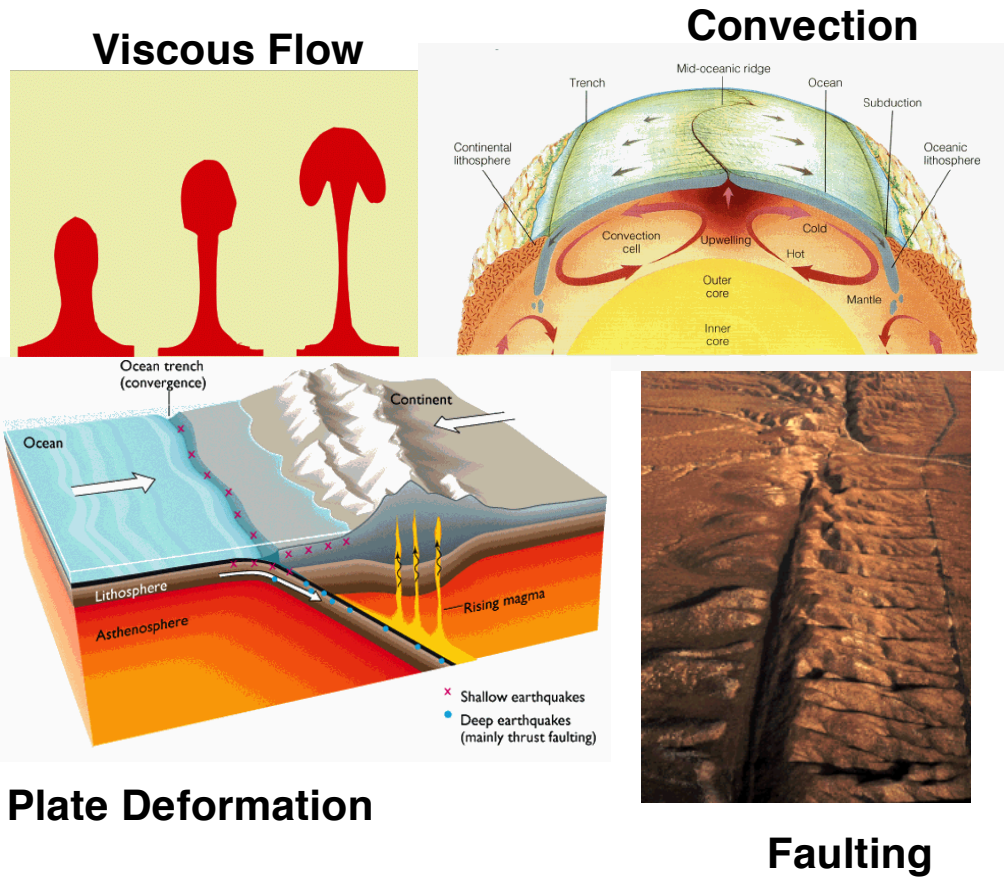
Department of Geology & Geophysics, Spring 2014

GG681: Continuum Mechanics in Geophysics



Instructor: **Clint Conrad** **804 POST, 956-6649**
clintc@hawaii.edu
office hours: after class, by appointment

Lectures: **Tues. & Thur. 9:00-10:15 in 702 POST**
Texts: **Introduction to Continuum Mechanics, by Lai, Rubin, & Krempl**
Geodynamics, by Turcotte & Schebert
Web Site: **www.soest.hawaii.edu/GG/FACULTY/conrad/classes/GG681/GG681.html**

The solid Earth deforms at a variety of length scales, locations, and time scales, and in a variety of different ways in response to a variety of different forcing mechanisms. In this class, we will use continuum mechanics, which describes the response of a material to an imposed force, to study and understand deformation of the solid earth.

Preliminary Schedule:

Week	Days	Topic	Reading
1	Jan 14, 16	Introduction / Tensors	Lai Ch. 2
2	Jan 21, 23	Stress in Solids	Lai Ch. 4
3	Jan 28, 30	Stress and Rock Failure (no class 1/26)	Lai Ch. 5, T&S Ch. 8
4	Feb 4, 6	Rock Failure (continued) & Strain	Lai Ch. 3, 5, T&S Ch. 8
5	Feb 11, 13	Strain Deformation	Lai Ch. 3
6	Feb 18, 20	Elasticity	Lai Ch. 5, T&S Ch. 3
7	Feb 25, 27	Elastic Plate Flexure	T&S Ch. 3
8	Mar 4, 6	Ductile Rheology	Lai Ch. 6, T&S Ch. 7
9	Mar 11, 13	Newtonian Fluids	Lai Ch. 6
10	Mar 18, 20	Newtonian Fluids (continued)	Lai Ch. 6
	Mar 27, 29	Spring Break	
11	Apr 1, 3	Viscous Deformations on Earth	T&S Ch. 6
12	Apr 8, 10	Heat Flow	T&S Ch. 4
13	Apr 15, 17	Thermal Convection	T&S Ch. 6
14	Apr 22, 24	Porous Media	T&S Ch. 9
15	April 29 …	Project Reports	
16	… to May 1	Project Reports	
	Note:	We will deviate from this schedule as necessary!	

Grading and Assignments

Homework assignments will be assigned approximately weekly, and students will be required to present the continuum mechanics underlying current research papers periodically throughout the course. Each student will complete a research-focused class project (see below). The relative weightings of homework assignments, class participation (including in-class presentations), and class projects are as follows:

Homework	50%
Class Presentations and Participation	25%
Class Project	25%
Total	100%

Cooperation: Collaboration is encouraged in order to discuss approaches to solving problems. However, do not copy answers to problem sets – work out the solutions yourself.

Class Project

An extensive class topic will be included as part of the class. Each student will be expected to develop and present a basic research project that relates continuum mechanics to an active research area in the Earth sciences. We will discuss possible research topics in class.

Other Reference Sources

Material Properties

Ranalli, G., *Rheology of the Earth*, Allen and Unwin, 1987.
Karato, S.-I., *Deformation of Earth Materials*, Cambridge Univ. Press, 2008.

Continuum Mechanics

Malvern, L. E., *Introduction to the Mechanics of a Continuous Medium*, Prentice-Hall, 1969.

Fluid Dynamics

Batchelor, G. K., *An Introduction to Fluid Dynamics*, Cambridge University Press, 1967.
Chandrasekhar, S. *Hydrodynamic and Hydromagnetic Stability*, Dover Publications, 1961.
Kundu, P., *Fluid Mechanics*, Academic Press, 1990.
Landau, L. D. and e. M. Lifshitz, 2nd ed, *Fluid Mechanics*, Pergamon, 1987.

Math and Mathematical Physics

Arfken, G., 3rd ed., Mathematical Methods for Physicists, Academic Press, 1985.
Marsden, J. D. and A. Tromba, 2nd ed., *Vector Calculus*, W. H. Freeman, 1981.
Press, W. H. S. A. Teukolsky, W. T. Vetterling, B. P. Flannery, *Numerical Recipes in Fortran: The art of scientific computing*, Cambridge University Press, 1992.
Schey, M., *Div, Grad, Curl, and all that: an informal text on vector calculus*, Norton, 1973.

Solid Earth Geophysics

Anderson, D. L., *New Theory of the Earth*, Cambridge University Press, 2007.
Davies, G., *Dynamic Earth: Plates, Plumes and Mantle Convection*, Cambridge University Press, 1999.
Fowler, C. M., *The Solid Earth: An Introduction to Global Geophysics*, 2nd ed., Cambridge Univ. Press, 2005.
Sleep, N. and K. Fujita, *Principles of Geophysics*, Blackwell Science, 1997.
Stacey, F.D. and P.M. Davis, *Physics of the Earth*, 4th ed., Brookfield Press, 2008.
Lowrie, W., *Fundamentals of Geophysics*, 2nd ed., Cambridge University Press, 2007.

Learning Objectives

The **Department of Geology & Geophysics** has established the following undergraduate student learning objectives. All of these objectives are relevant targets for the curriculum of GG610.

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.

Disability Access

If you have a disability and related access needs the Department will make every effort to assist and support you. For confidential services students are encouraged to contact the Office for Students with Disabilities (known as "Kokua") located on the ground floor (Room 013) of the Queen Lili'uokalani Center for Student Services:

KOKUA Program; 2600 Campus Road; Honolulu, Hawaii 96822
Voice: 956-7511; Email: kokua@hawaii.edu; URL: www.hawaii.edu/kokua