ConocoPhillips

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January 24, 2010

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Mr. Richard Ezeanym, P.E.
Chief Engineer
New Mexico Oil Conservation Division
1220 South St. Francis Drive
Santa Fe, New Mexico 87505

Reference: Technical Report Request
Pilot CO_2 Sequestration injection Project
Order No. R-12836
Case 13933
30-045-34305

Dear Mr. Ezeanym,

Pursuant to Order No. R-12836, Conoco Phillips and the partners of the Southwest Regional Partnership in San Juan Basin hereby submit its preliminary version of the final report on the results of the Pilot CO_2 Sequestration Injection Project within the Basin-Fruitland Coal Gas Pool (the Pump Canyon project).

As you are aware, this is one of seven regional partnerships sponsored by the U.S. Department of Energy (USDOE), and as per their requirements, this submission will be reviewed by USDOE before they will publish it as the final report for this project. Upon receipt of the USDOE version of the final report, we will submit a copy to you.

We thank you again for providing the time extension to compile and submit this comprehensive report. Should you have any questions, please don't hesitate to contact me.

Sincerely,

Sharon R. Zubrod
Manager, Stakeholder Engagement and Regulatory Affairs

Cc: NMOCD Aztec – Charlie Perrin
COP – Bill Akwari

SOUTHWEST PARTNERSHIP
CO2 SEQUESTRATION

Southwestern Regional Partnership For Carbon Sequestration (Phase 2)

Pump Canyon CO_2- ECBM/Sequestration Demonstration, San Juan Basin, New Mexico

Final Report

Submitted by:
Advanced Resources International, Inc.
Houston, TX

January 31, 2010

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Disclaimers

This is a preliminary version of a Final Report that will be submitted to the National Energy Technology Laboratory for publication by the U.S. Department of Energy.

U.S. Department of Energy

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Executive Summary

The Southwest Regional Partnership on Carbon Sequestration (SWP) is one of seven regional partnerships sponsored by the U.S. Department of Energy (USDOE).

Within the SWP, three demonstrations of geologic CO_2 sequestration are being performed – one in an oilfield (the SACROC Unit in the Permian basin of west Texas), one in a deep, unmineable coalbed (the Pump Canyon site in the San Juan basin of northern New Mexico), and one in a deep, saline reservoir (underlying the Aneth oilfield in the Paradox basin of southeast Utah). The Pump Canyon CO_2-enhanced coalbed methane (CO_2/ECBM) sequestration demonstration project plans to demonstrate the effectiveness of CO_2 sequestration in deep, unmineable coal seams via a small-scale geologic sequestration project. The site is located in San Juan County, northern New Mexico, just within the limits of the high-permeability fairway of prolific coalbed methane production. The study area for the SWP project consists of 31 coalbed methane production wells located in a nine section area.

CO_2 was injected continuously for a year and different monitoring, verification and accounting (MVA) techniques were implemented to track the CO_2 movement inside and outside the reservoir. A total of 256 MMscf of CO_2 (or 14,885 tons) were injected over a 12-month period (July 30st, 2008 to August 12th, 2009); primarily due to highly permeable coal. However, as expected, the CO_2 injectivity dramatically decreased over the injection period. This was mainly due to matrix swelling and permeability reduction, as a result of the CO_2 being adsorbed onto the coal, while displacing methane, as well as increasing reservoir pressure. It was also determinded that injection was predominately into the basal coal, reducing injectivity by 20%.

The CO_2 sensors installed at the three immediate offset wells, as well as the gas sampling from neighboring CBM wells (three immediate offset wells and an additional ring of immediately surrounding wells), suggest that no CO_2 breakthrough has occurred at the site. However, a steady increase in the CO_2 content at one of the offset wells, the FC State Com 1, might be a sign of breakthrough. The CO_2 monitoring system has been left in place and the data will be regularly updated to verify whether this is the case.

Perfluorocarbon tracers injected in the CO_2 stream showed up a few months later at the two closest offset wells, the FC State Com 1, followed by the EPNG Com A 300 (where breakthrough is expected to occur first due to its alignment with the face cleats, if it does occur). This may also could be an early sign of breakthrough.

In addition to monitoring for breakthrough, the project also adopted several ground monitoring techniques to observe any ground deformation. The different ground monitoring techniques used (Tiltmeters, GPS and InSar) all converge to the same conclusion, that no ground deformation is seen even though their effectiveness was probably limited due to the small amount of CO_2 injected.

In order to assess the integrity of the site, the project conducted a thorough seismic interpretation of about nine square miles of 3D seismic data centered around the injection well. The seismic interpretation reveals considerable stratigraphic complexity in the Fruitland formation depositional system. Post-stack processing of the 3D seismic suggests the presence of fracturing and minor faulting within the Kirtland Shale caprock, whereas indicators for extensive fracturing and faulting within the Fruitland sequence are much less apparent. However, interpreted faults and fracture zones, with limited vertical extent and major penetrative faults, have not been observed at the site reinforcing the fact that no leakage is expected. Baseline and post injection vertical seismic profiles (VSP) were collected at zero offset and three non-zero offsets, but the preliminary processing is still in progress. A detailed study of the integrity of the Kirtland Shale caprock is provided in an independent report.

The simulation work was able to adequately replicate the production/injection profile of the injector and the three immediate offset wells. The model is also showing that methane production was enhanced due to the CO_2 injection. While the match is not perfect and predicts breakthrough perhaps a bit too early, the model was successful in tying the results from the field, such as the gas samples (CO_2 content and nitrogen content), to the well performance, lending confidence in the accuracy of the match.

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Natural Tracers and Multi-Scale Assessment of Sealing Behavior at Geological CO_2 Storage Sites: Preliminary Findings from a Case Study of the Kirtland Formation, San Juan Basin, USA

Topical Report

Reporting period:
September 1, 2007 – February 28, 2010

Authors:
Jason E. Heath[1,2], Brian J.O.L. McPherson[3], and Thomas A. Dewers[4]

Date report was issued:
February 2010

U.S. Department of Energy
DOE Award No.: DE-FC26-05NT42591

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ABSTRACT

This study investigated the extent to which pore- and pore-throat-scale properties and processes govern sealing behavior of the Kirtland Formation, San Juan Basin, USA, at the site of CO_2 injection into coal seams. The Kirtland is considered a regional aquitard and reservoir seal. Nanometer- to formation-scale data facilitated evaluation of past fluid migration through the Kirtland and potential, future fluid flow. Mercury porosimetry indicates high quality sealing at the plug scale (~2.54 diameter by 2.54 cm long). However, image well logs and fracture analysis of core found open and mineralized fractures. The mineralization indicates multiple fluid-flow events through the Kirtland. Natural noble gas tracers evince stagnant, diffusion-dominated transport in the upper Kirtland, thus supporting the matrix-scale evidence of a high quality seal. The lower Kirtland has more log-based fractures than the rest of the Kirtland, and helium data indicates less diffusion-dominated transport than the upper Kirtland. Thus, the lower Kirtland, although it had the highest sealing capacity in terms of MICP data and has low matrix permeability (i.e., $\sim 8\times10^{-20}$ m^2), needs further investigation to determine if it indeed behaves as a significant barrier to fluid flow.

Keywords: seal or caprock, CO_2 or carbon dioxide, noble gases, isotopes, leakage, preferential flow path

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