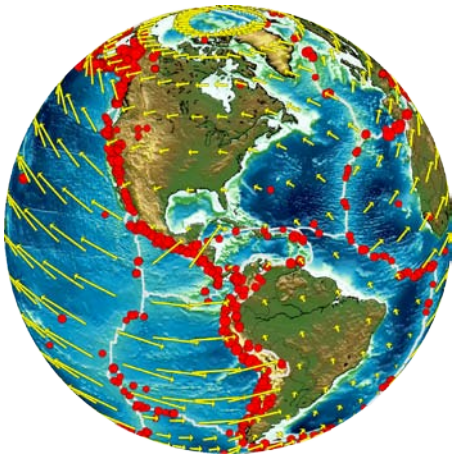
Syllabus

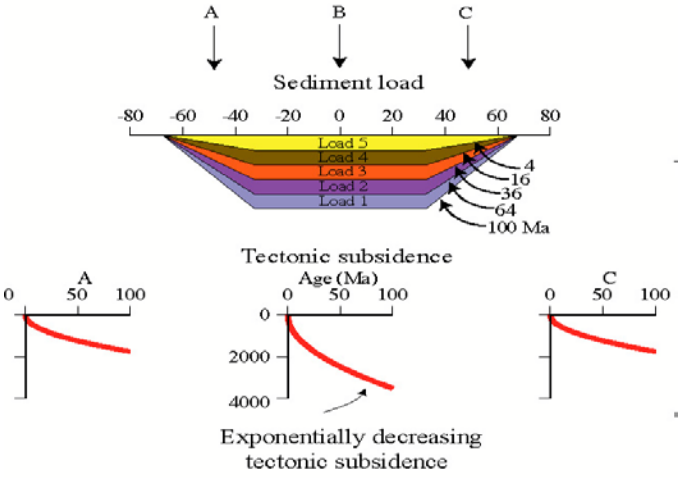
# Geodynamics (GEOL 5217-01)

Fall 2010

**Plate Tectonics**



**Subsidence of sedimentary basins**




## Time and Place:

Mondays 10am-10:50am (50 min lecture) Room 213
Wednesdays 10am-10:50am. (50 min lecture) Room 213
Thursdays 10:00 am-11:50 am (either a 50 min lecture **or** a 1.7 hour lab
Room 213

Course: GEOL 5217-01 Credits: 3


Instructor: Dr. Mike Cheadle
Email: cheadle@uwyo.edu
Office Hours: Tues Weds & Thurs 11am-12 noon
Phone: 766-3206


Course Aims:

**The aim of this course is to better understand plate tectonics and the nature of the Earth's lithosphere. In particular, it will try to teach you how simple mathematical analysis can explain the fundamental properties/features of the lithosphere (for example, the subsidence of sedimentary basins, the shape of mid oceanic ridges, and the thermal effects of an igneous intrusion). The course will hopefully provide you with a solid grounding for future study and research into the physical processes that go on within the Earth.**

The following topics will be covered:

i) **Plate tectonics,**
ii) **Stress & Strain,**
iii) **Elasticity, isostasy & the flexural strength of the lithosphere,**
iv) **Gravity,**
v) **Thermal Processes,**
vi) **and Fluid Mechanics, if we have time**.

In every sub-topic I will cover applications to the workings & evolution of the lithosphere (I will try to make it fun & relevant!). A knowledge of calculus & trigonometry will be required. In all cases we will try to use a minimum of mathematical complexity, but **we will be using math**.

Course Skills:

Ability to calculate plate motions on a sphere and reconstruct past plate movements; ability to derive partial differential equations in a geophysical context; ability to solve problems of both a scientific and logical nature; ability to use mathematical equations to describe geological phenomena.

Class Format:

The class will consist of 2 lectures a week plus either a third lecture (50mins) or a lab exercise (1.7hrs) or a debate. Problem sheets or labs will be issued approximately every other week. The best way to study for this course is to attend the lectures and solve the problems!
The problem sheets will be due one week after they have been set (late papers will not be accepted, without an excellent reason) and will be returned to you one week later.
We will also have two or three formal debates about the existence of plumes and the strength of faults and maybe the existence of low angle normal faults.

Grading/Evaluation:

Grading will be based on two criteria:

| | |
|---|---|
| • Lab exercises/Problem sheets | 60% |
| • Mid term exam (1 hr/50mins) | 13% |
| • Final exam (2 hrs) | 27% |

I will penalize for late homeworks, unless a good reason is given!!

What Is Expected of You:

- Regular attendance and alert participation. This class will work best if you participate in the labs and do the problem sheets and ask questions!
- Read any assigned papers in advance.
- Relax and have some fun with the topics in this class. This is fundamental, but fun stuff! The goal is for you to gain a fundamental understanding of some of the physics behind the exciting Earth processes, which we all know about and then, to think creatively about geodynamical processes

What You Can Expect of Me:

- I will provide lab exercises, and supplementary lecture material and help stimulate discussions during class.

- I will be accessible and will always be happy to answer your questions during class, during office hours, and by appointment.
- I would very much like your feedback on how this course is progressing. I value feedback during the class and the Department will perform a formal evaluation at the end of the semester.

If you have a physical, learning, or psychological disability and require accommodations, please let me know as soon as possible. You will need to register with, and provide documentation of your disability to, University Disability Support Services (UDSS) in SEO, room 330 Knight Hall, 766-6189, TTY: 766-3073."

*A&S - Students and Teachers Working Together:*
Please refer to the following web-site for a detailed explanation of what should be expected from both the teachers and the students.
http://uwadmnweb.uwyo.edu/a&s/Current/2005Stud&TeachersWorking%20Together(7-29-05).doc

Academic Dishonesty

University Regulation 802, Revision 2, defines academic dishonesty as "an act attempted or performed which misrepresents one's involvement in an academic task in any way, or permits another student to misrepresent the latter's involvement in an academic task by assisting the misrepresentation". In other words, no cheating! It will be hard to carry out in this class, but is an important aspect of scientific ethics.

Course Texts

There is no suitable set text for this course. Consequently, I will supply you with handouts during the course of this class to supplement the class lectures.
I do recommend the following text as a resource text (it's old and won't cover all of the course material, but at times it will be useful).

**Recommended Resource Text:** Geodynamics, 2nd Edition, D.L. Turcotte & G. Schubert, Cambridge, 2002.

The Brinkerhoff Library has two copies of Geodynamics (1st edition) and one copy of the 2nd edition.

**Other Texts (in the library):**

The Solid Earth, 2nd edition, C.M.R. Fowler, Cambridge, 2004. (1st edition 1990).

Geodynamics of the Lithosphere: An Introduction, 2nd Edition, K Stuwe, Springer, 2007

The New Theory of the Earth, 2nd Edition, D. Anderson, Cambridge, 2007.

Dynamic Earth, G. F. Davies, Cambridge, 1999

# Preliminary Schedule

Week 1 (Aug 23rd ) Organizational Meeting & Introduction to Course. What is Plate Tectonics & What is the lithosphere (water controlled, versus compositional control vs. thermal control vs. fluid dynamic control)?
Plate Boundaries & what controls magmatism at each of the boundaries?
**(No Thursday class: Rocky Mountain Field Trip)**

Week 2 (Aug 30th) Plate Tectonics: Mid Ocean Ridges **(No Monday class: Rocky Mountain Field Trip).** (possible long class Thursday)

Week 3 (Sept 6th) **No Class Monday (Labour Day)**: Plate Tectonics: Subduction Zones & Transform Faults.

Week 4 (Sept 13th) Plate Tectonics: Motions on a flat Earth. Triple Junctions.
*Thurs: **Lab 1:** Calculating the motions of plates and triple junctions

Week 5 (Sept 20th) Plate:Tectonics: Motions on a Sphere; adding vectors & calculating velocities. Changing plate motions (every few million years),
* Thurs: **Lab 2:** Plate motions on a sphere

Week 6 (Sept 27th) Plate Tectonics: Absolute plate motions. Models. Driving forces & motion on a sphere.
* Thurs: **Topics: 8 minute talks.** Each person will give a 8 minute talk on a different aspect of plate tectonics. Topics will include:
What controls the dip of the plates?
Why does the solid mantle behave like a fluid?
Why are transforms normally orthogonal to ridges?
Why do subduction zones have arcuate structures?
Is the temporal variability of plate tectonics stochastic or is it driven by episodicity in mantle convection?
Does delamination occur?

Week 7 (Oct. 4th) Mon: **Mid Term Exam (50mis or one hour).**
Elasticity & Flexure: Isostasy, flexure & elasticity Island chains, ocean trenches & sedimentary basins.
* Thurs: **Formal Debate**: Do plumes exist?
I will hand out readings for both the pro and con arguments. Two teams and an audience!

Week 8 (Oct 11th) Compensation functions and flexural response to complex loads (Fourier Transforms etc.). Top & bottom loads. Hawaii; & foreland basins.
**Homework 1: Flexure.**

Week 9 (Oct 18th) Gravity: Gravitational potential & the Geiod. Review of gravity, shape of the Earth.

Week 10 (Oct 25th) Gravity: Topography, Gravity anomalies and isostasy. Admittance & Coherence. Global maps of elastic & crustal thickness from gravity. USA, Africa, Continental Margins. Problems with Forsyth's coherence method. McKenzie's view.
**Homework 2**: Flexure & gravity.

Week 11 (Nov 1st ) Elasticity & Flexure: Flexural response to individual faults, flexural cantilever model of the lithosphere.
What controls the strength of the lithosphere? Crustal & Mantle rheology
* Thurs: **Computer Lab 3:** Forward & Reverse modeling of Sedimentary basins
**(GSA Annual Meeting Week: Class will be cancelled Mon & Weds if a lot of people are away).**

Week 12 (Nov 8th) Thermal Processes: Thermal Structure of the Earth. Conduction vs. convection vs. radiation.
*** Thurs: Formal Debate:** Strong vs. Weak Faults
I will hand out readings for both the pro and con arguments. Two teams and an audience!

Week 13 (Nov 15th) Thermal Processes: The heat equation and crustal geotherms. Radioactivity & the concept of thermo-tectonic age. Plate vs. half-space models & the cooling of the oceanic lithosphere. Response timescales to magmatic/tectonic events (i.e. plumes, intrusion, thrusting, extension: metamorphic P-T paths).

Week 14 (Nov 22nd) Thermal Processes: Intrusions (cooling of dykes & sills, latent heat) & sedimentary basins (rift vs. thermal subsidence; uplift vs. temperature, melting vs. extension).
**Homework 3:** Heat flow and thermal processes

**Thanksgiving: No wednesday or thursday class**

Week 15 (Nov 29th ) Fluid Mechanics: Types of fluids (Newtonian, Bingham etc.), channel & pipe flow with applications to the lower crust & asthenosphere, turbulence & the Reynolds Number, Navier-Stokes, convection & the Rayleigh Number.

**2hr Final Exam will most likely be on Thursday 9th December (10:00am-12:00am)**

The schedule above is subject to a certain amount of flexibility. The class is large and we may need extra time for talks etc. and lecture content may vary to meet your needs and vary depending on how fast we progress.