

A time lapse test of seismic waveform changes during several days at the green tuff area in Japan using a seismic vibrator

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In order to estimate the physical property changes in the subsurface, the time-lapse measurement is quite useful for various cases such as CCS (Carbon Capture and Sequestration) zone, EOR, shale gas exploration, and oil production. The authors have carried out the time lapse experiment at the water pumping area in Kingdom of Saudi Arabia using a very accurate and extremely stable seismic source called ACROSS (Accurately Controlled and Routinely Operated Signal System).

Because this seismic ACROSS has been installed semi-permanently at the Saudi test field, it is not easy to bring to any places. Instead, we alternatively used a much conventional electro-magnetic vibrator for this field test in the green tuff area in Japan.

We used the vibrator for 12 hours a day during five days in 2013. We also used 110 geophones and two borehole geophones placed just above the green tuff miming area with 2km x 3km. We used sweep signal from 10 Hz to 50Hz during 100 second.

We repeated 32 sweep during an hour. 32 stacking of waveforms of 100s second time-windows improved the S/N, and we can identify arrivals up to 3 km distance by this one-hour stacked data. If we look the 12 hours waveforms, it is difficult to find the change of those with time.

Using the subtraction of waveforms every day with 12-hour stack data from the first day, we generated residual waveforms. If we use residuals waveforms from the first day, we can clearly identify the change of waveforms with time. In conclusion we can use the time lapse method during five days by the use of residuals waveforms though the period is short. We can use conventional seismic vibrator(s) for the time lapse for several days.

Keywords: time lapse, ACROSS, seismic method, residual waveforms, vibrator source, green tuff