# Reservoir Modeling and Analysis of Niagaran Reefs, Michigan Basin

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## Abstract

The depleted hydrocarbon reservoirs that exist in the Michigan Basin, specifically Silurian-aged pinnacle reefs, provide ideal storage reservoirs for natural gas and CO2 sequestration. This study aims to construct a robust geological reservoir model that combines core, petrophysical, and seismic data to identify favorable zones for natural gas storage. The Michigan Basin spans much of the Lower Peninsula of Michigan. It is bordered to the southwest by the Kankakee Arch, and the southeast by the Findlay Arch. To the West, the basin is bordered by the eastern shore of Wisconsin, and reaches to Ontario at its easternmost border. This basin has been a historically prolific hydrocarbon producer, with Silurian Pinnacle Reefs being a main reservoir target. These reefs are located along the southeastern border of the Michigan Basin, and are in a Northeast-Southwest trend around the basin in southeastern Michigan. Extensive dissolution is present in the reef, which leads to widespread heterogeneity in the reservoir. Despite heavy production, a robust seismic-constrained model has not been constructed for these reservoirs. Furthermore, typical reservoir models lack the incorporation of 3-D seismic data, and including this in the study allows for better lateral constraints of the model. First, a structural framework is constructed by utilizing seismic data to outline the large-scale structure. Key stratigraphic surfaces are then interpreted after calibrating the seismic data to well logs. The generation of seismic attributes such as coherence and instantaneous frequency allows for more detailed seismic mapping. Coherence allows for the interpretation of the edges of the reef complex, and low instantaneous frequency values correspond with zones of higher porosity. Core analysis allows for the identification and grouping of lithofacies that then can be identified in well logs. Lithologies in non-cored wells are predicted using an Artificial Neural Network

(ANN), and the lithofacies within the reef are mapped out and correlated. An appropriate geostatistical model is then constructed and calibrated using log cut off values derived from the core to log calibration values and proper variograms. The reservoir quality of the reef system is then mapped out in three dimensions to highlight compartmentalized zones of high porosity to target for natural gas storage. The constrained geologic reservoir model allows for the identification and interpretation of architectural elements that are key to the understanding of the heterogeneous reservoir.

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