FURTHER CHARACTERIZATION OF ZAMA ACID GAS EOR, CO_2 STORAGE, AND MONITORING PROJECT COMPLETED

Plains CO_2 Reduction (PCOR) Partnership Phase III
Task 15 – Milestone M40

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FURTHER CHARACTERIZATION OF ZAMA ACID GAS EOR, CO_2 STORAGE, AND MONITORING PROJECT COMPLETED

Phase III of the Plains CO_2 Reduction (PCOR) Partnership is focused on large-scale, commercial demonstration of carbon dioxide (CO_2) storage in geologic sinks. One of the Phase III projects continuing from Phase II is the Zama project, a combined acid gas enhanced oil recovery (EOR) and storage project in the carbonate pinnacle reefs of the Zama oil field in northwestern Alberta. These pinnacles represent an excellent opportunity to recover incremental oil through EOR and have a large potential to store CO_2. With Apache Canada planning to continue its commercial injection operations beyond 2017, the PCOR Partnership was tasked with further characterization of this project during Phase III. Laboratory tests were conducted to study the effects of acid gas on storage integrity, and a rigorous geocellular modeling and simulation workflow was performed for several Zama pinnacles, with the purpose of developing a solid platform for both oil recovery and CO_2 storage at Zama. These additional characterization activities for the Zama project have been completed.

Six pinnacle reefs currently undergoing acid gas EOR were evaluated. The additional characterization focused on 1) estimating the feasibility of using existing wells to inject and store acid gas, 2) evaluating gas–rock reactions to further understand potential geochemical reactions, 3) developing a robust PVT (pressure, volume, temperature) model to predict miscibility behavior, 4) constructing high-resolution geocellular models, and 5) conducting dynamic reservoir simulations to develop effective strategies for EOR and long-term CO_2 storage.

The following work was conducted as part of the additional characterization activities for the Zama project (a complete report is in preparation):

- The feasibility of using existing wells as storage sites was evaluated. Wellbore integrity for CO_2 injection wells was demonstrated from both the standpoint of maintaining cost-effective carbon capture and storage operations and protecting the environment, especially drinking water sources. The effects of a typical Zama acid gas stream on the three materials that comprise the wellbore—reservoir rock, cement, and steel casing—were examined by a series of laboratory-based activities.

- The potential risks and factors related to cap rock degradation during long-term storage have been fully investigated and analyzed. Since there were no laboratory geochemical experimental data to support or refute the results of the Phase II study, laboratory activities were conducted to directly examine the geochemical interactions between Zama reservoir rocks, brine, and injectant (CO_2 and H_2S) under Zama reservoir pressure and temperature conditions.

- Efforts were made to minimize data gaps and reduce uncertainty during modeling. A wide variety of data (both geological and operational) were obtained to support modeling efforts, including petrophysical, completion, core analysis, fluid properties, and production.

- Rigorous PVT models were created for the F, G2G, and Muskeg L pools. In the phase behavior study, the minimum miscibility pressure (MMP) was estimated. The effect of H_2S on MMP was investigated, as were MMP changes due to reservoir depletion.

- High-resolution geocellular models for the F, G2G, and Muskeg L pools were constructed. Each of these models was history-matched, and the flooding efficiencies of current production and injection systems were analyzed using production data.

- EOR prediction scenarios for the F, G2G, and Muskeg L pools were simulated based on the analysis of current production conditions and continuing EOR operations into the future to gain insight into the potential for incremental oil recovery and long-term CO_2 storage capacity.

- A methodology was generated to quickly and efficiently evaluate the storage potential for other similar pinnacles. The results of this evaluation could be used to determine EOR and storage potential for other pinnacles in the Zama Field (Z3Z, NNN, and RRR) and other pinnacles throughout the world.