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Temporal change of transfer functions of seismic waves caused by an air-injection into the underground.

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The Summary for Policymakers (SPM) of the Working Group I contribution to the IPCC's Fifth Assessment Report reported that warming of the climate system was unequivocal and concentrations of greenhouse gases had increased. The SPM of the Working Group III contribution to the AR5 recognized that Carbon Dioxide Capture and Storage (CCS) contributed to reduce CO_2 emission. Since CCS has a risk of CO_2 leakage into the underground, it needs a monitoring of CO_2 reservoirs continuously for long term.

In this study we examined the temporal change in a transfer function of seismic waves by an air injection into the underground in order to monitor the geophysical structure. Previous study for CCS showed that the temporal changes during the injection in Nagaoka City, Niigata Prefecture in 2003 about once a month.

This study researched effects to seismic waves caused by injecting air. We used ultra-stable seismic source called ACROSS for the continuous monitoring. ACROSS had been developed by Kumazawa *et al.* (2000) at Nagoya University and Tono Geoscience Center. ACROSS source accurately controls and transmits seismic or electromagnetic waves to the underground continuously. We monitor a small change of geophysical structure of the underground by estimating the transfer function between the transmitted waves and observed data. We conducted the experiment with ACROSS sources and about 30 geophones near the Nojima Fault in Awaji Island from February to March in 2011. An amount of injected air was about 81 ton into the underground during 5 days.

We analyzed the transfer functions focusing on the temporal variations of the amplitude and frequency which may effectively change corresponding to the changes in the underground structure. Source characteristics (in a unit of force (N)) was estimated from geophone data set near the source and transfer functions (in a unit of m/N)were calculated by deconvolution between observed displacement data and source function. We attempted to detect the temporal changes of transfer functions by comparing the variations of amplitude and frequencies in a target travel-time window before and after the injection. We analyzed some arbitrary travel time windows, in which a particular seismic phase arrive from the particular range in the underground assuming as an isochronal scattering shell, after first arrival of transfer function.

As a result, we found that spectral amplitude at the particular frequencies (e.g. 12Hz and 14Hz) increased over 300% after a day from the start of the air injection at a few observation sites in the eastern side of the injection well. Since such temporal changes were observed at several observation sites and seemed to move towards the up-dip direction site in the eastern area of Mt. Odo, we considered that it might be caused by injected air movements.

Keywords: monitoring, ACROSS