Reservoir Characterization and 3D Modeling of Silurian Reef Slopes: Pipe Creek Jr. Quarry, Grant County, Indiana

G. Michael Grammer[1], Jim Karsten[1], Dennis Prezbindowski[2], Benjamin Dattilo[3], and Jonathan Havens[4]

[1]Oklahoma State University
[2]Petroleum Consulting Inc.
[3]Department of Biology, Indiana University-Purdue University Fort Wayne
[4]Irving Material Inc.

ABSTRACT

Silurian reefs are significant hydrocarbon reservoirs in the Michigan Basin, having produced over 490 MMBO and 2.9 TCF of gas. Primary production from the reefs is typically low, averaging 20-25% due to the complex internal heterogeneity of the reservoir. To date, a majority of the exploration and development of these reservoirs has been directed towards the cores of the reefs, rather than the associated reef slope deposits. Slope deposits of the Pipe Creek Jr. reef exhibit many similarities to productive slope reservoirs in the rock record (e.g. Poza Rica trend in Mexico; Malampaya in the Phillipines; Tengiz and Karachaganak in the Caspian region). As such, the depositional processes and resulting geometries of potential reservoir and seals in these Silurian reef slopes, as well as early diagenetic modification and effect on reservoir quality, likely have many similarities to those found in other forereef reservoirs. The current study is focused on the forereef slope deposits of the Pipe Creek reef complex and includes an in-depth analysis of the facies distribution, bed geometries, and reservoir characterization of the reef slope deposits, coupled with the development of a drone-based, georeferenced, 3-D outcrop model developed in Petrel. The Pipe Creek Jr. Reef has been previously studied with a focus on faunal assemblages, dolomitization of the reef, and the general depositional facies of the reef core. The reef complex has an inferred circular structure, with a minimum thickness of 48m, and the original height of the reef has been speculated as being anywhere from 35 to 200 meters. The exposed reef flank (forereef) facies consist of a mixture of coarse skeletal grainstone-packstones, stromatactis mudstone-wackestones, and argillaceous silty dolomite mudstones. Similar to what is seen in other forereef deposits, lenticular bedding consisting of skeletal packstones and grainstones deposited by grainflow processes make up the majority of the 40-45 degree depositional slopes. In addition, slump scars and channels are common, as are resedimented blocks from the inferred reef crest. Synsedimentary (Neptunian) dikes filled with marine cements are also common. Insights related to reservoir architecture in the forereef facies of these Silurian reefs can potentially open up additional exploration and development opportunities and increase hydrocarbon recovery efficiencies in existing similar complex reef reservoirs.