An Analysis of a Near-Surface Big Clifty (Jackson) Sandstone Reservoir in Logan County, Kentucky*

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Abstract

The Big Clifty (Jackson) Sandstone Member of the Golconda Formation is the most important of the Mississippian (Chesterian) heavy-oil reservoirs in the southeastern Illinois Basin. Heavy oil reservoirs, or asphalt rock deposits, have been studied extensively in south central and western Kentucky, and ~2 billion barrels of original oil in place (OOIP) is proposed to occur in the Big Clifty. Heterogeneities related to depositional facies changes are poorly understood in Kentucky, where the Big Clifty has been mostly described as a 60-120 feet thick sandstone unit. In some locations, in contrast, such as at the Stampede Mine in Logan County, the Big Clifty occurs as two distinct sandstone bodies with intercalated mud-rich units. Currently no predictable depositional model exists to explain abrupt facies changes observed during open pit mining conducted over the last couple of years.

This study integrates sedimentological, stratigraphic, and geophysical datasets to characterize the lithological changes occurring in Big Clifty reservoirs and may be used as a model down dip into the basin where conventional-oil Jackson reservoirs are targeted. Datasets used in this study include over 30 cores retrieved from across Stampede Mine's acreage, surface-mine exposures, Electrical Resistivity Tomography (ERT) surveys, and bitumen concentration values.

The Big Clifty Sandstone formed in a tidally influenced deltaic system occurring on a low-angle dipping ramp. Shallow marine ichnofacies occur in rhythmically bedded deposits. A brecciated mudstone and red-green shale occurs above the lower sandstone reservoir. This muddy facies represents an exposure surface that separates regressive and transgressive parasequences. Sedimentary features and bitumen concentration vary across the exposure surface making bitumen concentration trends difficult to ascertain without close subsurface control. The extent of channelized sandstone bodies and bitumen-rich units however can be generally documented.

References Cited

Baker, R.J., 1980, Geology of the Big Clifty formation in the Wheatonville consolidated oil field in Gibson County: Master’s Thesis, Ball State University, 85 p.


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Abstract

The Big Clifty (Jackson) Sandstone Member of the Gault Formation is the most important of the Mississippian (Chesterian) heavy-oil reservoirs in the southeastern Black River. Heavy-oil reservoirs, or asphalt-rod deposits, have been studied extensively in south central and western Kentucky, and -3 billion barrels of original oil-in-place (OIP) has been proposed to occur in the Big Clifty Sandstone. Despite high OIP estimates, heterogeneities in the reservoir negatively impact the production of heavy oil deposits. Heterogeneities related to depositional facies changes are poorly understood in the Big Clifty Sandstone of Kentucky, where it has been mostly described as a 100-200 ft thick sandstone unit. To overcome this, the authors collected core samples from 3 exploration wells in the Logan County, Kentucky area. The core samples were exposed to high-resolution imaging techniques to define heterogeneous nature of the reservoir. In addition, the core samples were analyzed for Seneca core, including porosity, permeability, and petrophysical characteristics. These analyses were performed at the University of Kentucky, Department of Geosciences. The study concludes with a detailed analysis of the reservoir heterogeneity and potential production opportunities. The results will be used to improve reservoir characterization and development plans for the Big Clifty Sandstone in Logan County, Kentucky; these efforts will enhance production and reduce the negative impacts of heavy-oil deposits in the area.

General Methodology

This study is primarily based on cores taken from the Stampsdale Mine and surrounding areas in Logan County. The core samples were subjected to high-resolution imaging techniques, including Seneca core, to determine the reservoir characteristics. These techniques included high-resolution imaging, core analysis, and Seneca core, yielding detailed measurements of surface exposure and core changes. These measurements were used to create a detailed reservoir characterization model. The study also included the collection of Seneca core, including porosity, permeability, and petrophysical characteristics. This analysis was performed at the University of Kentucky, Department of Geosciences. The results of this study will be used to improve reservoir characterization and development plans for the Big Clifty Sandstone in Logan County, Kentucky; these efforts will enhance production and reduce the negative impacts of heavy-oil deposits in the area.
Select Reservoir Tectonic, Sedimentological & Fracture/Fault Characteristics

In Stampede Mine Pit

Exposure Surface & Pedogenic Horizon

Net Sand Isopach Maps

Geophysical Surveys – For Reconnaissance and Pit Mining

Outcrops of Select Facies Away from Mine

Carbonate Partitions in Big Cliffy

Acknowledgements

Conclusions

References