrophysical and petrographic analyses from high density subsurface core data.

Based upon core and wireline log analysis, three end member interpretations to define the distribution and scale of the patch reef reservoirs in South Buckeye field are possible. These end-member interpretations vary on the size and continuity of the patch reefs, with models ranging from single well reefs below seismic scale, multiple well reefs with horizontal/multi-lateral potential, and two large reef bodies concluded from previous research. These end member interpretations will be modeled geostatistically in Petrel to compare 3-D visualizations of the reef complexes with known production histories from the field. As with many carbonate reservoirs, a three-dimensional static reservoir model is a critical step in the workflow for efficient hydrocarbon extraction, natural gas storage, and CO₂ sequestration, and will provide insight into the Michigan Basin Dundee patch reefs as well as possibly other Devonian carbonates and patch reef trends around the world.