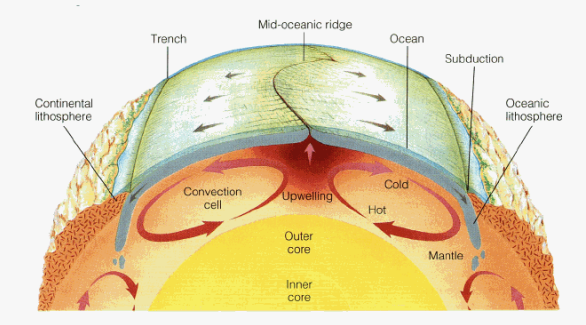
Department of Earth and Planetary Sciences

Geodynamics

Fall 2006: 270.303

A study of the basic principles that control deformation of our dynamic planet.

Mantle Convection



Mountain Building

Plate Tectonics

Faulting

Time: Monday, Tuesday, and Wednesday, 1:00–2:00 PM

Location: 304 Olin Hall

Web: www.jhu.edu/~eps/faculty/conrad/classes/geodynamics.html

Instructor: Dr. Clint Conrad

Contact: *conrad@jhu.edu*, 410-516-3922, 224 Olin Hall

Teaching Assistant: Nate Winslow

Contact: *nate.winslow@gmail.com*

Administrative

Class time: Monday, Tuesday, and Wednesday: 1:00 – 2:00 PM
Location: 304 Olin Hall

Instructor
Dr. Clint Conrad
Office: 224 Olin Hall
Office Hours: by appointment
e-mail: conrad@jhu.edu

Teaching Assistant
Nathan Winslow
Office: 323 (or lab across the hall)
Office Hours: Mondays 11-12
e-mail: nate.winslow@gmail.com

Grading:

50% Homework	Problem sets will be assigned each week, and are due on the last day of class (generally Wednesday) the following week.
20% Participation	This includes student presentations: Each student will present and lead discussion of a relevant research paper in the second half of the semester.
30% Final Exam	Monday, December 18th, 2-5 PM

Group Efforts:

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

Late Homework:

Homework that is submitted in after the due date will graded, but will be denoted as late. Homework that is submitted after graded homeworks are returned to other students will not be considered.

Textbook:

Turcotte, D. and G. Schubert, *Geodynamics: Second Edition*, Cambridge University Press, New York, 2002.

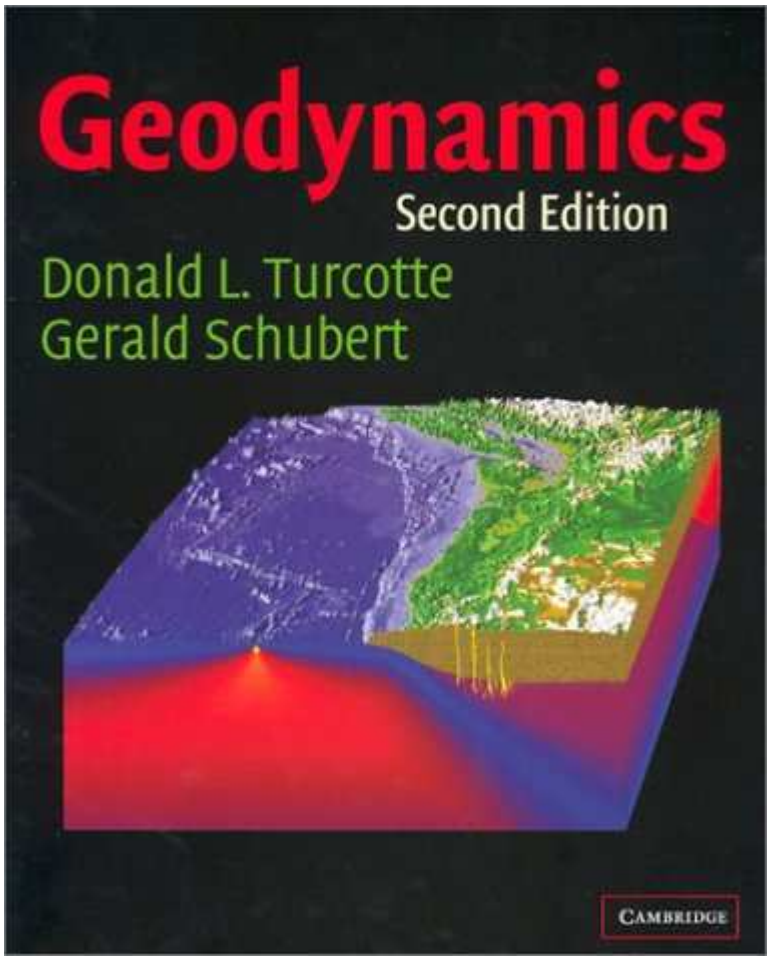
Geodynamics

What is Geodyamics?

Geodynamics is the study of the forces and processes that shape the "solid" part of our planet.
Length Scales: Microscopic deformation of rock crystals to the planet-wide tectonic motions.
Time scales: Seconds for rock fracture to hundreds of millions of years for plate tectonic cycles.
Locations: The mantle, lithosphere, crust, cryosphere, other planets, and more!

Our Approach:

Goal: To obtain a basic understanding of the deformation processes that govern our planet.
Focus: Is on *understanding processes*, not memorizing facts.
Approach: We examine problems within the context of a physics-based theoretical framework.
Understand: We want to know which aspects of a system control its behavior.
Constrain: Can we use geological observations as constraints to gain addition understanding?



Preliminary Syllabus

Week	Topic	Reading (T&S)
September 11-13	Introduction, The Earth and Plate Tectonics	Chapter 1
September 18-20	Stress and Strain	Chapter 2
September 25-27	Elasticity	Chapter 3-1 to 3-8
October 2-4	Plate Deformation	Chapter 3-9 to 3-18
October 9-11	Rock Failure and Faulting	Chapter 8
October 16-18	Heat Transfer	Chapter 4
October 23-25	Rock Rheology	Chapter 7
Oct. 30 – Nov. 1	Viscous Flow	Chapter 6-1 to 6-9
November 6-8	Instabilities	Chapter 6-10 to 6-15
November 13-15	Convection	Chapter 6-18 to 6-19
November 20-22	Boundary Layer Theory	Chapter 6-20 to 6-22
November 27-29	Gravity and the Geoid	Chapter 5
December 4-6	Application to the Earth	

Disclaimer: This schedule is preliminary: We will deviate from it as necessary!

Reference Sources

General Geophysics

Anderson, D. L., Theory of the Earth, Blackwell Scientific Publications, Boston, 1989.

Davies, G., *Dynamic Earth: Plates, Plumes and Mantle Convection*, Cambridge University Press, Cambridge, 1999.

Fowler, C. M., *The Solid Earth: An Introduction to Global Geophysics*, Cambridge Univ. Press, Cambridge, 1990.

W. Menke, and D. Abbott, *Geophysical Theory*, Columbia University Press, New York, 1990.

Sleep, N. and K. Fujita, *Principles of Geophysics*, Blackwell Science, Boston, 1997.

F. D. Stacey, *Physics of the Earth*, Brookfield Press, Brisbane, 3rd ed., 1997

Advanced Topics in Geophysics

Geomagnetism

Backus, G., R. Parker and C. Constable, *Foundations of Geomagnetism*, Cambridge Univ. Press, Cambridge, 1996.

Merrill, R. T., W. M. McElhinny and P. L. McFadden, *The Magnetic Field of the Earth: Paleomagnetism, the Core, and the Deep Mantle*, Academic Press, San Diego, 1998.

Seismology

Dahlen, F. A., and J. Tromp, *Theoretical Global Seismology*, Princeton University Press, Princeton, 1998.

Shearer, P. M, *Introduction to Seismology*, Cambridge University Press, Cambridge, 1999.

Inverse Theory

Parker, R. L., *Geophysical Inverse Theory*, Princeton University Press, Princeton, 1994.

Menke, W. Geophysical Data Analysis: Discrete Inverse Theory, Academic Press, 1989.

Material Properties

Ranalli, G., *Rheology of the Earth*, Allen and Unwin, Boston, 1987.

Mantle Convection

Olson, P., Schubert, G., and Turcotte, D., *Mantle Convection in the Earth and Planets*, Cambridge University Press, 2001.

Plate Tectonics

Cox A. and R. B. Hart, *Plate Tectonics: How it works*, Blackwell Scientific Publications, Boston, 1986.

Kearey P. and F. Vine, *Global Tectonics*, Blackwell Science, 2nd ed., Oxford, 1996

Continuum Mechanics

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

Fluid Dynamics

Batchelor, G. K., *An Introduction to Fluid Dynamics*, Cambridge University Press, Cambridge, 1967.

Chandrasekhar, S. *Hydrodynamic and Hydromagnetic Stability*, Dover Publications, New York, 1961.

Kundu, P., *Fluid Mechanics*, Academic Press, 1990.

Landau, L. D. and e. M. Lifshitz, *Fluid Mechanics*, Pergamon, 2nd ed, 1987.

Math and Mathematical Physics

Arfken, G., Mathematical Methods for Physicists, Academic Press, 3rd ed., Orlando, 1985.

Marsden, J. D. and A. Tromba, *Vector Calculus*, W. H. Freeman, 2nd ed., 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*, Cambridge, 1992.

Schey, M., *Div, Grad, Curl, and all that: an informal text on vector calculus*, W. W. Norton, New York, 1973.