ABSTRACT

Title: Application of Cutting-Edge 3-D Seismic Attribute Technology to the Assessment of Geological Reservoirs for CO2 Sequestration

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Subcontractor: University of Kansas Center for Research
Industrial Collaborator: Continental Resources of Illinois, Inc.
Grant Number: DE-FG26-06NT42734
Performance Period: 1/1/2006-3/31/2006

OBJECTIVES

The aim of this project is to develop innovative seismic technology and workflows that can be used to improve the assessment of structural integrity and reservoir heterogeneity of geological reservoirs for CO_2 sequestration. Our specific objectives are (1) to quantify reservoir porosity, permeability, saturations and small scale structural and stratigraphic features with new seismic attributes and (2) to validate attribute and processing results with field-based petrophysical and engineering data. The study areas are Dickman field, Kansas; Teapot Dome field, Wyoming; and Patoka field, Illinois; which represent a range of geologic settings.

ACCOMPLISHMENTS TO DATE

Seismic and well data have been assembled and the initial phases of quality control of the data and attribute generation are in progress for the three study areas, as summarized below.

Dickman field: Migrated with spectral whitening 3-D volumes have been assembled over a 2 square-mile area within a 3.5 square-mile survey. Log data are available from 18 wells, including three sonic logs, and monthly oil and water production data are available for 15 wells. Core data from the study objective Mississippian aged reservoir are available from seven of the wells. Inlines, crosslines, and time slices from the seismic data volumes have been examined and show that data quality is good, with high signal to noise and no visible acquisition footprint.

Coherence, inline and crossline energy gradient, model-based impedance inversion and six different curvature attributes have been generated. Time structure maps have been generated for several seismic horizons, including the top of Mississippian and the Gilmore City Limestone (the base of the aquifer supporting the bottom water drive in the reservoir). Lineaments have been interpreted on the most negative curvature extractions for the top of Mississippian and Gilmore City horizons.

Teapot Dome field: Migrated and unmigrated pre-stack 3-D data volumes have been assembled over a 28 square mile area. Data are available from over 300 wells, including 6 wells with FMI (Fullbore Formation MicroImage) logs and 35 wells that penetrate the Tensleep. Production data from 20 Tensleep wells are available. A complete core of the study objective Pennsylvanian aged Tensleep Formation and core data are available from one well. Inlines, crosslines, and time slices from the seismic data volumes have been examined and show that data quality is good. Pre-stack time and depth migrations have been initiated to yield seismic attributes with frequency-invariant processing.

Patoka field: A migrated 3-D data volume has been assembled over an 8.1 square-mile area. A sonic log is available from one well that reached the Ordovician aged study objective Trenton dolomite at the edge of the study area. Possible data quality problems associated with data-processing static corrections are being investigated. Overall the data quality is good. Principal component coherence, inline and crossline energy gradient, structure-oriented filtered principal component and negative and positive curvature attributes have been generated.

FUTURE WORK

Dickman field: Prestack data for the entire 3.5 square-mile survey has been requested from the field operator, Grand Mesa. Advanced attributes will be generated on both the poststack and prestack data, including offset- and azimuth-limited volumes.

Teapot Dome field: A check shot survery and two high-resolution seismic lines, which were acquired by BYU, have been requested from RMOTC and will be used to improve velocity control and correlations. Synthetic seismograms, which will be generated for key wells, will be integrated with the seismic data to establish better stratigraphic correlations across the field. FMI logs will be reviewed for use in understanding the fracture characteristics of the reservoir and in aiding the interpretation of attribute anomalies. Quality control efforts and the generation of advanced seismic attributes will continue. Critical future tasks are to develop procedures for prestack time migrated azimuthally-limited attributes and prestack depth migration attributes. To assist in the depth migration, a shallow map developed by RMOTC from 1300 wells will be used to account for any laterally varying near-surface velocites or variable surface elevations.

Patoka field: Before the application of further attribute analyses and the initiation of stratigraphic and structural studies, seismic data processing problems need to be resolved. Sources for additional velocity control, which is needed to improve the correlations of stratigraphic units, will also be investigated. After the resolution of these problems, we will continue to develop advanced attributes focused on characterizing the formation characteristics of the Trenton dolomite.

STUDENTS SUPPORTED UNDER THIS GRANT

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