

**TIME-LAPSE MODELING AND INVERSION OF CO<sub>2</sub> SATURATION FOR  
SEQUESTRATION AND ENHANCED OIL RECOVERY**

**Quarterly Report for the Period July 1, 2004 – September 30, 2004**

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## ABSTRACT

In the fourth quarter of this DOE NETL project, we have developed an algorithm for generating time-lapse seismic anomalies from changes in fluid properties over time. This forward-modeling algorithm constitutes the first step in the inversion procedure of Phase III of our project. Examples were generated illustrating the flexibility of this approach. Additional activities in this reporting period included a trip by the Principal Investigator to the 7th International Conference on Greenhouse Gas Control Technologies (GHGT-7) in Vancouver, Canada, September 5-9, 2004. In the next quarter, we will work on the second step of the inversion procedure, namely, the inversion of the seismic time-lapse anomalies to obtain changes in fluid properties, and will continue investigating alternative methods for calculating properties of oil/brine/CO<sub>2</sub> and brine/CO<sub>2</sub> systems.

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## I. EXECUTIVE SUMMARY

In this reporting period, we have developed a method for generating time-lapse seismic anomalies from changes in fluid properties over time. This forward-modeling algorithm constitutes the first step in the inversion procedure of Phase III of our study. Examples were generated illustrating the flexibility of this approach. Additional activities in this reporting period included a trip by the Principal Investigator to the 7th International Conference on Greenhouse Gas Control Technologies (GHGT-7) in Vancouver, Canada, September 5-9, 2004. In the next quarter, we will work on the second step of the inversion procedure, namely, the inversion of the seismic time-lapse anomalies to obtain changes in fluid properties, and will continue investigating alternative methods for generating properties of CO<sub>2</sub> fluid mixtures.

## II. EXPERIMENTAL

No experimental methods were used during this reporting period.

## III. RESULTS AND DISCUSSION

In this quarter we have focused primarily on algorithm development for the inversion procedure of Phase III. The inversion is carried out in several steps. In the initial step, we first establish a forward modeling relation between the rock and fluid properties of the reservoir and the resulting seismic data. Once this relationship is understood, it can be inverted in the second step to yield the time-lapse changes in fluid properties that correspond to the measured changes in the seismic data. We have written an algorithm for accomplishing the forward problem, as described in Appendix A. In the next reporting period, we will develop the second step of the inversion procedure that will ultimately be applied to time-lapse anomalies seen in the Sleipner North Sea CO<sub>2</sub> data set.

In addition to this activity, the Principal Investigator attended the 7th International Conference on Greenhouse Gas Control Technologies (GHGT-7) in Vancouver, Canada, September 5-9, 2004. The conference is held every two years, and is focused primarily on CO<sub>2</sub> capture, sequestration, long-term storage, risk assessment, and legal and economic issues. Important information was gathered regarding the modeling of CO<sub>2</sub> fluid mixtures in a variety of environments, including those from two well-known case studies at Sleipner and at Weyburn Field, Saskatchewan.

## IV. CONCLUSIONS

In this quarter we have focused on the first step of the inversion algorithm for Phase III of this study, namely, the forward-modeling problem of generating time-lapse seismic anomalies from changes in fluid properties over time. Examples were generated illustrating the flexibility of this approach. Additional activities in this reporting period included a trip by the Principal Investigator to the 7th International Conference on Greenhouse Gas Control Technologies

(GHGT-7) in Vancouver, Canada, September 5-9, 2004. In the next quarter, we will work on the second step of the inversion procedure, which is the inversion of seismic time-lapse anomalies to obtain changes in fluid properties. We will also continue investigating alternative methods for generating properties of CO<sub>2</sub> fluid mixtures by equation-of-state (EOS) methods and molecular dynamics modeling.