TIME-LAPSE MODELING AND INVERSION OF CO2 SATURATION FOR SEQUESTRATION AND ENHANCED OIL RECOVERY

Quarterly Report for the Period September 1, 2003 – December 31, 2003

Date Issued: April 15, 2004

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NATIONAL ENERGY TECHNOLOGY LABORATORY

Work Performed Under DOE Award Number DE-FC26-03NT15417

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ABSTRACT

In the first quarter of this DOE NETL project, we have initiated Phase I activities for researching and developing new technology to quantitatively model the rock physics effects of CO_2 injection (both miscible and immiscible) in porous reservoir/aquifer rock systems containing oil-water phases. We have begun a thorough literature search to investigate all current, published methodologies and their limitations for calculating CO_2-oil and CO_2-brine properties, including currently available equation-of-state (EOS) models.

TABLE OF CONTENTS

I. EXECUTIVE SUMMARY

In the first quarter of this DOE NETL project, we have initiated Phase I activities for researching and developing new technology to quantitatively model the rock physics effects of CO_2 injection (both miscible and immiscible) in porous reservoir/aquifer rock systems containing oil-water phases. These improved rock physics models will create a better understanding of how CO_2-brine and CO_2-oil mixtures affect seismic data. In Phase I, we will develop a practical rock physics workflow and a set of parametric regressions to calculate/predict the fluid compressibility and density of multi-phase oil-water-CO_2 mixtures, and the P-wave and S-wave elastic moduli and bulk density of porous rock saturated with these fluid mixtures, as a function of pressure and temperature. The elastic moduli and densities will be needed in Phases II and III of this project for generating synthetic seismograms and inverting time-lapse seismic travel time and amplitude changes to produce maps of changes in pore pressure and CO_2 saturation.

II. EXPERIMENTAL

No experimental methods were used during this reporting period.

III. RESULTS AND DISCUSSION

We have begun a thorough literature search to investigate all current, published methodologies and their limitations for calculating CO_2-oil and CO_2-brine properties, including currently available equation-of-state (EOS) models, such as those used in program STRAPP from the U.S. National Institute of Standards and Technology. From this information we will determine the best theoretical approach for the rock physics calculations. We have searched publication lists from the Society of Petroleum Engineers (SPE), Society of Exploration Geophysicists (SEG), European Association of Geoscientists and Engineers (EAGE), and other international societies and internet sites, and have found a number of relevant papers dealing with equation-of-state theory and phase behavior applicable to CO_2 mixtures (see References for examples).

IV. CONCLUSIONS

In the next quarter, we will continue our literature search and begin comparing various theoretical approaches and equations of state for oil-water-CO_2 mixtures. This will lead to a practical rock physics workflow that will allow us to model seismic effects of oil-water-CO_2 systems and to invert time-lapse seismic data to produce maps of changes in pore pressure and CO_2 saturation.

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