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Editorial

Wastewater Did Not Significantly Alter Seismic Stress Direction in Southern Kansas, Study Finds

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Although wastewater disposal has been the primary driving force behind increased earthquake activity in southern Kansas since 2013, a new study concludes that the disposal has not significantly changed the orientation of stress in the Earth's crust in the region.

Activities like wastewater disposal can alter pore pressure, shape and size within rock layers, in ways that cause nearby faults to fail during an earthquake. These effects are thought to be behind most recent induced earthquakes in the central and eastern United States.

It is possible; however, that human activity could also lead to earthquakes by altering the orientation of stresses that act on faults in the region, said U.S. Geological Survey seismologist, who co-authored the study in Seismological Research Letters with USGS seismologist.

"Since we do not see evidence for a significant stress rotation [in the region], we think most of the earthquakes in southern Kansas are due to changes in pore pressures or porelastic effects rather than due to stress rotations," researcher said.

One way that researchers can learn more about the orientation of the stress field in rock layers where fluid fills fractures in the rock is through a seismic wave effect called shear wave splitting. Some of the shear waves traveling through the rock move parallel to open fractures and are therefore faster, while others move perpendicular to the fractures and have a lower velocity. Estimating the direction of the fast waves can help determine the orientation of the stress field.

A previous shear wave splitting study in southern Kansas estimated a 90-degree rotation in the fast direction beginning in 2015, which the study authors attributed to elevated pore fluid pressures from wastewater disposal. However, the rotation coincided with a change in the stations used to observe the shear waves.

Researchers decided to take another look at stress changes in southern Kansas as part of a larger effort to characterize stress in rock reservoirs without drilling expensive boreholes. When they analyzed shear wave splitting using high-quality data collected from a stable local seismic network, they found that the regional stress orientation remained relatively constant between 2014 and 2017.

The geological conditions of a wastewater reservoir might affect whether injection can alter stress orientation, researcher noted. Most of the wastewater injected in southern Kansas went into rock layers called the Arbuckle Group, "which is underpressurized – fluid can be 'poured in' without the need of a pump," researcher said, noting that pore pressures can diffuse rapidly in the highly permeable rock.

There are no reports of significant stress rotations due to wastewater disposal, the authors note, suggesting that it may either not be a common occurrence, the stress rotations are smaller than can be detected with current methods, or that the phenomenon hasn't been studied enough. Until recently, seismic instrumentation has been sparse in many places that have experienced a large increase in wastewater disposal over the past decade.

"Documenting stress orientations is already challenging in these regions, and characterizing changes in those stresses over time is an even greater challenge," researcher said. "In the areas where we have looked though, we haven't seen compelling evidence for significant stress rotations due to wastewater disposal."

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