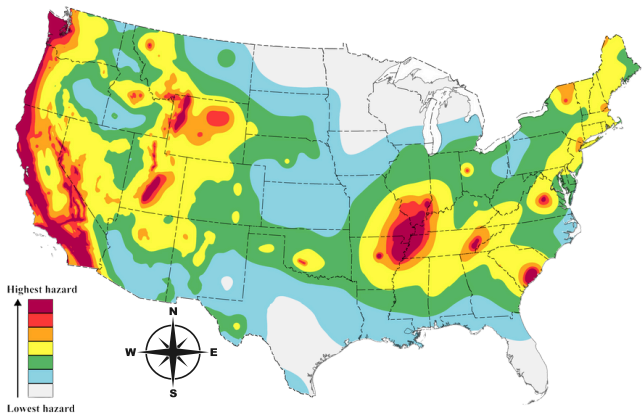
QUICK LOOK-CCS AND SEISMICTY

The chances of induced seismicity caused by CCS are low and can be mitigated through careful planning-but can we be certain?

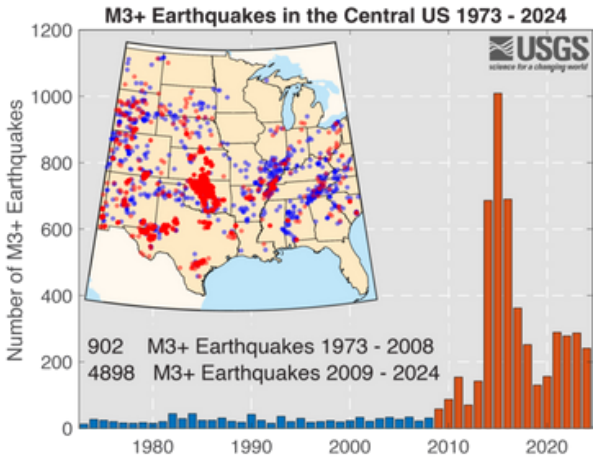
The precise science of predicting when and where earthquakes will occur remains elusive, but there is a lot we understand now about reducing risks associated with induced seismicity. Locational history, mini-frac tests, and monitoring systems are key tools used to assess and manage risks of induced seismicity associated with CCS operations.

EARTHQUAKE HAZARD AND INDUCED SEISMICITY MAPS

Local geologic conditions play a major role in determining earthquake hazard. For example, the West Coast of the US experiences more frequent and powerful earthquakes due to its proximity to tectonic plate boundaries and active faults.

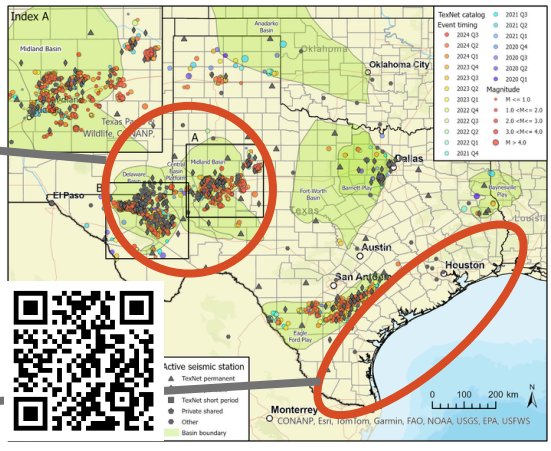


USGS, 2024. Hazards. https://www.usgs.gov/programs/earthquake-hazards/hazards



USGS, 2025. Induced Earthquakes. https://www.usgs.gov/programs/earthquake-hazards/science/induced-earthquakes

In contrast, Texas saw a rise in induced earthquakes starting in the 2010s because massive saltwater disposals in certain oil-producing regions triggered movement along faults that were already under stress. However, not all basins were equally affected. Earthquakes occurred mainly in areas like the Permian Basin, where high injection rates and volumes led to increased pore pressure. When combined with deep injection near highly stressed basement rock, the presence of suitably oriented faults, and older, brittle rock formations, seismic activity was more likely to be triggered. This is not the case in the Gulf Coast Basin, characterized by younger, more ductile rocks, where many CCS projects are planned.

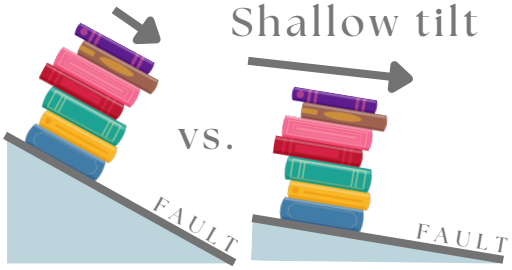


TEXNET. 2025. https://texnet.beg.utexas.edu/

Geologic conditions influence the strength of an earthquake—the hazard—while the potential impacts determine the risk. Faults with high slip potential, brittle rock formations, and regions already under high stress are more likely to produce stronger earthquakes, especially when additional pressure is applied.

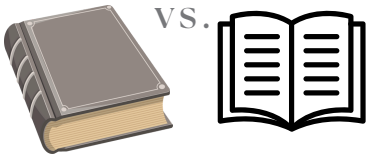
IF BOOKS WERE ROCKS...

Steep tilt vs. Shallow tilt



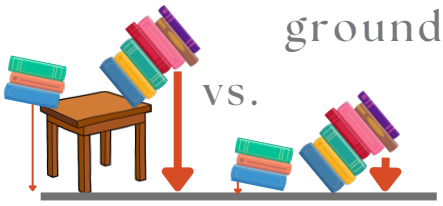
Books on a steep tilt require less pressure to trigger it to slide and tumble.
Likewise, faults under high shear stress require less of a nudge to trigger slip.

Hard-cover vs. Paper back



Dropping a hardcover book would have a stronger impact than paper back.
Hard, brittle rocks release energy suddenly when they slip. Softer rocks bend and release the energy slowly.

Fall from high vs. Fall from ground



A large stack of books falling from high up has more potential energy and hits harder than a small one, and both hit harder than if they fell near the ground.
Similarly, large, highly stressed faults can produce bigger earthquakes than small, lightly stressed ones.

CCS APPLICATIONS

Earthquakes are naturally occurring, some are mild while others are dangerous. Risk profiles depend not only on their magnitude, which can be influenced by local geology, but also on how close they are to population centers, critical infrastructure, and vulnerable communities.

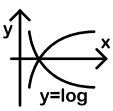
As a part of the CCS project planning process, operators strategize and plan to ensure that there is no risk of dangerous seismic events.

RICHTER SCALE

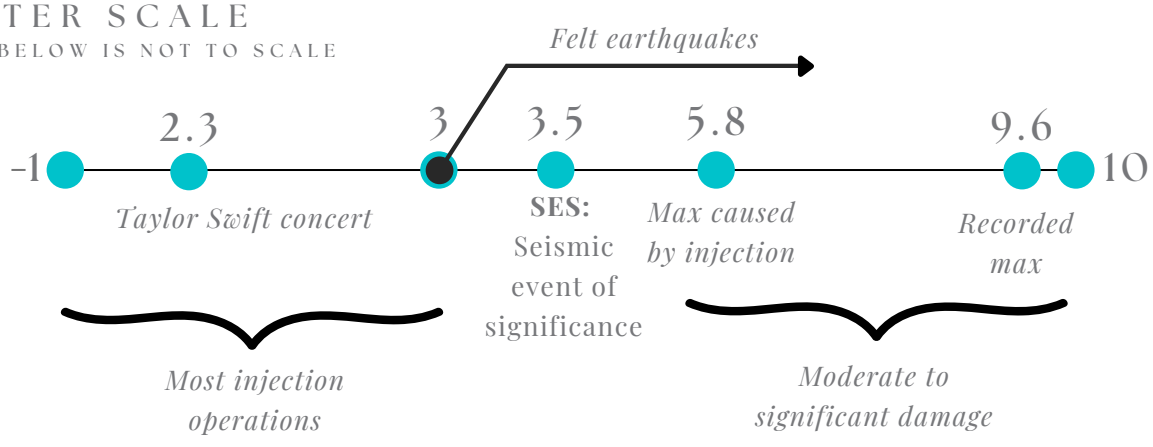
*RANGE BELOW IS NOT TO SCALE

LEARN MORE

The Richter scale is logarithmic.



A whole number increase represents a ten-fold increase in energy released!



In current field research and planned projects, microseismic monitoring tools are deployed to detect any seismic readings. Otherwise, injection operations are usually undetectable.

TEXAS Geosciences
The University of Texas at Austin
Jackson School of Geosciences
Bureau of Economic Geology

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GULF COAST CARBON CENTER

TXLA CMC
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