GEOCHEMICAL MODELING OF CARBON DIOXIDE INJECTION INTO CARBONATE FORMATION IN THE NORTHWEST MCGREGOR OIL FIELD FOR CO_2 STORAGE AND ENHANCED OIL RECOVERY (EOR)

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ABSTRACT

Injection of carbon dioxide (CO_2) for the purpose of enhanced oil recovery (EOR) is widely regarded as one of the key commercial applications of geological storage that will provide valuable insight into large-scale projects aimed at reducing CO_2 emissions to the atmosphere. The Plains CO_2 Reduction Partnership, one of the seven U.S. Department of Energy National Energy Technology Laboratory Regional Partnerships, is conducting a project in the Northwest McGregor oil field in North Dakota to determine the effects CO_2 will have on the productivity of the reservoir, wellbore integrity, and the carbonate formation into which CO_2 was injected. The method used in this project is "huff 'n' puff" whereby 400 tons of supercritical CO_2 was injected into a well over a 2-day period and allowed to "soak" for a 2-week period. Then the well was subsequently put back into production to recover incremental oil.

The purpose of this paper is to outline the approach and current observations for the numerical modeling of potential geochemical reactions in order to evaluate the short-term risks for operations (e.g., porosity and permeability decrease) and long-term implications for CO_2 storage via mineralization. Mineralogy of the reservoir was determined using well logs, traditional core sample analysis, x-ray diffraction, and QEMSCAN techniques. Using the results of these analyses, the mineral phases selected for model inputs were anhydrite, calcite, dolomite, illite, K-feldspar, and traces of pyrite. A pressurized bottom-hole fluid sample was also collected, and its composition was determined. The results of this fluid sample were also used as input parameters for the model.

Modeling was performed using PHREEQC and Geochemist Workbench software in order to determine the most favorable geochemical interactions, evaluate in situ fluid properties, etc. The Computer Modelling Group Ltd. GEM simulator was utilized for the creation of a 2-D cross-section model for reactive transport evaluation. It was determined that the already reducing environment of the Northwest McGregor oil field should not experience any significant changes in mineralogy, especially in the near term. However, the possibility of minor reprecipitation of pyrite and precipitation of siderite exists. Also, the long-term (over 10,000 years) dissolution of calcite with a following precipitation of gypsum and dolomite may occur.