# Justin L. Rubinstein

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## EDUCATION

**Ph.D. Geophysics** — **Stanford University** — **March 2006**
Thesis: Using Microearthquakes as Probes of Larger Earthquake Rupture
Advisor: Gregory C. Beroza

## INDUCED SEISMICITY EXPERIENCE

**Mendenhall Postdoctoral Fellow** — **USGS – Menlo Park** — **2008 – 2010**
**Research Geophysicist** — **2010-present**
**Deputy Chief -- Induced Seismicity Project** — **2013-present**

*Deputy Chief – Induced Seismicity Project*

- Coordinating development of internal USGS research priorities on induced seismicity
- Developing research priorities for USGS-funded external grants on induced seismicity

*Integrating induced earthquakes in the USGS National Seismic Hazard Map*

- Overseeing USGS-Menlo Park efforts to estimate hazard from induced earthquakes
- Coordinating with USGS-Golden to integrate induced seismicity into National Seismic Hazard Maps
- Developing rate models for induced earthquakes
- Identifying area effected by potentially induced earthquakes
- Co-organized USGS-Oklahoma Geol. Survey Workshop "Hazard from Induced Seismicity"

*Study of induced earthquakes in Kansas*

- Coordinating deployment of seismometers in Kansas
- Coordinating with local, state, and national regulators, politicians, and researchers
- Identified many earthquakes near high-rate injection wells
- In response to USGS studies on seismicity in Kansas, the Kansas Corporation Commission ordered a reduction in wastewater injection rates (March 19, 2015, docket 15-CONS-770-CMSC).

*Study of induced earthquakes in the Raton Basin (Colorado and New Mexico)*

- Provided definitive evidence that the earthquake sequence in the Raton Basin (ongoing since 2001) is induced by wastewater injection in the area
- Showed that the August 2011 mainshock and its early aftershocks lie within 0.5 – 2 km of high volume wastewater injection wells
- Statistically demonstrated with 97% confidence that the change in earthquake rate observed beginning in August 2001 is not natural

## INDUCED SEISMICITY SERVICE

Advisor to *Istituto Nazionale di Geofisica e Vulcanologia* (Italian USGS Equivalent) and *Dipartimento di Protezione Civile* (Italian FEMA Equivalent) on Estimating Hazard from Induced Earthquakes — 2014-present

USGS Representative on *Induced Seismicity by Injection Focus Group* — 2014-present
*Commissioned by the Ground Water Protection Council and Interstate Oil and Gas Compact Commissions*

USGS Representative on Kansas State Induced Seismicity Task Force — 2014-present
*Commissioned by Kansas Governor Sam Brownback*

## PUBLICATIONS RELATED TO INDUCED EARTHQUAKES

1. Weingarten, M., S. Ge., J. Godt, B. Bekins, and J.L. Rubinstein (2015), High-rate injection is associated with the increase in U.S. mid-continent seismicity, ***Science***, 348(6241), pp. 1336 – 1340, doi: 10.1126/science.aab.1345.

2. J.L. Rubinstein and A.B. Mahani (2015), Myths and Facts on Wastewater Injection, Hydraulic Fracturing, Enhanced Oil Recovery, and Induced Seismicity, ***Seismological Research Letters***, 86(4), doi:10.1785/0220150067.

3. Eaton, D.W. and J.L. Rubinstein (2015), Preface to the special section on injection-induced seismicity, ***Seismological Research Letters,*** 86(4), doi:10.1785/0220150093.

4. Ellsworth, W.L. *et al.* (2015), Increasing seismicity in the U. S. midcontinent: Implications for earthquake hazard, ***The Leading Edge***, 34(6), pp. 618-626, doi: 10.1190/tle34060618.1.

5. McNamara, D.E., J.L. Rubinstein, *et al.* (2015), Efforts to monitor and characterize the recent increasing seismicity in central Oklahoma, ***The Leading Edge***, 34(6), pp. 628-639, doi: 10.1190/tle34060628.1.

6. McGarr, A. *et al.* (2015), Coping with earthquakes induced by fluid injection, ***Science***, 347, 830-810, doi: 10.1126/science.aaa0494

7. Petersen, M.D., *et al.*, (2015), Incorporating Induced Seismicity in the 2014 United States National Seismic Hazard Model — Results of 2014 Workshop and Sensitivity Studies, ***USGS Open File Report,*** 2015-1070.

8. Rubinstein, J.L., W.L. Ellsworth, and A. McGarr (2014), The 2001 – Present Triggered Earthquake Sequence in the Raton Basin of Colorado and New Mexico, ***Bulletin of the Seismological Society of America***, v. 104(5), pp. 2162-2181 doi: 10.1785/0120140009.

9. Barnhart, WD., H. Benz, G. Hayes, J.L. Rubinstein., E. Bergman (2014), Seismological and geodetic constraints on the 2011 Mw5.3 Trinidad, Colorado earthquake and induced deformation in the Raton Basin**,** ***Journal of Geophysical Research***, v 114., doi: 10.1002/2014JB011227.

## OTHER PUBLICATIONS

1. Rubinstein, J.L. and W.L. Ellsworth, Afterslip Rate Controls The Moment Rate of Repeating Earthquake Behavior, ***manuscript in preparation for Geophysical Research Letters***.

2. Chen, K.H., T. Furumura, and J.L. Rubinstein (2015), Near-surface versus fault zone damage following the 1999 Chi-Chi earthquake: Observation and simulation of repeating earthquakes (2014), ***Journal of Geophysical Research***, 120, doi:10.1002/ 2014JB011719.

3. Lay, T., Y. Fujii, E. Geis, K. Koketsu, J. Rubinstein, T. Sagiya, and M. Simons (2013), Introduction to the Special Issue on the 2011 Tohoku Earthquake and Tsunami, ***Bulletin of the Seismological Society of America***, v. 103, pp. 1165-1170, doi: 10.1785/0120130001

4. Pollitz, F.F., J.L. Rubinstein, and W.L. Ellsworth (2012), Source characterization of near-surface chemical explosions, ***Bulletin of the Seismological Society of America,*** v. 102, pp. 1348-1360, doi:10.1785/012011201.

5. Rubinstein, J.L., W.L. Ellsworth, K.H. Chen, and N. Uchida (2012), Fixed Recurrence and Slip Models Better Predict Earthquake Behavior than the Time- and Slip-Predictable Models 1: Repeating Earthquakes, ***Journal of Geophysical Research***, v. 117, B02306, doi:10.1029/2011JB008724.

6. Rubinstein, J.L., W.L. Ellsworth, N. Beeler, B.D. Kilgore, D. Lockner, and H. Savage (2012), Fixed Recurrence and Slip Models Better Predict Earthquake Behavior than the Time- and Slip-Predictable Models 2: Laboratory Earthquakes, ***Journal of Geophysical Research,*** *v.* 117, B02307, doi:10.1029/2011JB008723.

7. Chen, K.H., T. Furumura, J.L. Rubinstein**,** and R-J. Rau (2011), Observations of the healing of subsurface damage after the 1999 Chi-Chi earthquake, ***Geophysical Research Letters,*** v. 38, L23302, doi:10.1029/2011GL049841.

8. Rubinstein, J.L., Nonlinear Site Response in Medium Magnitude Earthquakes Near Parkfield, CA (2011), ***Bulletin of the Seismological Society of America***, v. 101, 275-286, doi: 10.1785/0120090396.

9. Rubinstein, J.L. and W.L. Ellsworth (2010), Precise Estimation of Repeating Earthquake Moment: Example from Parkfield, CA., ***Bulletin of the Seismological Society of America***, v. 100, pp. 1952–1961, doi: 10.1785/012010.

10. Gomberg, J. *et al.,* (2010), Slow-slip phenomena in Cascadia from 2007 and beyond: A review, ***GSA Bulletin***, v. 122, 963-978, doi: 10.1130/B30287. (**Review Article)**

11. Rubinstein, J.L.**,** D.R. Shelly, and W.L. Ellsworth (2010), Non-Volcanic Tremor: A Window into the Roots of Fault Zones, in ***New Frontiers in Integrated Solid Earth Sciences***, edited by S. Cloetingh and J. Negendank, pp. 287-314, Springer Netherlands. (**Invited Review Article)**

12. Rubinstein, J.L., J. Gomberg, J.E. Vidale, A.G. Wech, H. Kao, K.C. Creager, G. Rogers (2009), Seismic Wave Triggering of Non-Volcanic Tremor, ETS, and Earthquakes on Vancouver Island, ***Journal of Geophysical Research***, v. 114, B00A01, doi: 10.1029/2008JB005875.

13. Rubinstein, J.L., M. La Rocca, J.E. Vidale, K.C. Creager, A.G. Wech (2008), Tidal Modulation of Non-Volcanic Tremor, ***Science***, v. 319, pp 186-189.

14. Gomberg, J., J.L. Rubinstein**,** Z. Peng, K.C. Creager, J.E. Vidale (2008), Widespread Triggering of Non-Volcanic Tremor in California, ***Science***, v. 319, pp 173.

15. Peng, Z., J.E. Vidale, K.C. Creager, J.L. Rubinstein, J. Gomberg, and P. Bodin (2008), Strong tremor near Parkfield, CA excited by the 2002 Denali Earthquake, ***Geophysical Research Letters***, vol. 35, L23305, doi: 10.1029/2008GL036080.

16. Rubinstein, J.L.**,** J.E. Vidale, J. Gomberg, P. Bodin, K.C. Creager, and S.D. Malone (2007). Non-volcanic tremor driven by large transient shear stresses, ***Nature***, v. 448, pp 579-582.

17. Rubinstein, J.L., N. Uchida, and G. Beroza (2007). Seismic Velocity Reductions Caused by the 2003 Tokachi-Oki Earthquake, ***Journal of Geophysical Research***, v. 112, B05315, doi: 10.1029/2006JB004440.

18. Rubinstein, J.L. and G. Beroza (2007). Full Waveform Earthquake Location: Application to Seismic Streaks on the Calaveras Fault, California, ***Journal of Geophysical Research***, v. 112, B05303, doi: 10.1029/2006B004463.

19. Rubinstein, J.L. and G. Beroza (2005). Depth constraints on nonlinear strong ground motion from the 2004 Parkfield earthquake, ***Geophysical Research Letters***, v. 32, L14313, doi: 10.1029/2005GL023189.

20. Rubinstein, J.L. and G. Beroza (2004). Nonlinear strong ground motion in the $M_L$ 5.4 Chittenden Earthquake: Evidence that preexisting damage increases susceptibility to further damage, ***Geophysical Research Letters***, v. 31, L23614, doi: 10.1029/2004GL021357.

21. Rubinstein, J.L. and G. Beroza (2004). Evidence for widespread nonlinear strong ground motion in the $M_w$ 6.9 Loma Prieta Earthquake, ***Bulletin of the Seismological Society of America***, v. 94, pp. 1595–1608.

22. Hooper, A., P. Segall, K. Johnson, and J.L. Rubinstein (2002). Reconciling seismic and geodetic models of the 1989 Kilauea South Flank Earthquake, ***Geophysical Research Letters***, v. 29, pp. 19-1 – 19-4, doi: 10.1029/2002GL016156.

23. Davis, P., J.L. Rubinstein, K. Liu, S. Gao, and L. Knopoff (2000). Northridge Earthquake damage caused by geologic focusing of seismic waves, ***Science***, v. 289, pp. 1746-1750.