CO_2 Sequestration Potential of Texas Low-Rank Coals

Quarterly Technical Progress Report

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ABSTRACT

The objectives of this project are to evaluate the feasibility of carbon dioxide (CO_2) sequestration in Texas low-rank coals and to determine the potential for enhanced coalbed methane (CBM) recovery as an added benefit of sequestration. There were two main objectives for this reporting period. First, we wanted to collect Wilcox coal samples from depths similar to those of probable sequestration sites, with the objective of determining accurate parameters for reservoir model description and for reservoir simulation. Our second objective was to pursue opportunities for determining permeability of deep Wilcox coal to use as additional, necessary data for modeling reservoir performance during CO_2 sequestration and enhanced coalbed methane recovery.

In mid-summer, Anadarko Petroleum Corporation agreed to allow us to collect Wilcox Group coal samples from a well that was to be drilled to the Austin Chalk, which is several thousand feet below the Wilcox. In addition, they agreed to allow us to perform permeability tests in coal beds in an existing shut-in well. Both wells are in the region of the Sam K. Seymour power station, a site that we earlier identified as a major point source of CO_2. We negotiated contracts for sidewall core collection and core analyses, and we began discussions with a service company to perform permeability testing.

To collect sidewall core samples of the Wilcox coals, we made structure and isopach maps and cross sections to select coal beds and to determine their depths for coring. On September 29, 10 sidewall core samples were obtained from 3 coal beds of the Lower Calvert Bluff Formation of the Wilcox Group. The samples were desorbed in 4 sidewall core canisters. Desorbed gas samples were sent to a laboratory for gas compositional analyses, and the coal samples were sent to another laboratory to measure CO_2, CH_4, and N_2 sorption isotherms. All analyses should be finished by the end of December.

A preliminary report shows methane content values for the desorbed coal samples ranged between 330 and 388 scf/t., on an “as received” basis. Residual gas content of the coals was not included in the analyses, which results in an approximate 5-10% underestimation of in-situ gas content. Coal maps indicate that total coal thickness is 40-70 ft in the Lower Calvert Bluff Formation of the Wilcox Group in the vicinity of the Sam K. Seymour power plant. A conservative estimate indicates that methane in place for a well on 160-acre spacing is approximately 3.5 Bcf in Lower Calvert Bluff coal beds. When we receive sorption isotherm data from the laboratory, we will determine the amount of CO_2 that it may be possible to sequester in Wilcox coals. In December, when the final laboratory and field test data are available, we will complete the reservoir model and begin to simulate CO_2 sequestration and enhanced CH_4 production.

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INTRODUCTION

The objectives of this project are to evaluate the feasibility of carbon dioxide (CO_2) sequestration in Texas low-rank coals and to determine the potential for enhanced coalbed methane (ECBM) recovery as an added benefit of sequestration. During this reporting period, we collected Wilcox coal samples from depths similar to those of probable sequestration sites, with the objective of determining accurate parameters for reservoir model description and for reservoir simulation. Also, we pursued opportunities for determining permeability of deep Wilcox coal to use as additional, necessary data for modeling reservoir performance during CO_2 sequestration and ECBM recovery.

EXPERIMENTAL

For this project, it is critical that we have CO_2, CH_4, and N_2 isotherms of Wilcox coal from depths similar to those at which we propose CO_2 sequestration and ECBM recovery projects. The only existing CO_2 isotherms from Texas Wilcox coals are from shallow (<400 ft deep) samples analyzed by the U.S. Geological Survey. Coals at shallow depth are thermally less mature than deeper coals and, thus, they have significantly lower sorptive capacities for all gas species. Moreover, shallow coals may have less stored CH_4 that may be produced by enhanced recovery and thus offset CO_2 sequestration costs. Therefore, a major objective of this project is to obtain isotherms for different gas species using coal samples retrieved from depths comparable to those of proposed projects. As part of this sample collection and analysis, we will measure gas content and gas chemical composition to supplement the database provided by Anadarko Petroleum.

This quarter, we worked with Anadarko Petroleum to collect sidewall core samples of Wilcox coals in a well that Anadarko was drilling to the deeper Austin Chalk in East-Central Texas. This well is in the general region of the Sam K. Seymour electric generating plant (Figure 1), which was earlier identified as a major point source for CO_2 in this area (Quarterly Report, First Quarter 2003). The well was to be drilled vertically through the Wilcox interval to near the top of the Austin Chalk, at which point the well would be drilled horizontally.

To assess data collection opportunities in advance of drilling, we made a series of cross sections and Wilcox structure, isopach, and coal maps for the region of the planned well, using geophysical well logs. Our coal maps indicate that total coal thickness is 40-70 ft in the Lower Calvert Bluff Formation of the Wilcox Group in the vicinity of the Sam K. Seymour power plant. Upon interpreting these cross sections and maps, we selected several of the Lower Calvert Bluff coals for testing. We predicted that the Lower Calvert Bluff coal zone would occur between measured depths of 5,700 and 6,300 ft in the target well (Figure 2). Rather than drilling to the end of the vertical segment of the well near the top of the Austin Chalk before collecting sidewall samples, Anadarko agreed to drill to just below the target coals (to a depth of 6,600 ft), then pull the drill string, log the well to identify and select the coal beds to be sampled, and take rotary sidewall cores. Our goal was to minimize the potential for washouts of the coals that

might occur if the well was drilled to the end of the vertical leg, several thousand feet deeper. Thus, we hoped to increase the probability of high percentage of sidewall core recovery.

RESULTS AND DISCUSSION

The well reached the target depth below the Lower Calvert Bluff coal zone on September 29. Baker Hughes logged the well, and we correlated the coals identified in our pre-drill study. We identified 10 coal beds having individual bed thickness ranging between 2 and 11 ft and total coal thickness of approximately 65 ft in the Lower Calvert Bluff. Evaluation of the caliper log confirmed excellent borehole integrity, with very little washout of coal beds. We selected 3 coal beds from which Baker Hughes attempted to collect 10 one-inch diameter sidewall core samples (Figures 3 and 4, and Table 1). Core recovery was excellent; total coal collected from the 3 coal beds was approximately 150 g.

The coal samples were retrieved from the core barrel, quickly washed, weighed, and placed in 4 canisters for desorption by an onsite geologist from Hampton, Waechter & Associates, who had been contracted to perform gas desorption analyses. We combined the 10 samples into 4 canisters to minimize desorption costs and headspace in the canisters, and to capture any gas content variations among the coal beds (Table 1). Samples were initially desorbed onsite, then they were taken to the lab for final desorption.

Preliminary reports show gas content values for the desorbed coal samples ranged between 330 and 388 scf/t (Table 1). These are “as received” values and, thus, they are not adjusted for inorganic (ash) content of the coal. Residual gas is not included in the results, which causes an approximate 5-10% underestimation of in-situ gas content. Ash and residual gas content values were not measured because gas content determination was not the primary objective of sampling. Instead, when primary desorption was completed, desorbed gas samples were sent to a laboratory for gas compositional analyses and the coal samples were shipped to CBM Solutions Laboratory in British Columbia for isotherm analyses. CBM Solutions will combine sidewall cores into one composite sample, grind the composite sample to specified size, humidify the samples to equilibrium moisture, and then perform sorption isotherms for CO_2, CH_4 and N_2. A cut of the composite sample will be used for proximate analysis and vitrinite reflectance.

The preliminary gas desorption and coal resource results indicate significant methane resources in deep Wilcox coals. Assuming conservative values, a well completed in 35 ft of coal having average methane content of 350 scf/t would have approximately 3.5 Bcf of gas in place, on 160-acre spacing (based on 1,780 tons of coal per acre-ft). Sorption isotherms, when available, will indicate the amount of CO_2 that it may be theoretical possible to store in the coal.

Our second objective for this reporting period was to pursue opportunities for determining permeability of deep Wilcox coal to use as additional, necessary data for modeling reservoir performance during CO_2 sequestration and ECBM recovery.

Anadarko has agreed to allow us to perform permeability tests in coal beds in an existing shut-in well in the vicinity of the Sam K. Seymour power station, a site that we earlier identified as a major point source of CO_2. We have identified two coal intervals for permeability testing. Currently, we are negotiating contractual agreements between Anadarko and Pinnacle Technologies, the service company that will be conducting the permeability tests.

Final results of gas composition and isotherm analyses and permeability testing should be available by the end of December. The data from these analyses will be used to finalize our coal model for the reservoir simulation phase of the project.

CONCLUSION

Our coal resource maps indicate that Lower Calvert total coal thickness is 40-70 ft in the vicinity of the Sam K. Seymour power plant. The Anadarko well penetrated 10 Lower Calvert Bluff coal beds having individual bed thicknesses between 2 and 11 ft and total coal thickness of approximately 65 ft. Preliminary laboratory desorption results from 3 coal beds at average depth of approximately 6,200-ft depth indicated that these Wilcox coals have more than 325 scf/t of stored methane, which improves the chance for ECBM recovery to offset costs of CO_2 sequestration. The CO_2, CH_4, and N_2 sorption isotherm that are currently being run will provide additional date required to build the coalbed reservoir model.

REFERENCE

1) Ayers, W.B. and Lewis, Amy H.: The Wilcox Group and Carrizo Sand (Paleogene) in East-Central Texas: *Depositional Systems and Deep-Basin Lignite*, Bureau of Economic Geology, Austin, Texas (1985), plate 25.

Table 1 – Preliminary data from sidewall core samples collected from Lower Calvert Bluff coal beds in an Anadarko Petroleum well. See Figure 4 for well log with coal beds A-C identified.

Sample Number	Sample Depth	Coal Bed	Coal Bed Top And Base (MD, ft)	Coal Thickness (ft)	Desorption Canister Number	Gas Content (scf/t) Without Residual Gas (Bulk Sample)
1	6112	A	T = 6109.5 B = 6120.0	10.5	526	330
2	6114	A				
3	6116	A			525	364
4	6118	A				
5	6148	B	T = 6145 B = 6154	9	527	388
6	6152	B				
7	6264	C	T = 6262 B = 6276	14	528	349
8	6266	C				
9	6268	C				
10	6274	C				

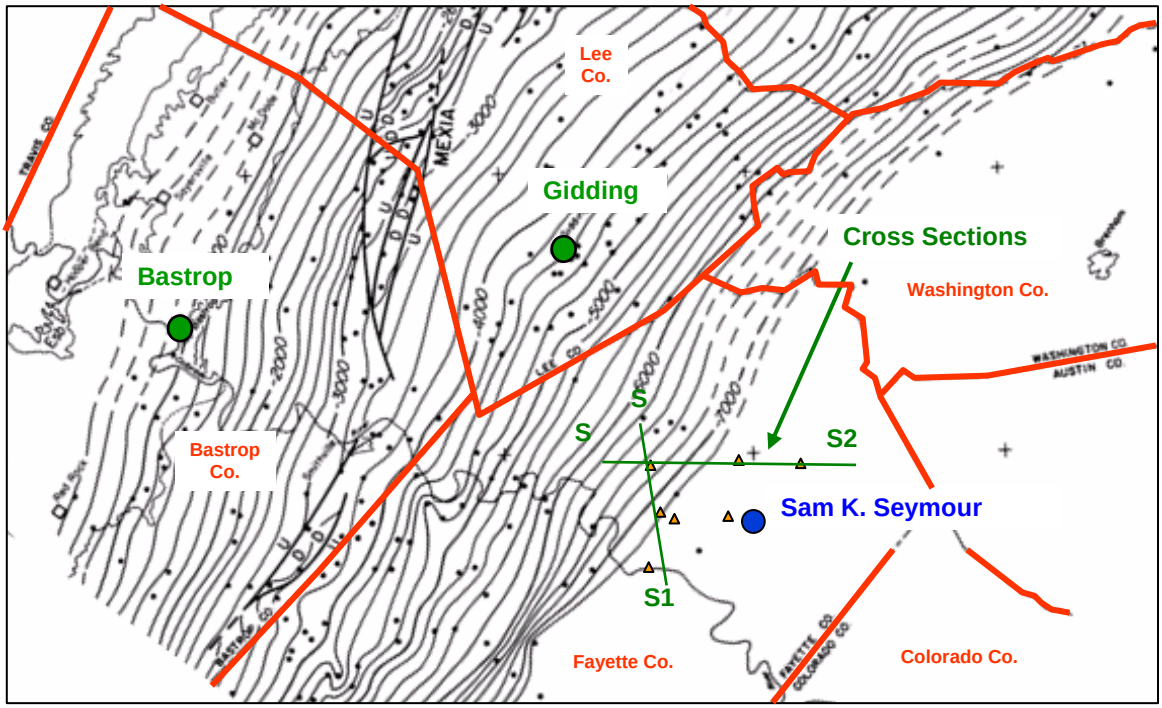

Fig. 1- Structure map of base of the Wilcox Group in East-Central Texas, showing location of Sam K. Seymour power plant. The base of the Lower Calvert Bluff coal zone is approximately 1400 ft above the Wilcox base in central Fayette Co. On September 29, 2004, ten sidewall cores were collected from 3 Lower Calvert Bluff coal beds in this area. Modified from Ayers and Lewis.[1]

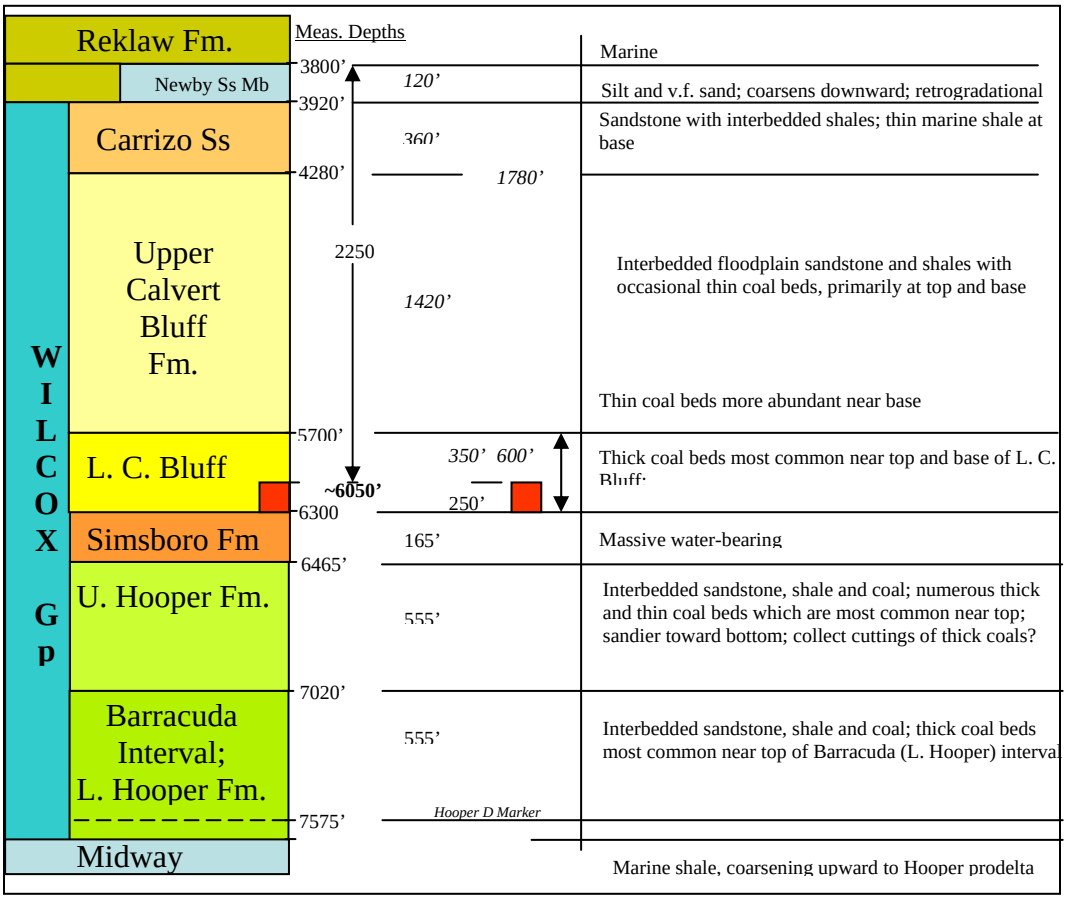

Fig. 2 – Stratigraphic column for the Wilcox Group and adjacent strata, showing prognoses for measured depths to formation boundaries and the interval proposed for sidewall coring in an Anadarko Petroleum Corporation well.

Fig. 3 – Sidewall core samples (ten 1-inch diameter samples) collected September 29, 2004, from 3 Lower Wilcox coal beds penetrated in a well drilled by Anadarko Petroleum Corporation.

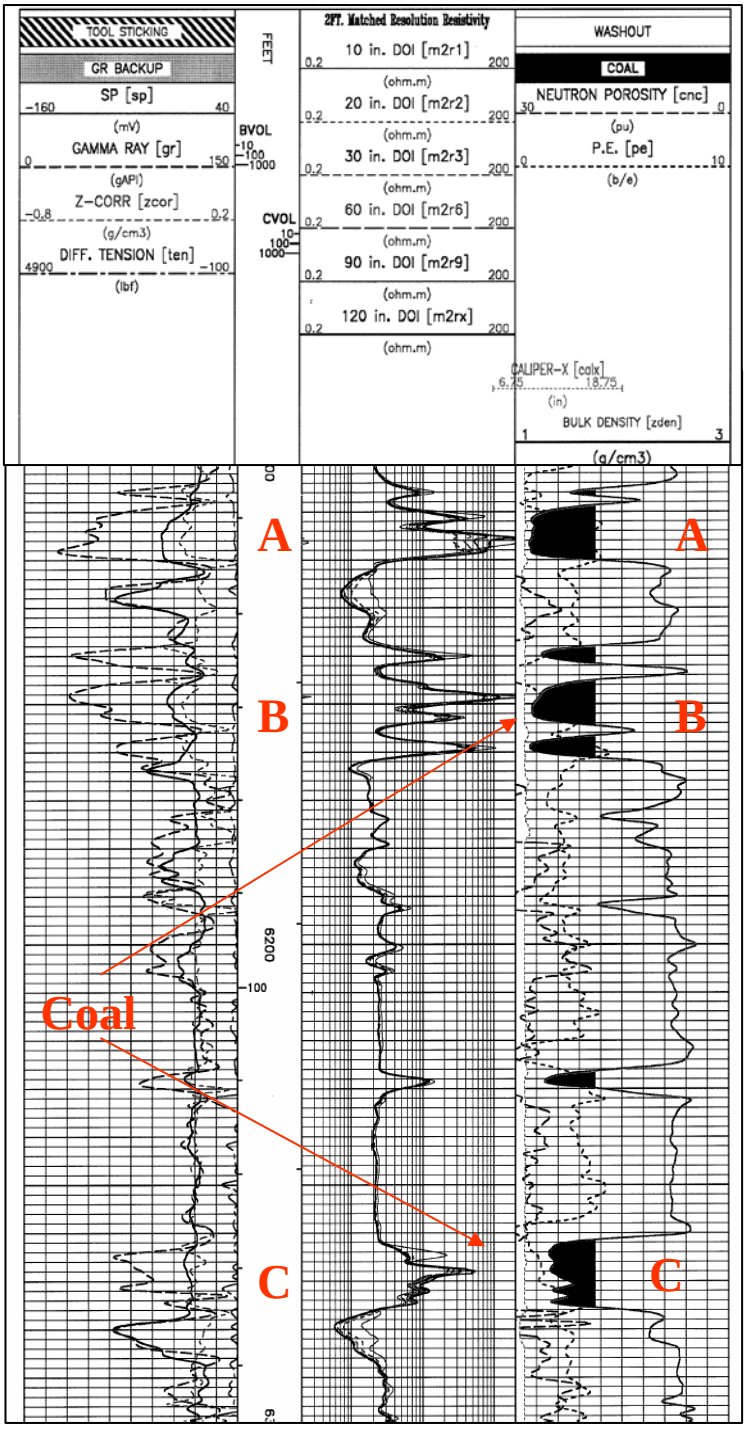

Fig. 4 – Well log of part of the Lower Calvert Bluff coal interval in Anadarko Petroleum Corp. well, showing 3 coal beds (**A-C**) from which sidewall core samples were obtained. Coals are shaded black.