Using Multiple-Point Statistics for Conditioning a Zama Pinnacle Reef Facies Model to Production History

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ABSTRACT

Since October 2005, the Zama oil field in northwestern Alberta, Canada, has been the site of acid gas (approximately 80% carbon dioxide [CO_2] and 20% hydrogen sulfide [H_2S]) injection for the simultaneous purpose of enhanced oil recovery (EOR), H_2S disposal, and CO_2 storage. Injection began in December 2006 and continues through the present at a depth of 4900 feet into the Zama F Pool, which is one of over 800 pinnacle reef structures identified in the Zama Subbasin. To date, over 90,000 tons of acid gas has been injected, with an incremental production of over 50,000 barrels of oil. The primary purpose of this work is to verify and validate stored volumes of CO_2, with the ultimate goal of monetizing carbon credits.

Pinnacle reefs have very complex geologic and facies relationships, and as a result, a thorough understanding of the geology is necessary in order to properly monitor and predict fluid movement in the reservoir. Core-calibrated multimineral petrophysical analysis was performed on well logs, and borehole image logs were used to more accurately identify the different facies and determine each facies' properties along the wellbores. Seismic attribute data interpretations were used to identify the reef versus nonreef facies to aid in the distribution of the facies in the reservoir. These properties were then spatially distributed throughout the reservoir using a combination of multiple-point statistics and object modeling to produce equiprobable reef facies, structure, and volumetric realizations. These equiprobable static realizations were ranked to further use them in dynamic modeling.

Both static and dynamic models will be further conditioned to obtain a reasonable match between simulated results and historical data. A more realistic depiction of geological and reservoir features using the approach adopted in this study is expected to provide more reliable dynamic models for simulating long-term behavior and migration of the injected gas plume. A few of the best-matched dynamic models will then be used to predict ultimate CO_2 storage capacity. Long-term (>100 years) prediction simulations coupled with monitoring data will help in developing a cost-effective monitoring plan for ensuring safe and effective storage of injected acid gas in the depleted F Pool oil reservoir.