Department of Earth and Space Sciences
UCLA
Los Angeles, CA 90095-1567
Thursday, February 20, 2014

Dear Dr. Igel:

I am applying for a postdoctoral position in geophysics/seismology at LMU Munich's Department of Earth and Environmental Sciences, to continue and expand my research in seismology and fault mechanics. My current research, as a PhD candidate in UCLA's Geophysics and Space Physics graduate program, focuses on developing a viable physics-based earthquake forecast that can outperform forecasts solely based upon statistical seismology. Static Coulomb stress-based earthquake forecasts show potential in improving upon smoothed seismicity earthquake forecasts in the far field. However, uncertainties in inter-, co- and postseismic stress transfer near earthquake sources currently prevent physics-based earthquake probabilities from prospectively forecasting a significant fraction of seismicity within and near faults.

In future research, I plan to further investigate sources of stress heterogeneity, and how uncertainties in the stress field influence prospective earthquake forecast reliability. Retrospective forecast results indicate that dynamic stress transfer is necessary to accurately characterize the stress environment under which most aftershocks are trigged. Through increased understanding of ground motion and slip distribution following earthquakes, much of the uncertainty in both static and dynamic stress fields can be reduced, allowing for earthquake probability distributions that more accurately reflect seismicity rates where earthquake triggering is imminent. The data acquired through installation of the current 3-D seismic array, as well as other multi-component seismic sensors, will greatly contribute toward elucidating slip distribution and ground motion near earthquake sources, which is vital in determining how earthquakes are directly triggered.

I have included a statement of my research interests, my CV, and a list of two references. Thank you for your consideration of my work and application, and please email any questions to astrader@ucla.edu.

Sincerely,

Anne Strader
PhD candidate, UCLA Department of Earth and Space Sciences

ANNE STRADER
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EDUCATION

- 2010: BSc in Geology with Honors, minors in mathematics and physics, *Bucknell University*.
- 2013: MSc in Geophysics, *UCLA.*
- 2014: PhD in Geophysics, *UCLA.* (degree expected June 2014)

PUBLICATIONS

- Strader, A. E. and D. D. Jackson, 2013. Almost-Prospective Test of Coulomb Stress Triggering. *accepted for publication by Journal of Geophysical Research – Solid Earth, 2014*
- Strader, A. E. and D. D. Jackson, 2014. Static Coulomb Stress-Based Southern California Earthquake Forecasts: a Pseudo-Prospective Test. *to be submitted to Journal of Geophysical Research – Solid Earth*

AWARDS AND HONORS

- NSF graduate student research fellowship, four years of funding.
- 2010-2011 Chancellor's Prize, UCLA Graduate Division
- ExxonMobil SAGE Scholar, 2010
- Honors thesis in Geology, *Bucknell University.*
- Program for Undergraduate Research grant, *Bucknell University*

PROFESSIONAL EXPERIENCE

- 2010-2014: Research assistant, *UCLA EPSS Dept.*
    - My PhD research, with advisor Prof. Dave Jackson, focuses on implementing earthquake mechanics, particularly Coulomb stress evolution, into prospective earthquake forecasts.
- 2014: Teaching assistant, *UCLA EPSS Dept.*, EPSS8 (Earthquakes).
- 2010: Summer of Applied Geophysical Experience (SAGE).
    - By conducting a long-period magnetotelluric survey, I constrained the depth of a mid crustal conductor in the Rio Grande Rift.
- 2009: IRIS Undergraduate Internship, *Scripps Institute of Oceanography*.
    - Working with Dr. Gabi Laske, I participated in the Hawaiian PLUME (Plume-Lithosphere Undersea Mantle Experiment), analyzing teleseismic earthquake travel times to detect low-velocity zones potentially indicative of mantle plume activity.

SKILLS

- Programming/Software: Matlab, Java, Unix, ArcGIS, Coulomb 3.3, SAC (Seismic Analysis Code), GMT (Generic Mapping tools), Mathematica.
- Geophysical Survey Methods: Seismic refraction/reflection, gravimetry, magnetic, magnetotellurics (MT), transverse electromagnetic (TEM), ground penetrating radar (GPR), GPS.

PROFESSIONAL MEETINGS

- American Geophysical Union (AGU): IRIS, SAGE, earthquake forecasting research.
- Southern California Earthquake Center (SCEC): earthquake forecasting research.
- Seismological Society of America (SSA): earthquake forecasting research.
- International Union of Geodesy and Geophysics (IUGG): earthquake forecasting research.

Research Statement

My primary research interest is in sufficiently understanding earthquake nucleation/growth to reliably forecast future earthquakes. Whereas statistical seismicity can often indicate future earthquake locations, I intend to include earthquake physics to further explain seismicity rate distribution. Identifying how seismicity responds to crustal stress variation may illuminate seismic triggering mechanisms or thresholds at which earthquakes nucleate and/or grow. Although elevated stress has retrospectively been shown to coincide with earthquake locations and times, stress fields become increasingly uncertain near ruptured faults, particularly at the ends of fault sections where aftershock sequences tend to occur. Characterization of a continuous and complete stress field, therefore, is imperative to identifying specific earthquake triggering mechanisms.

My thesis work has consisted of deriving expected seismicity rates from both time-dependent and time-independent static/quasi-static Coulomb stress models within southern California, and testing the resulting forecast against statistical earthquake forecasts. For purely static stress evolution, in which the effects of stress changes are assumed not to decay over time, I fit the Coulomb stress and recent seismicity distributions to a normalized index function, where seismicity rates should increase monotonically with stress. When pseudo-prospectively evaluating the forecast, I found that smoothed seismicity more effectively forecasted earthquake locations than Coulomb stress, at the 95% confidence interval. However, a hybrid Coulomb stress/smoothed seismicity model that gave more weight to Coulomb stress-derived seismicity rates in the far field improved upon a purely smoothed seismicity forecast.

Currently, I am testing rate-and-state-based earthquake forecasts that allow the effects of stress perturbations to decay exponentially over time. Unlike the static stress model, rate-and-state allows seismicity rates to decay following mainshocks without requiring a subsequent stress jump. Here, I implement Coulomb stress as a multiplier to background seismicity, so as not to overestimate seismicity in the far field. Although the model forecasts earthquakes in areas of recent seismicity and elevated stress, stress uncertainties result in over-forecasting seismicity rates during aftershock sequences.

In future research, I aim to develop a more complete and accurate stress model that can reliably characterize and explain current and future seismicity rates in a variety of tectonic settings. For example, I intend to delineate the effects of dynamic stress on aftershock rates through numerical fault rupture simulation. Additionally, the role of postseismic deformation in earthquake triggering requires further study. Rate-and-state friction, as modeled in current forecasts, does not completely represent processes such as viscoelastic relaxation, which could cause Coulomb stress changes to spatially decay at a slower rate with distance from faults. Previous and current results generally assume a homogeneous and isotropic crust, which vastly oversimplifies stress change as a function of slip rate. I plan to investigate fault and crustal heterogeneity by taking into account pore fluid pressure and introducing fractal fault ruptures. Inverting geodetic data for continuous strain rates, rather than calculating strain from a segmented fault model, may also resolve stress singularities that yield physically unreasonable stress changes near aftershock clusters. Ultimately, I would like to sufficiently reduce uncertainties in the Coulomb stress field to form a testable physics-based earthquake forecast, which at least retrospectively could outperform forecasts solely based on statistics.

List of References

- Prof. David Jackson, UCLA Dept. of Earth and Space Sciences
    - email: David.D.Jackson@ucla.edu
- Prof. Paul Davis, UCLA Dept. of Earth and Space Sciences
    - email: pdavis@ess.ucla.edu