Bay Area Geophysical Society Seminar Series

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Using numerical simulation to understand the interaction of tectonic and operational forces at the Coso geothermal field

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In-person in Building 643 Rooms 1400A/B
LLNL Open Campus and on Zoom

Abstract:

In 2019, two large earthquakes occurred near Ridgecrest, California, ~35 km southeast of the Coso Geothermal Plant (CGP). The M6.4 and M7.1 Ridgecrest earthquakes were separated by only 34 hours and generated vigorous aftershock sequences. Curiously, a paucity of aftershock activity has been observed in the area surrounding the greater Coso geothermal field (gCGF). In fact, the rate of remote earthquake triggering after the last five large North American earthquakes in the area of the gCGF has been orders of magnitude smaller than expected, despite active geothermal circulation, which, in some cases leads to heightened remote triggering. Manipulation of subsurface stress state by fluid injection or extraction for energy production or other industrial operations can induce earthquake activity. It has been speculated that actively managing reservoir pressures via co-extraction of fluid during an injection operation may reduce the occurrence of seismicity by reducing the overpressure along subsurface faults and fractures. Modeling studies show that in highly idealized settings, co-extraction does reduce overpressures and generally reduces seismicity, but it does not

guarantee complete seismic quiescence. There are few robust observations of this type of causal mechanism influencing operational control of induced seismicity, primarily due to lack of systematic experimentation at the field-scale and lack of robust seismicity catalogs. The unexpected paucity of seismic triggering observed near the gCGF provides an excellent field laboratory to study whether natural tectonic, viscoelastic relaxation or industrial activities relieved stress and/or overpressure on faults in the gCGF, such that they are less likely to be triggered by coseismic stress changes. In this work, we couple 3D non-isothermal multiphase poromechanical simulations with 3D physics-based earthquake simulations to understand the mechanisms controlling aftershock activity in the gGCF. Poromechanical simulations include site specific injection and production information and characteristics and are constrained by InSAR time-series of surface deformation. Earthquake simulations are constrained based on 30+ years of well-located seismicity and local fault slip-rate data. Prepared by LLNL under Contract DE-AC52-07NA27344.

Author:

Dr. Kayla Kroll received a BSc in structural geology from California State Polytechnic University, Pomona in 2008 and her MSc and Ph.D. from in Earthquake Physics from the University of California, Riverside in 2012 and 2015, respectively. At UCR, Kayla applied observational seismology and numerical earthquake simulation methods to understand earthquake nucleation and triggering, fault interaction, and induced seismicity. Kayla completed a postdoc at Lawrence Livermore National Laboratory and converted to Research Scientist in 2018, where she focuses on understanding induced seismicity, hazard assessment, and developing mitigation strategies related to energy applications including carbon storage, geothermal and oil and gas operations. Kayla leads the Induced Seismicity task for the National Risk Assessment Partnership and oversees all geothermal related work at LLNL.

Zoom meeting information:

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