Joint Inversion of Time-Lapse Seismic Data

Award Number: DE-FE0031540

Project Summary:

The Energy and Environmental Research Center developed two joint inversion modeling and monitoring workflows to address and resolve shortcomings of existing inversion technology and time-lapse amplitude difference interpretation. Information about the probability of the presence of litho-fluid facies is paramount to reducing uncertainty in forecasting CO_2 saturation changes within the target reservoir.The two joint inversion techniques were applied to an existing time-lapse (4D) seismic data set. The first workflow is based on the seismic wave-equation based (WEB) amplitude variation with offset (AVO) inversion. The Joint Impedance and Facies Inversion (Ji-Fi) is the other technique applied in this project.

Prime Performer:
University of North Dakota Energy and Environmental Research Center

Principal Investigator:
César Barajas-Olalde

Project Duration:
1/19/2018 – 1/18/2020

Performer Location:
Grand Forks, North Dakota

Program:
Carbon Transport & Storage

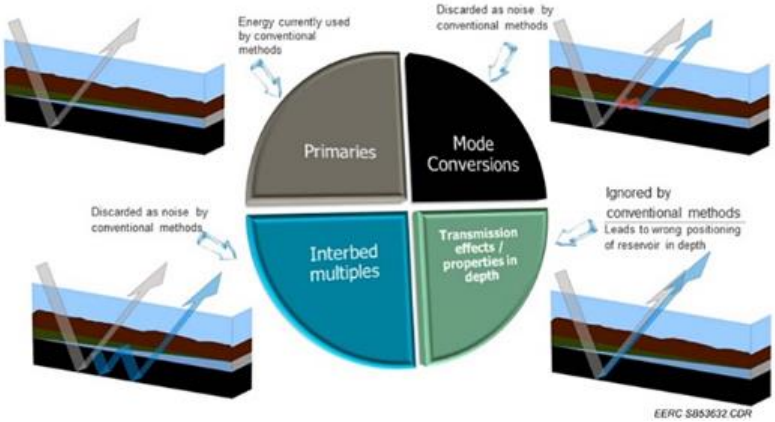

Figure 1: Schematic representation of the complex seismic wave field honored by the Method 1 inversion, which leads to more accurate estimation of properties and time-lapse changes.

Project Outcomes:

Both techniques were successfully applied to an existing time-lapse seismic data set. The WEB-AVO workflow is based on a new feature of the technology specifically developed for this project: the simultaneous joint inversion of the monitor and baseline. One of its main advantages is the robustness against the noise associated with the non-repeatability of seismic surveys. The estimated time-lapse changes of WEB-AVO compressibility and shear compliance were assessed, and it was concluded that shear compliance is a good indicator of the pressure effect due to the CO_2-enhanced oil recovery (EOR) activities in the study area. This ability to separate the effect of pressure from CO_2 saturation can be used to better assess the location of CO_2 within the target reservoir.

The facies and their probability distributions corresponding to the highly heterogeneous target reservoir and its fluid conditions from the CO_2-EOR activities were successfully separated in the seismic elastic space as part of the Ji-Fi workflow This separation provided favorable conditions for the application of the Ji-Fi method. Reliable acoustic impedances and, most probably, litho-fluid facies of the target reservoir were obtained from the application of the Ji-Fi method separately to the baseline and monitor surveys.

Presentations, Papers, and Publications

Final Report: Joint Inversion of Time-Lapse Seismic Data (December 2019) – César Barajas-Olalde, Donald C. Adams, Lu Jin, Jun He, Nicholas S. Kalenze, John A. Hamling, Charles D. Gorecki