Time-lapse surface seismic inversion with thin bed resolution for monitoring CO2 sequestration: A case study from Cranfield, Mississippi

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Abstract:
The feasibility of carbon dioxide sequestration research at Cranfield, Mississippi is studied by injecting millions tonnes of CO2 into the lower Tuscaloosa sandstone Formation over a two year period. Time-lapse surface seismic surveys were recorded at pre-(2007) and post-(2010) injection stages to monitor the subsurface fluid plume. The injection interval, appearing as a thin layer in the well-log data, shows very weak signature of CO2 injection in the time-lapse seismic amplitude data. In order to improve the capability of tracking CO2 plume movement using seismic data, we have applied a basis pursuit inversion (BPI) method to the post-stack seismic datasets. This method of inversion incorporates a priori information as a wedge dictionary and employs a L1-norm optimization for obtaining solutions with improved resolution. The inverted time-lapse acoustic impedances show a strongly decreasing trend mostly at the top of the injection interval, which is in agreement with well-log measurements for CO2 saturation. Improved resolution time-lapse impedance mapping therefore is an effective tool for imaging the displacement of the CO2 plume.