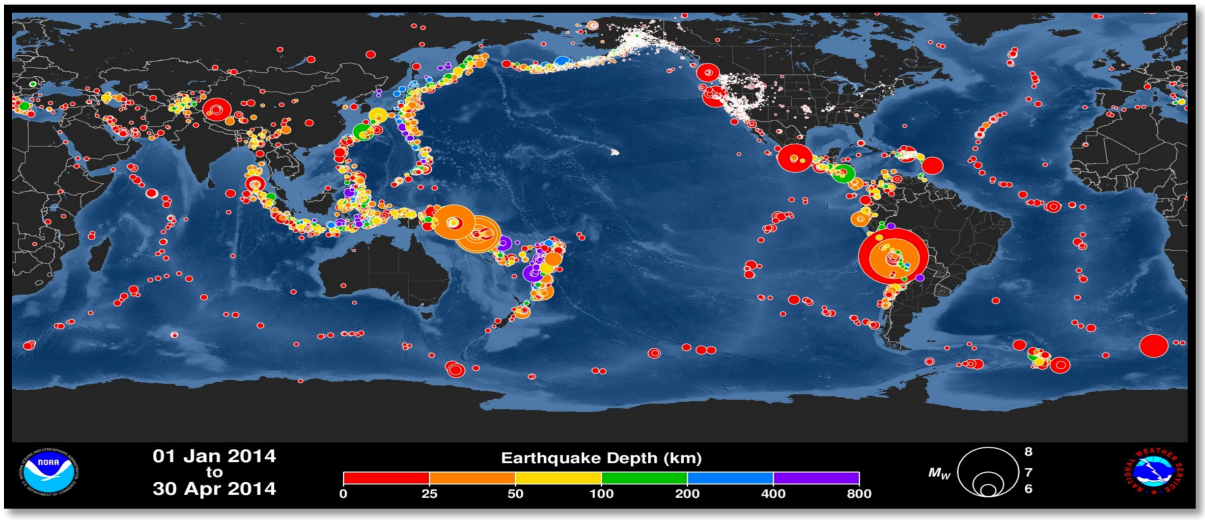
ERTH451 – Earthquakes and Crustal Deformation - Spring 2021



Instructor: Helen Janiszewski
Email: hajanisz@hawaii.edu

Meeting Time: Tues/Thurs 12:00 - 1:15 pm
Room: At Home

Course description: This course will explore the fundamentals of earthquakes and tectonic crustal deformation through modern seismological and geodetic observations. In this course, we will focus on elastic properties of rocks, earthquake waves, and the causes, detection, location, and prediction of earthquakes. We will explore the role of plate tectonic stress and strain in earthquake generation and crustal motions associated with the earthquake cycle. Tsunami wave generation, liquefaction, and relevant planetary observations of "quake" like events will also be discussed.

Prerequisites: MATH 241(Calc I) and PHYS 170 (Gen. Physics I), or instructor consent

Text: Relevant lecture and reading material will be provided on the course website.

Grading: Grades will be formed based on a combination of homework, participation (attendance, preparation, inquiry), Question of the Day, a Midterm exam, and a final project (paper and presentation):

Problem sets (homework)	40%
Question of the Day	10%
Class participation, attendance	10%
Midterm Exam	15%
Earthquake Project	25% [10% /15%]

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Course topics (*hit or miss*):

- Basic Earth observations: Realizing plate tectonics
- Plate tectonics in motion, global seismicity
- The earthquake cycle, stress and strain
- Tectonic geodesy: observing crustal deformation
- Earthquake basics, seismic waves, seismograms
- Locating earthquakes
- Earth structure, seismic velocities, density
- Ray theory, seismic phases
- Estimating travel times
- USArray, 3D Earth structure
- Faults, focal mechanisms, moment tensors
- Earthquake magnitudes, source parameters
- InSAR crustal deformation observations
- Coulomb failure
- Earthquake recurrence, Parkfield,
- Seismic hazards, prediction vs. precursors
- 1906 San Francisco earthquake
- Hawaiian earthquakes
- Paradox of deep earthquakes
- Volcano seismology
- Episodic tremor and slip (Cascadia, Japan)
- Tsunamis
- Planetary quakes and tectonics: terrestrial planets, icy satellites

Homework:

- **Assignments**: Homework assignments will be assigned approximately weekly, and are due at the beginning of class exactly 1 week after they are assigned (unless otherwise stated - the due date will be stated on the assignment).
- **Working Together on Homework:** Studies have shown that students learn best when they work together. You are encouraged to work with each other on assigned homework. However, each student must turn in his or her own assignment, written using his or her own words. Any student who fails to follow this rule will receive zero credit for the question, and if the offense is severe, for the assignment.
- **Format:** Neatness, clarity of expression, and completeness are essential to obtain full credit on exams and homework. Please make sure to:
  (1) Write out the equations, or derive new ones, that you will use to solve the problem, and explain (in words) your reasoning. Specify known and unknown information.
  (2) Draw illustrative figures that describe the problem.
  (3) Show clearly how you solved the problem.
  (4) Check your answer – does your solution make physical sense? Check units! Explain why you think your answer is correct.

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Exam Policy:

- **Make-Up Exams/Early Exams.** Make-up exams will not be given except when a student misses the exam for a legitimate reason such as illness or family emergency (a doctor's note or other documentation is required). Please get in touch with me as soon as possible if such a situation arises. Anyone with sporting event conflicts must provide at least 2 weeks notice with appropriate signed paperwork.
- **Note that make-up and/or early exams will be essay format.**

Final project

In lieu of a Final Exam, you will be expected to research and present (oral presentation and short paper) a major earthquake or crustal deformation event of your choice. More details will be provided throughout the semester, stay tuned. Presentations and paper should reflect both scientific data and societal impact.

Tips For Success

- **Lectures:** Attend *every* lecture, as they are the key to your success in this course. Some aspects of the course material will be covered in more detail in class than is provided the text, so it is highly recommended that you not only bring your body to class, but your mind and your concentration as well! There will also be a daily in-class quiz (Question of the Day) that will count toward your grade (see grading policy below).
- **Homeworks:** Do *each* homework assignment, and submit each one on time. Homework assignments help you learn the material and are a great study guide for the exams.
- **Exams:** Do not miss an exam. Study. Read. Review.
- **Questions:** Questions are welcome and encouraged. Your questions are likely to help other students as well, so you should never feel intimidated to ask questions about course material.
- **Read**: Any assigned reading material will reinforce lecture material, so do complete each reading assignment.

Student Learning Objectives for ERTH Bachelor's Degrees

This course will aim to meet the following ERTH undergraduate degree program student learning objectives, as established by the Department of Earth Sciences:

1. Students can explain the relevance of geology and geophysics to human needs, including those appropriate to Hawaii, and be able to discuss issues related to geology and its impact on society and planet Earth.
2. Students can apply technical knowledge of relevant computer applications, laboratory methods, and field methods to solve real-world problems in geology and geophysics.
3. Students use the scientific method to define, critically analyze, and solve a problem in Earth science.
4. Students can reconstruct, clearly and ethically, geological knowledge in both oral presentations and written reports.
5. Students can evaluate, interpret, and summarize the basic principles of geology and geophysics, including the fundamental tenets of the sub- disciplines, and their

context in relationship to other core sciences, to explain complex phenomena in geology and geophysics.

Course Learning Objectives

This course will introduce fundamental concepts related to the physics of earthquakes, such as stress, strain, the seismic wave equation, wave propagation, earthquake focal mechanisms, earthquake moments and magnitudes, frequency magnitude relationships, and earthquake hazards. The following course learning objectives will be emphasized:

1. Develop skills in applying physics, mathematics, and computational analyses to problems in earthquake seismology and geodesy.
2. Develop problem-solving and critical thinking skills using geophysical data and proven geophysical theories.
3. Illustrate the impacts of earthquakes on society, focusing on past notable earthquakes and our ability to forecast seismic hazards.

Student Conduct and Academic Integrity:

University guidelines for acceptable student conduct are very specific and will be strictly followed. Please read the guidelines (http://www.catalog.hawaii.edu/about-uh/campus-policies1.htm) and contact your instructor if you have any concerns. Fundamentals:

- Cheating, of any form, will not be tolerated.
- Blind copying of intellectual material (text) from resources such as books, journals, and the internet is plagiarism and is illegal. Instead, you should write things in your own words with a proper reference to your source. If any homework exercises require you to look up an answer in something else than the class textbook, I will expect you to reference the source and write it in your own words. *Any plagiarized work will receive "0" for the whole assignment and cannot be re-done or made up*

Disability Access

The Earth Sciences Department will make every effort to assist those with disability and related access needs. For confidential services, please contact the Office for Students with Disabilities (known as "Kokua") located in the Queen Lili'uokalani Center for Student Services (Room 013): kokua@hawaii.edu www.hawaii.edu/kokua

Title IX

The University of Hawai'i is committed to providing a learning, working and living environment that promotes personal integrity, civility, and mutual respect and is free of all forms of sex discrimination and gender-based violence, including sexual assault, sexual harassment, gender-based harassment, domestic violence, dating violence, and stalking. If you or someone you know is experiencing any of these, the University has staff and resources on your campus to support and assist you. Staff can also direct you to resources that are in the community. Here are some of your options:

As members of the University faculty, your instructors are required to immediately report any incident of potential sex discrimination or gender-based violence to the campus Title IX Coordinator. Although the Title IX Coordinator and your instructors cannot guarantee confidentiality, you will still have options about how your case will be handled. Our goal is to make sure you are aware of the range of options available to you and have access to the resources and support you need.

If you wish to remain ANONYMOUS, speak with someone CONFIDENTIALLY, or would like to receive information and support in a CONFIDENTIAL setting, use the **confidential resources available here**:

http://www.manoa.hawaii.edu/titleix/resources.html#confidential

If you wish to directly REPORT an incident of sex discrimination or gender-based violence including sexual assault, sexual harassment, gender-based harassment, domestic violence, dating violence or stalking as well as receive information and support, contact: Dee Uwono Title IX Coordinator (808) 956-2299 t9uhm@hawaii.edu.