Study shows 'plausible' connection between DFW quakes, saltwater injection well

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SMU scientists place monitoring equipment. Credit: Jackson

(PhysOrg.com) -- A study of seismic activity near Dallas/Fort Worth International Airport by researchers from Southern Methodist University and UT-Austin reveals that the operation of a saltwater injection disposal well in the area was a "plausible cause" for the series of small earthquakes that occurred in the area between Oct. 30, 2008, and May 16, 2009.

The incidents under study occurred in an area of North Texas where the vast Barnett Shale geological formation traps natural gas deposits in subsurface rock.

Production in the Barnett Shale relies on the injection of pressurized water into the ground to crack open the gas-bearing rock, a process

known as "hydraulic fracturing." Some of the injected water is recovered with the produced gas in the form of waste fluids that require disposal.

The earthquakes do not appear to be directly connected to the drilling, hydraulic fracturing or gas production in the Barnett Shale, the study concludes.
However, re-injection of waste fluids into a zone below the Barnett Shale at the nearby saltwater disposal well began in September 2008, seven weeks before the first DFW earthquakes occurred.

No earthquakes were recorded in the area after the injection well stopped operating in August 2009.

The largest of the DFW-area earthquakes was a 3.3 magnitude event reported by the USGS National Earthquake Information Center.

Fluid injection stressed fault?

A state tectonic map prepared by the Texas Bureau of Economic Geology shows a northeast-trending fault intersects the Dallas-Tarrant county line approximately at the location where the DFW quakes occurred. The study concludes, "It is plausible that the fluid injection in the southwest saltwater disposal well could have affected the in-situ tectonic stress regime on the fault, reactivating it and generating the DFW earthquakes."

An SMU team led by seismologists Brian Stump and Chris Hayward placed portable, broadband seismic monitoring equipment in the area after the earthquakes began.

The seismographs recorded 11 earthquakes between Nov. 9, 2008, and Jan. 2, 2009, that were too small to be felt by area residents. Cliff Frohlich and Eric Potter of UT-Austin joined the SMU team in studying

the DFW-area sequence of "felt" earthquakes as well as the 11 "non-felt" earthquakes. Their study, "Dallas-Fort Worth earthquakes coincident with activity associated with natural gas production," appears in the March issue of *The Leading Edge*, a publication of the Society of Exploration Geophysicists.

The SMU team also installed temporary monitors in and around Cleburne, Texas where another series of small earthquake began June 2, 2009. Results from that study are not yet available.

Study raises more questions

Stump and Hayward caution that the DFW study raises more questions than it answers.

"What we have is a correlation between seismicity, and the time and location of saltwater injection," Stump said. "What we don't have is complete information about the subsurface structure in the area — things like the porosity and permeability of the rock, the fluid path and how that might induce an earthquake."

"More than 200 saltwater disposal wells are active in the area of Barnett production," the study notes. "If the DFW earthquakes were caused by saltwater injection or other activities associated with producing gas, it is puzzling why there are only one or two areas of felt seismicity."

Further compounding the problem, Hayward said, is that there is not a good system in place to measure the naturally occurring seismicity in Texas: "We don't have a baseline for study."

Call for more fluid injection research

Enhanced geothermal projects also rely on methods of rock fracturing and fluid circulation. Geological carbon sequestration, an approach being researched to combat climate change, calls for pumping large volumes of carbon dioxide into subsurface rock formations.

"It's important we understand why and under what circumstances fluid injection sometimes causes small, felt earthquakes so that we can minimize their effects," Frohlich said.

The study notes that fault ruptures for typical induced earthquakes generally are too small to cause much damage.

"There needs to be collaboration between universities, the state of Texas, local government, the energy industry and possibly the federal government for study of this complicated question of induced seismicity," Stump said. "Everyone wants quick answers. What I can tell you is the direction these questions are leading us."

More information: dx.doi.org/10.1190/1.3353720

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