

Seismic Activity in the Inglewood Oil Field

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1 Data

Seismic data was provided to me from the USGS Southern California catalog, and separated into two groups: one 0 to 4 km from the center of the field (here labeled as *near*) and a second group from 4 to 10 km from the center of the field (here labeled as *far*).

The first step in the analysis is to determine the *magnitude of completeness* for these data sets. Lower magnitude events are not sufficiently well recorded to have statistically significant properties. The standard method for determining the completeness magnitude is to compare the observed frequency magnitude distribution with the *Gutenberg-Richter* distribution, as in Figure 1. This figure shows the size distribution of earthquakes (for the full time period) for the near-in and farther away earthquakes on semi-log plot. Earthquake distributions universally follow a linear trend on such a plot, as seen here for magnitudes between approximately M 1.75 and 3. From this we can conclude that (averaged over the full time period) the earthquake catalog is missing events of $M < 1.75$. (Note that the network's ability to detect smaller events undoubtedly improved with time, thus the catalog may be complete at smaller magnitude level, since for example 2000.) The negative slope on this plot, is known as the b-value; values near 1 are typical. The b-value for the inner zone is roughly 1.2, while for the outer region it is 0.99; these are within the standard range for tectonic earthquakes. The linear trend on a the semi-log plot breaks down at larger magnitudes (roughly magnitude 3) , as there are few events of this size in the data set.

Figure 2 shows $M > 1.75$ events as a function of time for both the near (top) and far (bottom) catalogs. Focussing on the top plot, there is a M 3.8 event in 2015, and what appears to be an increase in activity around that time, but it turns out that these events are fairly deep compared to oil-field operations. This can be

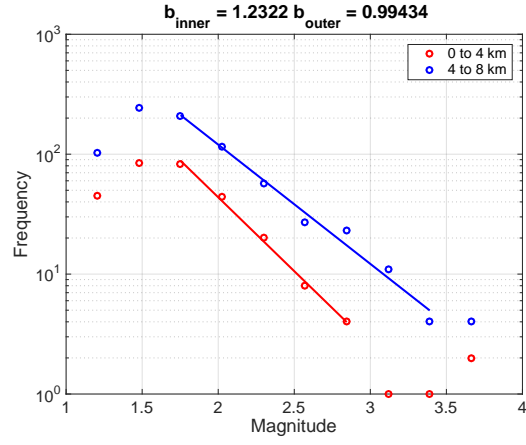


Figure 1: Frequency magnitude distribution of earthquakes in and near the Inglewood Oil Field. Red: 0 to 4 km from the center of the field. Blue: 4 to 10 km from center.

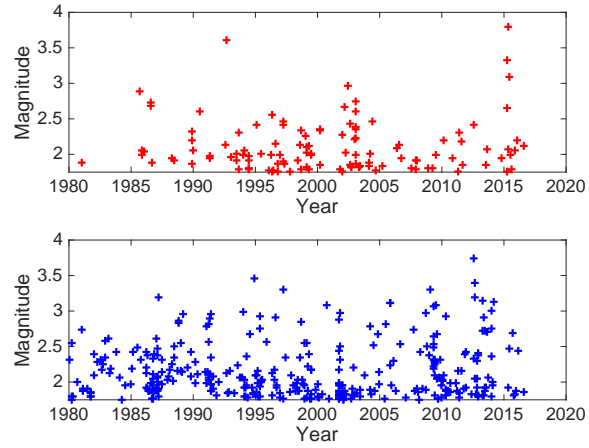


Figure 2: Magnitude vs time for events greater than 1.75, in the near (top) and far (bottom) zones. All depths.

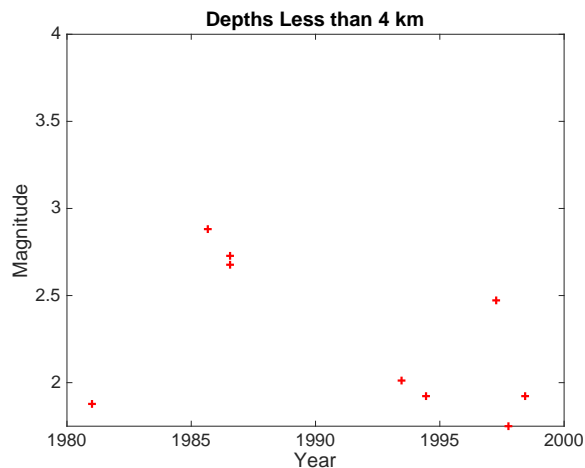


Figure 3: Magnitude vs time for events greater than 1.75, and depth shallower than 4 km, for the near field events.

seen by considering only events shallower than 4 km, as in Fig. 3. 4 km was chosen as it is roughly the depth of the deeper Sentous formation at the margin of the field. There are relatively few shallow (less than 4 km) events, and they appear somewhat clustered in time. Significantly, there does not appear to be an obvious trend of increasing shallow earthquakes with time that might indicate effects of oil-field operations. The rate of activity for the more distant group of earthquakes (4-10 km) is fairly uniform in time (Figure 2b). Perhaps the first 5 years or so are lacking in $M > 3$ events but that may be due changes in the network detection capability with time.

I did not have available to me time series of injected volumes within the Inglewood Oil Field during this time interval. Thus, it was not possible to compare such a data set with the earthquake data. However, there are no obvious trends in these subsets of data that indicate an influence of oil-field operations. That does not prove that they do not exist. Simply there is no evidence (such as a increasing rate of shallow earthquakes) that is suggestive of human induced impact in the data.

2 Poisson Test

I tested whether or not the data are consistent with a Poisson process. A Poisson process is random in time, and is commonly used as a *null hypothesis* for natural, background seismicity. For this test I used the data from the ‘inner’ region with

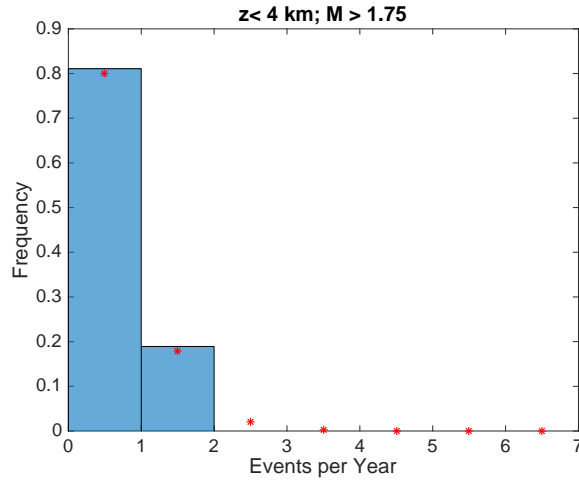


Figure 4: Blue histogram: Observed number of earthquakes per year within inner region and depths less than 4 km. Red stars: Predicted Poisson distribution given the observed frequency of events in this category.

depths less than 4 km, shown in Figure 3. I found that one cannot reject the Poisson distribution for these data at the 95% confidence level. That is the data are consistent with the Poisson distribution at this confidence level. Figure 4 illustrates this, comparing the observed and predicted number of earthquakes per year. The figure shows that the observations are quite consistent with the expected Poisson distribution – there is an 80% chance of no earthquakes within this region with depth less than 4 km and magnitude greater than 1.75 in a given year, exactly as observed.

Thus, while we cannot prove that the earthquakes are all due to natural tectonic processes, there does not seem to be anything based on this evaluation of the data that would indicate an unusual pattern of earthquakes with time.

People (Profile) *Paul Segall* has been updated.

Education

- 1981 | Ph.D. Geology Stanford University
- 1976 | B.A./M.S. Earth Sciences Case Western Reserve University

Professional Experience

- 2000 Visiting | Professor Insitute de Physique du Globe, Paris
- 1998 - Present | Professor Stanford University
- 1993 - 1998 | Associate Professor Stanford University
- 1991 | Visiting Associate Professor University of Grenoble
- 1989 - 1993 | Associate Professor (Research) Stanford University
- 1987 - 1989 | Consulting Professor Stanford University
- 1983 - 1993 | Project Chief Mechanics of Faulting and Fracturing, USGS
- 1981 - 1983 | Geologist USGS

Honors & Awards

- 2011 | William Smith Lecturer, Geological Society of London
- 2009 | Stanford Postdoctoral Mentoring Award (Honorable Mention)
- 2002 | Citation for Excellence in Refereeing, American Geophysical Union
- 1997 | Fellow, Geological Society of America
- 1990 | J.B. Macelwane Medal, American Geophysical Union
- 1990 | Fellow, American Geophysical Union
- 1984 | USGS Special Achievement Award

University Service

- 2013-2014 | Freshman Advisor
- 2010-2012 | Office of Judicial Affairs – Internal Review Panel
- 2005 - 2013 | Instructor, Stanford (Summer) Engineering Academy
- 2011 - 2012 |School of Earth Sciences Space Committee

2010 | Geoscape Bay Area: Teacher Professional Development Course on Volcanoes

2008 - 2010 | Admit Weekend Lecture

2005 - 2006 | Admit Weekend Lecture

2003 - 2004 | Associate Chair, Geophysics Department

2002 - 2004 | Member, Earth Sciences Council

2000 - 2001 | Alumni Weekend Lecture

2000 - 2001 | Member, University Needs Task Force on Information Technology

2000 - 2001 | Chair, C-ACIS Committee on Academic Computing and Information Services

1997 - 2000 | Member, C-ACIS Committee on Academic Computing and Information Services

1995 - 2005 | Freshman/Sophomore Advisor

1995 - 1998 | Chair, Geophysics Department Admissions Committee

1994 - 2007 | Chair, School of Earth Sciences Computer Committee

Professional Activities

2013 | U.K. National Centre of Earth Observation Assessment Panel

2013 | Invited Speaker, Hawaiian Volcano Observatory

2013 | Invited Speaker, Earthquake Research Institute, University of Tokyo

2013 | Invited Speaker, Oberlin College

2013 | NSF Panel: Frontiers of Earth System Dynamics

2012 | Earth and Ocean Sciences Colloquium, University of British Columbia.

2012 | Keynote speaker, Chapman Conference on Hawaiian Volcanism.

2011 | Keynote speaker, Seismic and aseismic deformation workshop, Strasbourg France.

2011 | Invited speaker, USGS Workshop on Great Cascadia earthquakes, Eugene Oregon.

2011 | Plenary speaker: Chapman Conference, The Galápagos as a Laboratory for the Earth Sciences, Puerto Ayora, Ecuador.

2011 | Invited Speaker, University of Kyoto, Disaster Prevention Research Institute.

2011 | Invited Speaker, Royal Society Workshop, Magma Migration, Storage and Eruption.

2011 | Chair Reid Medal Committee, Seismological Society of America

2011 | Invited Participant - USGS New Madrid Workshop

2011 | Invited Speaker - Univ. Colorado

2011 | Invited Speaker - J.R. Rice Symposium Caltech

2010 | Invited Speaker - Hawaiian Volcano Observatory

2010 | Invited Speaker - Earthscope Institute: Spectrum of Fault Slip Behavior

2009 | Invited presentation: UC Santa Cruz

2009 | Invited Keynote Speaker: Earthscope National Meeting

2009 | Invited Speaker: Workshop on Numerical Modeling of Crustal Deformation and Earthquake Faulting

2009 | Invited Seminar U.C. Berkeley

2009 | NSF Long Range Science Plan for Geodesy - Discussion Leader

2008 | Chair, U.C. Riverside IGPP External Review

2008 | Invited Presentation: Caltech Geological and Planetary Sciences

2008 | Invited Presentation: US Geological Survey

2008 | Invited Presentation: Volcano Deformation Workshop

2008 | Review Panel: Canadian Institute for Advanced Research

2008 | NSF Long Range Planning for Seismology Workshop

2007 | Invited presentation: IGPP U. C. San Diego

2007 | Invited presentation: Harvard University

2007 - Present | Southern California Earthquake Center Board of Directors

2007 | Invited Speaker: Euro-Conference - Rock Physics and Geomechanic

2006 | USGS working group on National Volcano Early Warning System extramural program

2006 | Invited presentation: SCEC/ERI Workshop

2006 | Chair, UNAVCO Nominating Committee

2005 | Invited Participant, Dahlem Workshop "Dynamics of Fault Zones", Berlin

2005 - 2008 | Donath Medal Committee, Geological Society of America

2005 | Invited presentation Purdue University 2005 Invited participant: Kavli Institute of Theoretical Physics "Fracture and friction from atomic to tectonic scales"

2004 | Newton Institute of Mathematical Sciences, School on physics of granular media

2003 | Invited Presentation, U.C. Riverside

2003 - 2004 | President, Tectonophysics Section, AGU

2003 - 2006 | Chair, Plate Boundary Observatory (Earthscope) Standing Committee

2003 | Coconvener, NSF/USGS sponsored workshop "volcanic processes in Long Valley Caldera - Mono Craters volcanic field"

2002 - 2006 | Department of Interior's Scientific Earthquake Advisory Committee

2002 | Invited Seminar, I.G.P.P., Scripps Institute of Oceanography

2002 | Invited Presentation, Academia Sinica, Taipei, Taiwan

2002 - 2009 | Member CEPEC, California Earthquake Prediction Evaluation Council

2002 | Invited Seminar, University of Southern California

2001 | Invited presentation: Caltech

2001 | Invited presentation: University of Utah, Rate Debate Workshop

2001 | Invited Presentation: University of Hawaii

2001 | Invited Presentation: Hawaiian Volcano Observatory

2001 | Invited Presentation: Whole Earth Seminar, U.C. Santa Cruz

2001 - 2003 | UNAVCO, Inc. Board of Directors

2000 - 2001 | UNAVCO (University Navstar Consortium) Steering Committee

2000 - 2002 | President Elect, American Geophysical Union, Tectonophysics Section

2000 - 2002 | American Geophysical Union Meetings Committee

2000 - 2001 | Invited Presentation: U.S.G.S. Workshop on New Madrid Earthquakes

2000 - 2001 | Invited Presentation: D.O.E. Workshop, Gaithersburg Md.

2000 - 2001 | Invited Presentation: E.G.S. Nice, France

2000 - 2001 | Invited Presentation: Institute de Physique du Globe, Paris, France

2000 - 2001 | Invited Presentation: Universite de Bretagne Occidentale, Brest, France

2000 - 2001 | Invited Presentation: Ecole Normale Supérieur, Paris, France

2000 - 2001 | Invited Presentation: Observatoire du Midi Pyrenees, Toulouse, France

2000 - 2001 | Invited Presentation: Stress Interactions Workshop, Erice, Italy

2000 - 2001 | Invited Presentation: 2nd Plate Boundary Observatory Workshop

2000 - 2001 | Invited Presentation: U.S.- Japan Conference on Earthquake Studies

2000 - 2001 | Invited Presentation: Southern California Earthquake Center (SCEC) Annual Meeting

2000 | CNRS review committee of Laboratoire de Tectonique-Mechanique de la Lithosphere, Institute de Physique du Globe, Paris

2000 - 2003 | UNAVCO (NSF GPS Facility) Board of Directors

1999 | Invited presentations: UNAVCO Annual Meeting

1999 | Invited presentations: AGU (Spring) | Meeting

1999 | Invited presentations: UCLA

1999 | Invited presentations: UNAVCO workshop on Volcano Deformation

1999 | Invited presentations: Plate Boundary Observatory Workshop, Snowbird, Utah

1999 | Invited presentations: GPS 99, Tsukuba, Japan

1999 | Invited presentations: Stanford University Statistics Department

1999 - 2002 | Member, Plate Boundary Observatory Steering Committee

1999 - 2000 | Member, NAS Committee to review the Volcano Hazards Program of the U.S. Geological Survey

1999 | Chair, UC Santa Cruz Tectonics Advisory Committee

1998 - 2002 | Southern California Integrated GPS Network Advisory Council

1998 | Invited lectures: IRIS Annual Meeting

1998 | Invited lectures: Special Session Organizer and Presentation, SSA Annual Meeting

1998 | Invited Symposium Presentation: Space-Based Geoscience Observations: Looking Down at the Future, University of Texas, Austin, Feb 5-6, 1998

1997 - 2000 | NSF Review Panel, Instruments and Facilities

1997 - 1998 | NASA, Solid Earth and Natural Hazards, Science Plan Committee

1996 - 1998 | James B. Macelwane Medal Committee, American Geophysical Union

1994 - Present | Science Advisory Team for Long Valley caldera, USGS

Courses Taught

2014 (Winter) | 288B Crustal Deformation [Enrolled 8]

2014 (Winter) | 385L Earthquake Seismology, Deformation, and Stress [Enrolled 12]

2014 (Spring) | 385L Earthquake Seismology, Deformation, and Stress [Enrolled 9]

2014 (Spring) | 289 Global Positioning System in Earth Sciences [Enrolled 7/10]

2014 (Spring) | 20N Predicting Volcanic Eruptions [Enrolled 12/15]

2013 (Fall) | 385L Earthquake Seismology, Deformation, and Stress [Enrolled 11]

2013 (Fall) | 288A Crustal Deformation [Enrolled 9]

2012 (Spring) | 385L Quake Seismology & Stress [Enrolled 9]

2012 (Winter) | 288B Crustal Deformation [Enrolled 6]

2012 (Winter) | 385L Quake Seismology & Stress [Enrolled 6]

2011 (Fall) | 288A Crustal Deformation [Enrolled 13]

2011 (Fall) | 385L Quake Seismology & Stress [Enrolled 10]

2010 (Summer) | 400 Geophysics Research [Enrolled 1]

2010 (Spring) | Sabbatical

2010 (Winter) | 385L Quake Seismology & Stress [Enrolled 10]

2010 (Winter) | 400 Geophysics Research [Enrolled 4]

2010 (Winter) | 802 TGR Dissertation [Enrolled 2]

2010 (Winter) | GP 113 Earthquakes and Volcanoes [Enrolled 3]

2010 (Winter) | Earth Systems 113 Earthquakes and Volcanoes [Enrolled 16]

2010 (Fall) | 385L Quake Seismology & Stress [Enrolled 9]

2010 (Fall) | 400 Geophysics Research [Enrolled 3]

2010 (Fall) | 802 TGR Dissertation [Enrolled 2]

2010 (Fall) | 281 Inverse Problems [Enrolled 14]

2010 (Fall) | Earth Sciences 117 Earth Sciences of Hawai'i [Enrolled 14]

2009 (Summer) | 802 TGR Dissertation [Enrolled 2]

2009 (Summer) | 400 Geophysics Research [Enrolled 2]

2009 (Fall) | 288A Crustal Deformation [Enrolled 11]

2009 (Fall) | 385L Quake Seismology & Stress [Enrolled 7]

2009 (Fall) | 400 Geophysics Research [Enrolled 3]

2009 (Fall) | 802 TGR Dissertation [Enrolled 1]

2009 (Winter) | 385L Quake Seismology & Stress [Enrolled 8]

2009 (Winter) | 288B Crustal Deformation [Enrolled 6]

2009 (Winter) | 400 Geophysics Research [Enrolled 2]

2009 (Winter) | 802 TGR Dissertation [Enrolled 2]

2009 (Spring) | 385L Quake Seismology & Stress [Enrolled 8]

2009 (Spring) | 400 Geophysics Research [Enrolled 3]

2009 (Spring) | 802 TGR Dissertation [Enrolled 2]

2009 (Spring) | 113 Earthquakes and Volcanoes [Enrolled 1]

2009 (Spring) | 113 Earthquakes and Volcanoes [Enrolled 13]

2008 (Fall) | 400 Geophysics Research [Enrolled 4]

2008 (Winter) | 802 TGR Dissertation [Enrolled 1]

2008 (Winter) | 400 Geophysics Research [Enrolled 2]

2008 (Winter) | 289 GPS in EarthScience (note 19 enrolled in AA272C) [Enrolled 2]

2008 (Fall) | 281 Inverse Problems (w/ Beroza) [Enrolled 11]

2008 (Fall) | 180 Inverse Problems (w/ Beroza) [Enrolled 4]

2008 (Fall) | 385L Quake Seismology & Stress [Enrolled 9]

2008 (Winter) | 385L Quake Seismology & Stress [Enrolled 9]

2008 (Spring) | 20Q Predicting Volcanic Eruptions [Enrolled 8]

2008 (Spring) | 113 Earthquakes and Volcanoes (w/Beroza) [Enrolled 45]

2008 (Spring) | 385L Quake Seismology & Stress [Enrolled 9]

2008 (Spring) | 400 Geophysics Research [Enrolled 3]

2008 (Spring) | 802 TGR Dissertation [Enrolled 1]

2008 (Summer) | 400 Geophysics Research [Enrolled 3]

2008 (Summer) | 802 TGR Dissertation [Enrolled 1]

2007 (Winter) | 400 Geophysics Research [Enrolled 3]

2007 (Winter) | 385L Quake Seismology & Stress [Enrolled 5]

2007 (Winter) | 802 TGR Dissertation [Enrolled 1]

2007 (Winter) | 288A Crustal Deformation [Enrolled 13]

2007 (Fall) | 385L Quake Seismology & Stress [Enrolled 5]

2007 (Fall) | 400 Geophysics Research [Enrolled 4]

2007 (Fall) | 802 TGR Dissertation [Enrolled 1]

2007 (Spring) | 288B Crustal Deformation [Enrolled 10]

2007 (Spring) | 802 TGR Dissertation [Enrolled 1]

2007 (Spring) | 113 Earthquakes & Volcanoes (w/Beroza) [Enrolled 41]

2007 (Spring) | 185L/385L Quake Seismology & Stress [Enrolled 7]

2006 (Spring) | 400 Geophysics Research [Enrolled 3]

2006 (Fall) | 120 Frontiers Geophysics Res. [Enrolled 15]

2006 (Fall) | 385L Quake Seismology and Stress [Enrolled 4]

2006 (Fall) | 180 Inverse Problems [Enrolled 11]

2006 (Fall) | 400 Geophysics Research [Enrolled 2]

2006 (Fall) | 802 TGR Dissertation [Enrolled 1]

2006 (Winter) | 385L Quake Seismology and Stress [Enrolled 5]

2006 (Winter) | 400 Geophysics Research [Enrolled 2]

2006 (Winter) | 802 TGR Dissertation [Enrolled 1]

2006 (Winter) | 289 Global Positioning [Enrolled 2]

2005 (Spring) | 801 TGR Project [Enrolled 1]

2005 (Spring) | 385L Quake Seismology and stress [Enrolled 5]

2005 (Winter) | GP 288 Crustal Deformation [Enrolled 6]

2005 (Fall) | GP 288 Crustal Deformation [Enrolled 10]

2005 (Winter) | GP 113/ES 113 Earthquakes & Volcanoes w/ Beroza [Enrolled 32]

2004 (Fall) | GP 180 Inverse Problems w/Beroza [Enrolled 7]

2004 (Fall) | GP 20Q Predicting Volcanic Eruptions [Enrolled 8]

2004 (Fall) | GP 289 Global Positioning [Enrolled 8]

2004 | GP 185L / 385L Quake Seismology and Stress [Enrolled 5]

2003 | GP20Q Predicting Volcanic Eruptions [Enrolled 8]

2003 | GP003 Earthquakes and Volcanoes (with Beroza) [Enrolled 11]

2003 | GP 385L Quake Seismology and Stress [Enrolled 6]

2003 (Fall) | GP 288 Crustal Deformation [Enrolled 6]

2003 | GP 385L Quake Seismology and Stress [Enrolled 6]

2002 | GP288 Crustal Deformation [Enrolled 11]

2002 | GP385L Quake Seismology and Stress (with Beroza, Zoback) [Enrolled 13]

2002 | GP185L Quake Seismology and Stress (with Beroza, Zoback) [Enrolled 3]

2002 | GP400 Geophysics Research [Enrolled 17]

2002 | GP399 Teaching Experience [Enrolled 1]

2002 | GP802 TGR Dissertation [Enrolled 2]

2001 | GP400 Research [Enrolled 4]

2001 | GP802 TGR Dissertation [Enrolled 2]

2001 | GP802 TGR Dissertation [Enrolled 2]

2001 | GP400 Research [Enrolled 4]

2001 | GP385 Earthquake Seismology (with Zoback, Beroza) [Enrolled 5]

2001 | GP004 Natural Hazards (with Beroza) [Enrolled 14]

2001 | GP180 Inverse Problems (with Beroza) [Enrolled 16]

2001 | GP399 Teaching Experience [Enrolled 1]

2001 | GP385 Quake Seismology (with Beroza, Zoback) [Enrolled 4]

2001 | GP185 Quake Seismology (with Beroza, Zoback) [Enrolled 1]

2001 | GP289 Global Positioning [Enrolled 7]

2001 | GP385 Quake Seismology (with Beroza, Zoback) [Enrolled 2]

2001 | GP399 Teaching Experience [Enrolled 1]

2001 | GP400 Research [Enrolled 2]

2001 | GP802 TGR Dissertation [Enrolled 2]

2001 | GP400 Research [Enrolled 4]

2001 | GP185 Quake Seismology (with Beroza, Zoback) [Enrolled 1]

2000 | GP385 Earthquake Seismology (with Zoback, Beroza) [Enrolled 8]

2000 | GP004 Natural Hazards (with Beroza) [Enrolled 27]

2000 | GP288 Crustal Deformation [Enrolled 10]

2000 | GP400 Research [Enrolled 12]

1999 | GP004 Natural Hazards (with Beroza) [Enrolled 29]

1999 | GP289 Global Positioning [Enrolled 9]

1999 | GP385 Earthquake Seismology (with Zoback, Beroza) [Enrolled 5]

1999 | GP400 Research [Enrolled 3]

1999 | GP180 Geophysical Inverse Problems (with Beroza) [Enrolled 15]

1998 | GP004 Natural Hazards (with Beroza) [Enrolled 45]

1998 | GP400 Research [Enrolled 12]

1998 | GP385 Earthquake Seismology (with Zoback, Beroza) [Enrolled 5]

1998 | GP385 Crustal Deformation [Enrolled 1]

1998 | GP288 Crustal Deformation [Enrolled 14]

Publications

2014* | Mavrommatis, A., P. Segall, and K. Johnson, A decadal-scale deformation transient prior to the Mw 9.0 2011 Tohoku-oki earthquake, *Geophys. Res. Letts*, in review.

2014* | Bartlow, N.M., L. M Wallace, R J Beavan, S Bannister, P Segall, Time-dependent modeling of slow slip events and associated seismicity and tremor at the Hikurangi subduction zone, New Zealand, *J. Geophys. Res. Solid Earth*, 119, 2169-9356, 10.1002/2013JB010609, 2014.

2013* | Anderson, K., and P. Segall, Bayesian inversion of data from effusive volcanic eruptions using physics-based models: Application to Mount St. Helens 2004-2008, *J. Geophys. Res.*, 2013, DOI: 10.1002/jgrb.50169, 2013.

2013* | Segall, P., Volcano Deformation and Eruption Forecasting, in *Remote Sensing of Volcanoes and Volcanic Processes*, Geol. Soc. London, 29p.

2013* | P. Segall, A. L. Llenos, S.-H. Yun, A. M. Bradley, E. M. Syracuse, Time-Dependent Dike Propagation From Joint Inversion of Seismicity and Deformation Data, *J. Geophys. Res.*, 118, 1–20, doi:10.1002/2013JB010251, 2013.

2012* | Johnson, K.M., J-I Fukuda, and P. Segall, Afterslip on historical earthquake asperities following the 2011 M9 Tohoku-oki, Japan earthquake, *Geophysical Research Letters*, 39, L20302, doi:10.1029/2012GL052901, 2012.

2012* | Segall, P. Understanding Earthquakes, *Science* **336**, 676 (2012); doi: 10.1126/science.1220946.

2012* | Segall, P. and A. M. Bradley, Slow-slip Evolves into Megathrust Earthquakes in 2D Numerical Simulations, *Geophysical Research Letters*. 39, L18308, doi:10.1029/2012GL052811, 2012.

2012* | Segall, P. and A. M. Bradley, The role of thermal pressurization and dilatancy in controlling the rate of fault slip, *Journal of Applied Mechanics*, 79, 2012, doi:10.1115/1.4005896.

2011 * | Montgomery-Brown, E. K., D. K. Sinnett, K. M. Larson, M. P. Poland, P. Segall, and A. Miklius, Spatiotemporal evolution of dike opening and décollement slip at Kīlauea Volcano, Hawai'i, *J. Geophys. Res.*, 116, B03401, doi:10.1029/2010JB007762.

2011 * | Anderson, K., and P. Segall, Ground deformation at effusively erupting volcanoes from physics-based models, I: Development and Analysis, *Jour. Geophys. Res.*, 116, B07204, doi:10.1029/2010JB007939.

2011 * | Schmitt, S.V, P. Segall, and T. Matsuzawa, Thermal pressurization during earthquake nucleation, *Jour. Geophys. Res.*, 116, B06308, doi:10.1029/2010JB008035, 2011

2011 * | Miyazaki, S.I., J. J. McGuire, and Paul Segall, Seismic and aseismic fault slip before and during the 2011 Tohoku Earthquake, *Earth Planets, and Space*, Vol. 63 (No. 7), pp. 637-642, 2011.

2011 * | Bartlow, N. M., S.I Miyazaki, A.M. Bradley, P. Segall, Space-time relationship of slip and tremor during the 2009 Cascadia slow slip event, *Geophysical Research Letters*, 38, L18309, 2011 doi:10.1029/2011GL048714.

2010 * | Anderson, K., M. Lisowski, and P. Segall. Cyclic ground tilt associated with the 2004-2008 eruption of Mount St. Helens, *J. Geophys. Res.*, 115, B11201, doi:10.1029/2009JB007102.

2010 * | Ohtani, R., J.J. McGuire, and P. Segall, The Network Strain Filter, a new tool for monitoring and detecting transient deformation signals in GPS arrays, *Jour. Geoph. Res.*, 115, B12418, doi:10.1029/2010JB007442.

2010 * | Segall, P. A. Rubin, A. M. Bradley, J.R. Rice, Dilatant Strengthening as a Mechanism for Slow Slip Events, *Jour. Geophys. Res.*, vol. 115, B12305, 37 PP., 2010 doi:10.1029/2010JB007449.

2010 * | Montgomery-Brown, E.K., K.M. Larson, D. Sinnett, M. Poland, P. Segall, A. Miklius, Spatio-temporal distribution dike opening and fault slip during the June 17-19, 2007 intrusion at Kilauea volcano, Hawaii, Jour. Geophys. Res., v. 115, B07405, doi:10.1029/2009JB006658, 2010.

2010 * | Segall, P., Earthquake and Volcano Deformation, Princeton University Press, 424, pp., 2010.

2009 * | Montgomery-Brown, E. K. P. Segall and A. Miklius, Kilauea slow-slip events: Identification, source inversions, and relation to seismicity, J. Geophys. Res, 114, B00A03, doi:10.1029/2008JB006074, 2009.

2008 * | Song, S.-G., G. C. Beroza, P. Segall, A Unified source model of the 1906 San Francisco earthquake, Bull. Seism. Soc. Amer, v. 98; no. 2; p. 823-831, 2008.

2008 * | Rivalta, E., and P. Segall, Magma compressibility and the missing source for some dike intrusions, Geophys. Res Lett., 35, L04306, doi:10.1029/2007GL032521, 2008.

2007 * | Desmarias, E.K., and P. Segall, Transient deformation following the January 30, 1997 dike intrusion at Kilauea Volcano, Hawaii, Bulletin Volcanology, 69 (4): 353-363, 2007.

2007 * | Hooper, A., P. Segall, H. Zebker, Persistent Scatterer InSAR for Crustal Deformation Analysis, with Application to Volcan Alcedo, Galapagos, J. Geophys. Res, 112, B07407, doi:10.1029/2006JB004763.

2007 * | Hsu, Ya-Ju, P. Segall, S.-B. Yu, and L.-C. Kuo,, Temporal and spatial variations of afterslip following the 1999 Chi-Chi, Taiwan earthquake, Geophysical Jour. International, 169, 367-379 doi: 10.1111/j.1365-246X.2006.03310.x, 2007.

2007 * | Yun, S., Zebker, H., Segall, P., Hooper, A., and Poland, M., Interferogram formation in the presence of large deformation, Geophysical Research Letters, 34, L12305, doi:10.1029/2007GL029745, 2007.

2007 * | Amelung, F., Yun, S., Walter, T., and Segall, P., Stress control of deep rift intrusion at Mauna Loa volcano, Hawaii, Science, Vol. 316. no. 5827, pp. 1026 – 1030 DOI: 10.1126/science.1140035, 2007.

2006 * | Johnson, K. M, and P. Segall, Kinematic and mechanical models of deformation in convergent plate boundary zones, J. Geophys. Res. In revision following review, 2006.

2006 * | Yun, S., P. Segall, and H. Zebker, Constraints on magma chamber geometry at Sierra Negra volcano, Galapagos Islands, based on InSAR observations. Journal of Volcanology and Geothermal Research; Feb 1 2006; v.150, no.1-3, p.232-243

2006 * | Miyazaki, S.-I., P. Segall, J. J. McGuire, T. Kato, and Y. Hatanaka, Spatial and temporal evolution of stress and slip rate during the 2000 Tokai slow earthquake, J. Geophys. Res., vol. 111, B03409, doi:10.1029/2004JB003426, 2006.

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Advisee Degrees

2013 | Noel Bartlow: The physics of slow slip, tremor, and associated seismicity from geodetic and laboratory studies Ph.D. (Postdoc Scripps)

2011 | Kyle Anderson: The dynamics of effusive volcanic eruptions: Kinematic and physics-based inversions of observations at Mount St. Helens, 2004-2011, Ph. D. (Postdoc USGS).

2008 | Emily Montgomery-Brown: Time Dependent Deformation of Kilauea Volcano, Hawaii, Ph.D. (Postdoc)

2008 | Dan Sinnet, M.S. (Graduate Student)

2007 | Sang-ho Yun: A mechanical model of the large-deformation 2005 Sierra Negra Volcanic eruption derived from InSAR measurements (with Zebker), Ph.D. (J.P.L.)

2007 | Kyle Anderson, M.S. (Stanford, Grad student)

2006 | Andy Hooper: Persistent Scatterer Radar Interferometry for crustal deformation studies and modeling of volcanic deformation (with Zebker), Ph.D. (Delft University)

2005 | Emily Desmarais, M.S. (Stanford)

2004 | Kaj M. Johnson: Mechanical Models of Interseismic Deformation in California and Taiwan, Ph.D. (University of Indiana)

2003 | Jessica Murray: Deformation Studies at Parkfield, Ph.D. (U.S.G.S.)

2003 | Sang-Ho Yun, M.S. (Graduate Student)

2002 | Peter Cervelli: Using geodetic data to infer the kinematic and mechanical properties of deformation sources on Kilauea volcano, Hawaii, Ph.D. (U.S.G.S. Hawaiian Volcano Observatory)

2002 | Maurizio Battaglia: Unrest at Long Valley Caldera: GPS and gravity investigations, Ph.D. (U.C. Berkeley)

2002 | Antony Mossop: Seismicity, subsidence, and strain at The Geysers Geothermal field, Ph.D. (Sandia Labs)

2002 | Sigurjon Jonsson: Modeling volcano and earthquake deformation from satellite radar interferometric observations, Ph.D. (ETH, Zurich)

2000 | Jessica Murray, M.S. (Ph.D., Stanford)

2000 | Shelley Kenner: Mechanical modeling of time dependent deformation in the lower crust and its effect on earthquake recurrence, Ph.D. (University of Kentucky)

1999 | Susan Owen: GPS measurements and kinematic models of the surface deformation on Kilauea volcano, Hawaii, Ph.D. (U. of S. California)

1999 | Peter Cervelli, M.S. (Ph.D., Stanford)

1998 | Maurizio Battaglia, M.S. (Ph.D., Stanford)

1998 | Shelley Kenner, M.S. (Ph.D., Stanford)

1998 | David Lessick (with Howard Zebker), M.S. (Unknown)

Advisee Publications

2014 | Bradley, A. M., Software for efficient static dislocation-traction calculations in fault simulators, Bull. Seism. Soc, in review.

2012 | Bartlow, N. M., D. A. Locker, and N. M. Beeler (2012) Laboratory triggering of stick-slip events by oscillatory loading in the presence of pore fluid with implications for physics of tectonic tremor. *J. Geophys. Res.*, doi:10.1029/2012JB009452.

2011 | Bradley, A. M., "HMMVP: Software to Compute Matrix-Vector Products with an H-Matrix", [arXiv:1110.2807v1](#) [math.NA].

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