Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

HRE28-15 Room:105 Time:May 25 14:45-15:00

Geomechanical modelling for CO2 geological storage: insights from natural analogue research

LEI, Xinglin[1*] ; FUNATSU, Takahiro[1] ; OKUYAMA, Yasuko[1] ; NAKAO, Shinsuke[1]

[1]National Institute of Advanced Industrial Science and Technology(AIST)

When CO2 gas is pressure-injected into an underground reservoir for geological storage, the pore pressure underground increases, and the stress distribution underground may change. Stress redistribution within and surrounding the reservoir and caprock system my lead to geophysical changes, microseismicity, fault reactivation, and may even trigger large earthquakes. For example, at a gas field in In Salah, Algeria, where CO2 is pressure-injected to enhance natural gas production, synthetic-aperture radar observations from a satellite have indicated a ground uplift rate of about 1 cm/year around the CO2 pressure injection wells, along with a similar amount of subsidence around the gas production wells. In some gas fields in the Sichuan Basin, China, following injection of unwanted water into depleted gas reservoirs, a number of seismic sequences have been observed with sizable earthquakes ranging up to M5.

Indeed, geophysical changes and microseismicity are useful in the monitoring and management required during and after a large-scale injection project. However, the risks related to fluid leakage and earthquakes that can be felt may give rise to strong social impacts. The issue of noticeable or damage-causing earthquakes induced by artificial operations is controversial, and has been the cause of delays and threatened cancellation of some projections such as the EGS (Enhance Geothermal System) project at Basel. To carry out geological CO2 storage safely and for this technology to be accepted not only by the inhabitants around the storage sites, but also by the society as a whole, technological developments that address such public concerns is essential. In addition, there is a strong desire to be able to control or predict the occurrence of damaging earthquakes. In these regards, geophysical/geomechanical modelling is key in site selection, injection operation, and post injection management.

In geological CO2 storage, it is important to clarify the mechanisms and geomechanical conditions of worst-case events, such as damaging earthquakes and reservoir leakage, so that they can either be avoided or mitigated. It is most desirable to use an actual CO2 geological storage site in which such events have actually occurred and have been well monitored. However, many pilot projects are sited in places with good conditions for safely pressing CO2 into the reservoir. Thus it is valuable to carry out "natural analogue research", analysing similar phenomena caused by the activity of a natural CO2-quality fluid to examining the modelling technology. In the Matsushiro area, a series of more than 700,000 earthquakes occurred over a 2-year period (1965-1967). This swarm, termed the Matsushiro swarm, resulted in ground surface deformations (uplifts as large as 75 cm), cracking of the topsoil, enhanced spring outflows with changes in chemical compositions, and CO2 degassing. Ten million tons of CO2-rich saltwater seeped was estimated to have seeped out from underground along the cracks. Thus the Matsushiro swarm is believed to have been triggered and driven by high pressure CO2-rich fluid from deep sources. Data observed during the Matsushiro swarm can therefore be used as a natural analogue for examining the geomechanical modelling technology based numerical simulation using the coupled THM (heat transferring, fluid flow, rock mechanics) analysis. Here, we make a brief review of studies on the Matsushiro fluid-driven earthquake swarm based on TOUGH-FLAC approach.

Acknowledgements. This research is funded and supported by Ministry of Economy, Trade and Industry (METI).

Keywords: CCS, Geomechanical modelling, Fault, Matsushiro seismic swarm, Deep fluid