Application of sequentially discounting autoregressive (SDAR) on seismic event detection for CO_2 injection safety management

*Luchen Wang[1], Tetsuma Toshioka[1], Takahiro Nakajima[1], Akira Narita[2], Ziqiu Xue[1]

1. RITE Research Institute of Innovative Technology for the Earth, 2. Mitsubishi Space Software Co., Ltd.

When injecting fluid into the deep formations or reservoirs, a big concern is the potential induced micro-seismic events. An earthquake-based monitoring system, called Traffic Light System (TLS), has already been applied to evaluate the micro-seismic events and manage the fluid injection (e.g. the geothermal exploration and the shale gas development). As injecting CO2 is similar to fluid, the similar system can also be employed to automatically evaluate the CO2 injecting situation and inform the anomaly for injection safety management. For the application at regions with frequent natural earthquakes (e.g. the CCS site at Tomakomai, Japan), we are developing an Advanced Traffic Light System (ATLS) to achieve self-adaptive seismic monitoring and injection management. Combining the baseline seismicity information and the seismic behavior of aftershock, the ATLS can provide valuable information of the induced seismic events.

The primary task for ATLS management is the micro-seismic event identification in a long-term sustained time series. It is a challenge for ATLS to detect such weak energy seismic signal with potential low Signal to Noise Ratio (SNR). In order to optimize the effect of ATLS seismic monitoring, a high-sensitivity micro-seismic detection method is necessary. In this study, the Sequentially Discounting AutoRegressive (SDAR) method is applied for seismic event detection. Considering that the seismic observation data is a stochastic time series consisting of valid seismic event signal and random noise, the SDAR method assumes that the segments between earthquake and noise are stationary as different autoregressive statistical models. Since the SDAR method avoids the signal energy calculation, it can work on weak seismicity identification, especially micro-seismic events.

Here we apply the SDAR method on the Ocean Bottom Cable (OBC) baseline recording at Tomakomai CCS project for natural earthquake detection. The corresponding data was observed from Feb. 1st 2015 to Jan. 31st 2016. The earthquake detection result confirms that the SDAR is a feasible and robust tool for earthquake detection in long-term time series record, especially for micro-seismic events (magnitude < 1) at CCS site. Near Tomakomai CCS site, only weak earthquakes (magnitude < 2) occurred during the baseline period. This detecting result can be used by ATLS to obtain the background seismic activity information.

