Volumetric and 3-D Property Modeling of the Grand Tower Formation in the Salem Field, Southern Illinois

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ABSTRACT

Since its discovery in 1938, Salem Field, in south-central Illinois, has produced over 400 million barrels of oil from Mississippian and Devonian reservoirs. The main producing intervals of the Devonian Grand Tower Formation are dolomitized carbonates with vuggy and intercrystalline porosities. To date, over 1,100 wells have been drilled and completed in the formation covering an area of 19,000 acres. From 1938 to 1940, initial productions from these wells reached a producing rate of approximately 2,030 barrels of oil per day. However, the rates declined to less than 31 barrels of oil per day for those wells completed between 2010 through 2014. This study generated detailed 3-D geocellular models to characterize porosity and water saturation trends, estimate original hydrocarbon in place and to identify potential areas for future enhanced oil recovery (EOR) projects. Wireline logs, including gamma ray, porosity, photoelectric, density and resistivity logs, were used to delineate 2-D and 3-D structural and stratigraphic framework of the reservoir. The 3-D structural framework was divided into 4 distinct zones, 28 vertical layers, and 450,000 cells. The porosity and water saturation data were calculated from wireline logs and populated stochastically within the 3-D grids, using Sequential Indicator Simulation (SIS) and Sequential Gaussian Simulation (SGS) algorithms. Examination of property models revealed that the main hydrocarbon bearing intervals consist of dolomite and dolomitic limestone in the middle parts of the formation with a range of 10 to 25% porosity. The average net pay thickness of reservoir is about 60ft (18m) in northern parts of the field, decreasing southward to around 30ft (9m) due to the presence of thin and dense limestone intervals, interbedded with porous dolomite intervals. The volumetric and uncertainty analysis indicates that the stock tank original oil in place (STOOIP) of the Grand Tower Formation in the field is approximately 218 million barrels of oil. This research suggests that there are significant oil reserves still to be recovered. The 3-D models in this study can be used for locating potential sites for water flooding and EOR.