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Natural and artificial pore pressure variation for distinguishing earthquakes induced by CO2 injection from natural earthquakes

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It is important to distinguish between natural earthquakes and those induced by CO_2 injection at carbon capture and storage sites. For example, the 2004 M_w 6.8 Chuetsu earthquake occurred close to the Nagaoka CO_2 storage site during gas injection, but we could not quantify whether the earthquake was due to CO_2 injection or not. Here, changes in pore pressure during CO_2 injection at the Nagaoka site were simulated and compared with estimated natural seasonal fluctuations in pore pressure due to rainfall and snowmelt, as well as estimated pore pressure increases related to remote earthquakes. Changes in pore pressure due to CO_2 injection were clearly distinguished from those due to rainfall and snowmelt. The simulated local increase in pore pressure at the seismogenic fault area was much less than the seasonal fluctuations related to precipitation and increases caused by remote earthquakes, and the lateral extent of pore pressure increase was insufficient to influence seismogenic faults. We also demonstrated that pore pressure changes due to distant earthquakes are capable of triggering slip on seismogenic faults. The approach we developed could be used to distinguish natural from injection-induced earthquakes and will be useful for that purpose at other CO_2 sequestration sites.

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