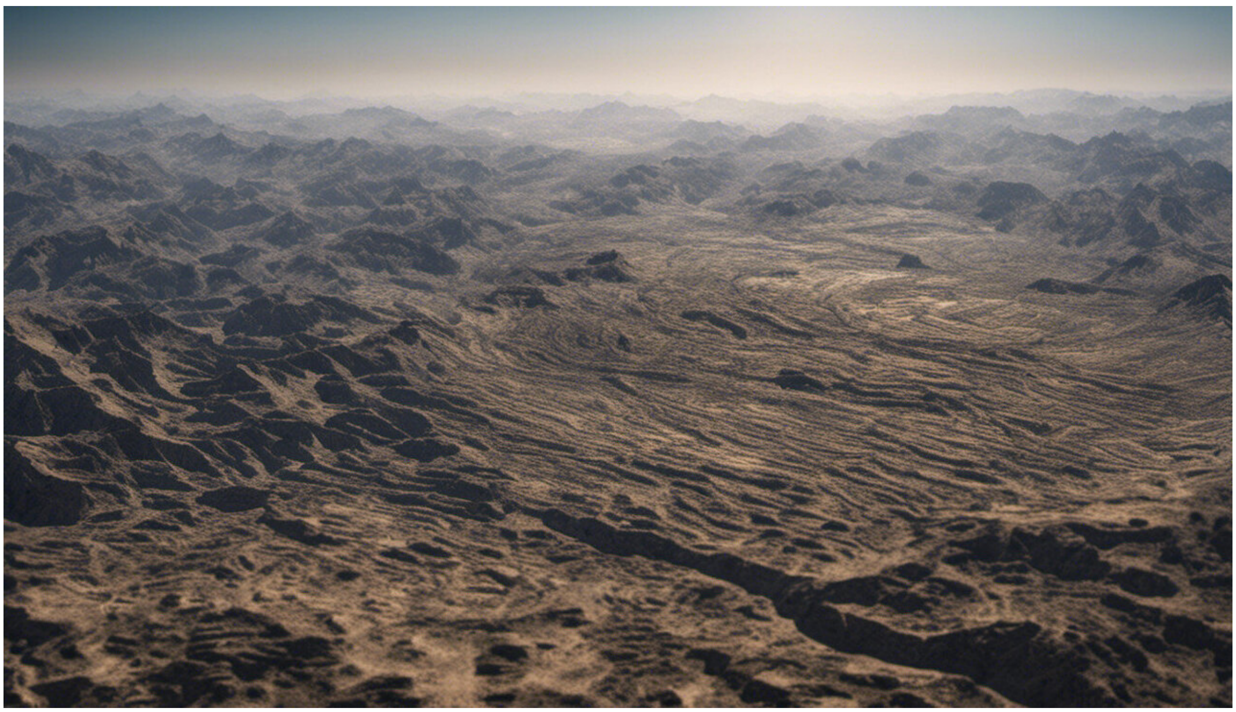
Earthquakes can be weakened by groundwater

August 6 2018, by Sarah Perrin



Credit: AI-generated image (disclaimer)

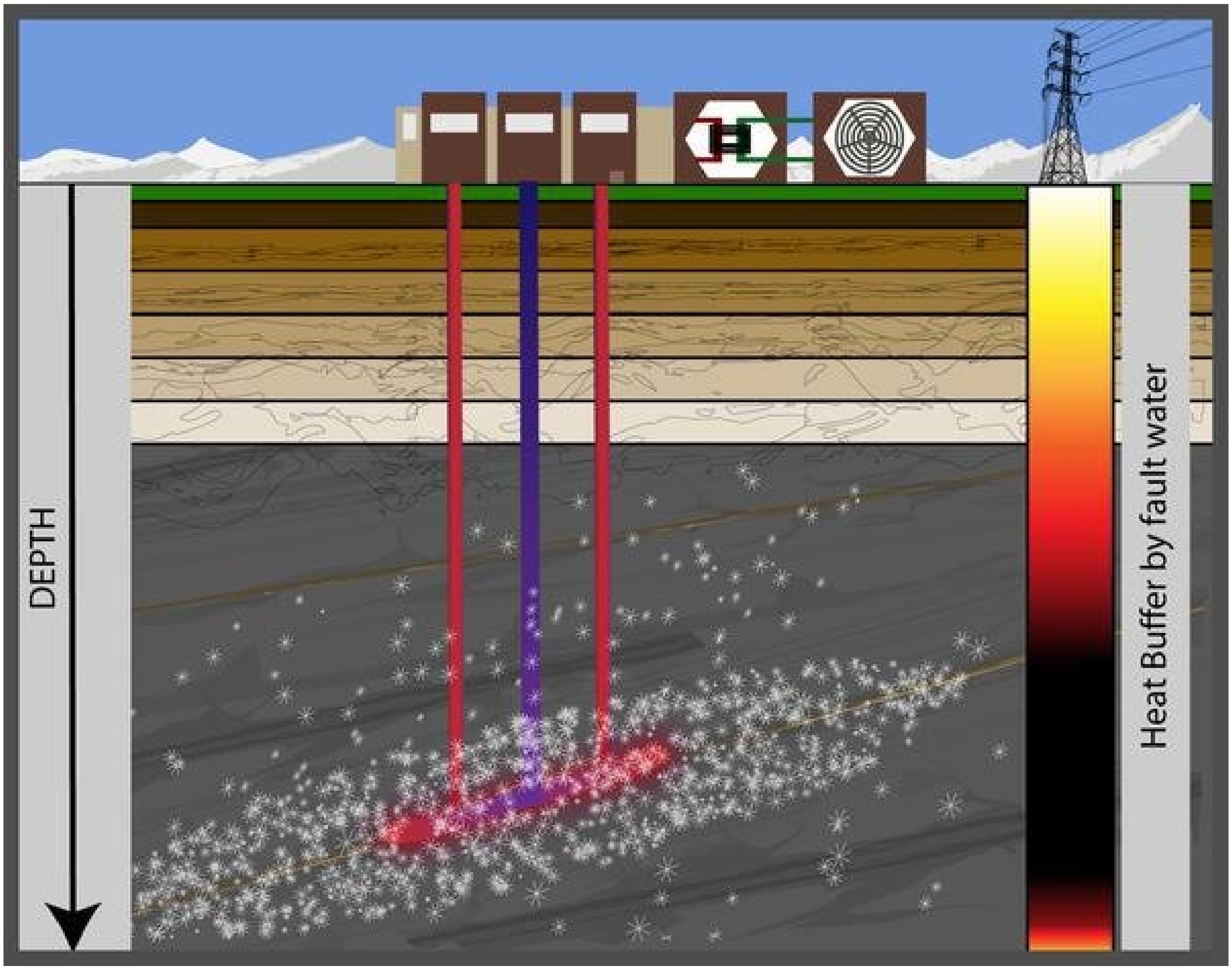
Researchers from EPFL and the Ecole Normale Supérieure in Paris have found that the presence of pressurized fluid in surrounding rock can reduce the intensity of earthquakes triggered by underground human activities like geothermal energy production.

Around 100,000 earthquakes are recorded worldwide every year, but not all are naturally occurring. Some of the weaker ones are triggered by human activity underground – this is referred to as induced seismicity. Researchers from EPFL's Laboratory of Experimental Rock Mechanics (LEMR) and the Ecole Normale Supérieure in Paris have just completed a study into the role of fluids in the propagation of induced earthquakes in an effort to decipher the underlying mechanisms. Their findings include the extremely counterintuitive discovery that highly pressurized water in the vicinity of an earthquake tends to limit – rather than increase – its intensity. These results were published today in *Nature Communications*.

Induced earthquakes can be the result of activities like mining, gas and oil extraction, toxic waste or CO2 storage, and the construction of tunnels and dam reservoirs. The generation of geothermal energy is another potential source of induced earthquakes – and the main one in Switzerland. According to the Swiss Seismological Service, a geothermal project near Basel caused a 3.4 magnitude earthquake in 2006, and one in St. Gallen triggered a 3.5 magnitude trembler in 2013.

Geothermal energy is captured by tapping into subterranean heat. Highly pressurized water is pumped into the earth's crust at a depth of between two and four kilometers. The water is then recovered as steam and used to drive an electricity-producing turbine. "Injecting water can affect water-rock equilibria and disrupt nearby faults, thus triggering earthquakes in the area," says Marie Violay, who runs LEMR.

This type of earthquake is a thorn in the side of geothermal proponents, notes Mateo Acosta, a Ph.D. student at LEMR and the study's lead author: "These earthquakes may be low in intensity, but they can cause damage and affect public opinion – to the point of derailing projects."



Credit: Ecole Polytechnique Federale de Lausanne

Heat absorption

Acosta ran tests in which he sought to replicate earthquake conditions in order to study the impact of different levels of underground water pressure on fault dynamics. He focused mainly on earthquake propagation, which is when the two plates in a fault rub against each other, sending seismic waves out into the surrounding area.

"Rock friction generates a significant amount of heat, which further fuels the propagation effect," says the Ph.D. student. "Some of this heat is absorbed by the water in the surrounding rock, and the amount absorbed depends to a large extent on the water's thermodynamic parameters. What we learned from our experiments is that the closer the fluid's initial pressure is to the critical pressure of water, the weaker the earthquake will be."

"This research shows that the initial fluid pressure in the rocks is crucial, especially at depths commonly reached by geothermal activities. Geothermal models need to take this into account," says François-Xavier Passelègue, an LEMR researcher and the study's second author.

The laboratory recently acquired sophisticated equipment that can be used to simulate pressure and temperature levels at a depth of 10 to 15 kilometers in the earth's crust. The researchers plan to use this equipment to more accurately measure the impact of groundwater on earthquake intensity.

More information: M. Acosta et al. Dynamic weakening during earthquakes controlled by fluid thermodynamics, *Nature Communications* (2018). DOI: 10.1038/s41467-018-05603-9

Provided by Ecole Polytechnique Federale de Lausanne