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Seismic monitoring at the commercial-scale CO2 geological storage site, Cranfield, U.S (Part 3)

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Public concerns about felt seismic events induced by fluid injection have been raised recently. These felt events have magnitudes of more than $M_L 3$ and occur in the area where seismicity not active. The induced seismic events were triggered due to the pressure changes at the reservoir. CO_2 geological storage, a kind of the fluid injection activities, is regarded as a key potential technology to mitigate greenhouse gas emission. Since this technology involves long-term and large amount of CO_2 injection, some researchers warm that CO_2 geological storage would trigger felt seismicities at the site. Passive seismic monitoring is conducted at CCS sites around the world since 2000's. A few of the sites reported occurrences of seismic events related to CO_2 injection and these events were unfelt with small magnitudes. To ensure the safety against induced seismicity and obtaining public acceptance, seismic monitoring is necessary for operating CCS project, especially for countries with high seismicity such as Japan.

RITE has performed a long-term seismic monitoring at the commercial-scale CO_2 injection site in the U.S. to elucidate the relation between CO_2 injection and occurrences of seismic events collaborating with Lawrence Berkeley National laboratory (LBNL) and Bureau of Economic Geology, University of Texas at Austin (BEG) since 2011. Seismic monitoring is conducted at the Cranfield oilfield, Mississippi. This oilfield is the CO_2-EOR field and a million tonnes of CO2 is annually injected into the Cretaceous sandstone reservoir (porosity 20 ˜30%, permeability for 10 ˜200mD) at the depth of about 3,100m. A total of more than four million tonnes of CO_2 have stored as of January 2013. We composed a circle seismic monitoring array deploying 6-3component of seismometers at the depth of 100m in a 3km radius.

We have monitored seismicities more than two years now, but we have recorded no seismic events at the Cranfield site. The recorded of vertical components of waveforms were examined by semi-automated processing and visual judgments for the entire monitoring of period, and the triggered signals were all identified as artificial noises, noises due to weather changes such as lighting or strong wind, and distant earthquakes.

In this presentation, we discuss why seismic events were not recorded at the Cranfield site. We estimated minimum detectable magnitudes of our monitoring array by means of theoretical calculations based on discrete wavenumber integration method which concerned geological properties from surface to the reservoir. We confirmed that the array could detect seismic events with more than Mw0.4 at the hypocentral distance of 3.2 km. We also discuss the question in terms of pressure changes at the reservoir and other studies conducted at the Cranfield site.

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Keywords: CO_2geological storage, Seismic monitoring, fluid injection