

Instructor: Heidi Houston

Office: ZHS 101

Office Hours: Wed 3-5PM or by appt.

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Seismology Clinic - A focus on earthquake sources and stresses

Course Description

This class aims to build on your knowledge of seismology and give you experience with some analysis tools that may be helpful for investigating relationships between earthquakes and stresses. I'll first discuss the basic theory describing static and dynamic deformations due to faulting and how the mathematical description was derived. The goal is a very clear and convenient expression of the total dynamic and static deformations due to any moment tensor. We'll then review some well-known review papers on seismic sources. Then we will turn to determining stress orientations from focal mechanisms, and in certain favorable circumstances utilizing that information to determine further constraints on stress (such as absolute levels of stress). Students will apply available software codes to earthquake data from regions of their choice in collaborative projects.

Learning Objectives

At the end of the course, students will be able to:

- critically read, analyze and discuss key scientific papers about the nature of seismic sources
- be able to describe quantitatively the many types of seismic sources
- understand the basic physics and mathematics describing static and dynamic deformations due to faulting and how the mathematical description was derived
- gain a good understanding of the near-, intermediate-, and far-field terms comprising a seismic wave
- apply that understanding to determine the stress field associated with any fault deformation
- understand the principles and apply codes to determine the stress state implied by suites of earthquakes, and to determine the static stress tensor due to a slip distribution
- combine the above results to infer the absolute level of stress (if data are sufficient)
- understand the limitations of these methods and the necessary conditions for them to be applicable

Required Reading

We will follow 2 chapters in the textbook *Elastic Wave Propagation and Generation in Seismology* by J Pujol, and 2 to 3 review papers. Additionally, a few topical papers will be assigned to illustrate and provide examples for the projects in the latter part of the course.

Class Format

During the first 4 weeks the instructor will guide students through the theory behind the mathematical description of the deformations produced by faulting. The goal is a very clear and convenient expression of the total dynamic and static deformations due to any moment tensor. Then we will discuss two review papers that present concepts and observations to illustrate the nature of anomalous sources. During the second half of the course we will apply several software packages to earthquake data to gain mastery of key methods of studying stresses associated with faulting. Instructor lectures will introduce background concepts and previous observations to provide context for the projects. We will also pay close attention to the conditions under which various methods can legitimately be applied.

Grades

Students will be evaluated on participation, presentations, 4 homework sets and a project. All students will submit a short report (4-5 pages) on their project at the end of the course (Dec 7), with an outline due Nov 16, and an abstract due Nov 30. Grading breakdown - 10% participation, 20% student-led presentation/discussion, 25% homework sets, 25% project report, 20% presentation of project.

Weekly Course Schedule

	Tuesday	Sampling of readings
Week 1	Aug 24: Introduction and motivation	
Week 2	Aug 31: Introduction to equations for static and dynamic deformation	Pujol, Elastic Wave Propagation and Generation in Seismology
Week 3	Sep 7: Solution to full wave equation	Pujol
Week 4	Sep 14: Near-, intermediate-, and far-field terms	Pujol
Week 5	Sep 21: Application and problems	Pujol
Week 6	Sep 28: Anomalous seismic sources	Julian et al (1998)
Week 7	Oct 5: Anomalous seismic sources - examples	various papers
Week 8	Oct 12: No class - Fall Break	
Week 9	Oct 19: Stress from focal mechanisms	Michael (1984), Vavrycuk (2014)

Week 10	Oct 26: Implementation&Application	
Week 11	Nov 2: Static stress from faulting	Okada (1992)
Week 12	Nov 9: Combining the stress orientations and static stress from main shock	Delbridge et al (2023)
Week 13	Nov 16: Waveform inversion for slip distributions	Stein & Wyession
Week 14	Nov 23: No class - Thanksgiving	
Week 15	Nov 30: Application	
Week 16	Dec 7: Student project presentations	Project Report due Dec 8

Student Accessibility Services

Students requesting academic accommodations based on a disability are required to register with the Office of Student Accessibility Services (OSAS) each semester. A letter of verification for approved accommodations can be obtained from OSAS. Please be sure the letter is delivered to the instructor as early in the semester as possible. OSAS is located in Room 120 Grace Ford Salvatori Hall, and is open 8:30 am - 5:00 pm, Monday through Friday. The phone number is (213) 740-0776; their email is ability@usc.edu. The website is osas.usc.edu.

Academic Conduct:

Plagiarism – presenting someone else’s ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Part B, Section 11, “Behavior Violating University Standards” policy.usc.edu/scampus-part-b. Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on scientific misconduct, <http://policy.usc.edu/scientific-misconduct>.

Support Systems:

Student Counseling Services (SCS) – (213) 740-7711 – 24/7 on call

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention. engemannshc.usc.edu/counseling

National Suicide Prevention Lifeline – 1 (800) 273-8255

Provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week. www.suicidepreventionlifeline.org

Relationship and Sexual Violence Prevention Services (RSVP) – (213) 740-4900 – 24/7 on call

Free and confidential therapy services, workshops, and training for situations related to gender-based harm. engemannshc.usc.edu/rsvp

Sexual Assault Resource Center

Draft

For more information about how to get help or help a survivor, rights, reporting options, and additional resources, visit the website: sarc.usc.edu

Office of Equity and Diversity (OED)/Title IX Compliance – (213) 740-5086

Works with faculty, staff, visitors, applicants, and students around issues of protected class. equity.usc.edu

Bias Assessment Response and Support

Incidents of bias, hate crimes, or aggression need to be reported allowing for appropriate investigation and response. studentaffairs.usc.edu/bias-assessment-response-support

The Office of Disability Services and Programs

Provides certification for students with disabilities and helps arrange relevant accommodations. dsp.usc.edu

Student Support and Advocacy – (213) 821-4710

Assists students and families in resolving complex issues adversely affecting their success as a student EX: personal, financial, and academic. studentaffairs.usc.edu/ssa

Diversity at USC

Information on events, programs and training, the Diversity Task Force (including representatives for each school), chronology, participation, and various resources for students. diversity.usc.edu

USC Emergency Information

Provides safety and other updates, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible. emergency.usc.edu

USC Department of Public Safety – UPC: (213) 740-4321 – HSC: (323) 442-1000 – 24-hour emergency or to report a crime.

Provides overall safety to USC community. dps.usc.edu