

CEE 595 – Geotechnical Engineering Seminar

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Induced seismicity in geo-energy applications

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Abstract

Induced seismicity has occurred in hundreds of sites all around the world as a result of subsurface energy operations. In this presentation, I will focus on Geologic Carbon Storage (GCS) and Enhanced Geothermal Systems (EGS). On the one hand, the feasibility of GCS as an option to significantly reduce CO₂ emissions to the atmosphere has been questioned recently. It has been argued that the overpressure induced by CO₂ injection would reactivate faults through which CO₂ could migrate upwards, ruining the objective of permanently storing CO₂ deep underground. In this presentation, it will be shown that GCS can be performed safely, i.e., without reactivating faults that could induce large seismic events and lead to CO₂ leakage. A multidisciplinary approach has been followed, combining analytical solutions with coupled thermo-hydro-mechanical simulations of cold CO₂ injection in deep saline formations. We find that a proper site characterization and pressure management are required to achieve a safe CO₂ storage. On the other hand, we investigate the potential triggering mechanisms of post-injection induced seismicity that occurs in the stimulation of EGS. We investigate the superposition of poromechanical, thermo-mechanical, and shear slip stress transfer as potential triggering mechanisms of induced seismicity. We find that pressure gradients generate compressive stresses during injection that increase the stability of certain fractures, but these fractures become rapidly unstable after shut-in. By progressively decreasing the injection rate, the occurrence of large post-injection induced earthquakes may be minimized.



Short Bio

Victor Vilarrasa is a researcher at the Institute of Environmental Assessment and Water Research, Spanish National Research Council (IDAEA-CSIC). His research deals with dimensional analysis and modeling of coupled thermo-hydro-mechanical-chemical (THMC) processes related to geo-energy and geo-engineering applications. One of his main interests is to understand the effects of fluid injection in the subsurface. Fluid injection results in pressure buildup and cooling that brings the stress state closer to failure conditions, which may induce seismic events. He applies his research to several geo-energy applications, including CO₂ storage, geological nuclear waste disposal and enhanced geothermal systems.

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