

Structural Geology (GE 231) Syllabus

Fall, 2011

1. Instructor

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2. Texts and required materials

Structural Geology of Rocks and Regions by: Davis, G.H., and Reynolds, S.J., 1996. John Wiley and Sons Inc., 800 p.

Optional text: Basic Methods of Structural Geology by: Marshak, S., and Mitra, G., 1988. Prentice Hall Inc., 446 p.

Additional materials: You will need high-quality mechanical pencils (0.5-mm lead or smaller) and a scientific calculator for some in-class exercises. For field trips you will need hiking boots, sunscreen, a hat, rain gear, and a warm sweatshirt or fleece.

Bring pencils, colored pencils, a ruler, a protractor, and a scientific calculator to EVERY class meeting.

3. Course objectives

Structural geologists study the geometry of geologic structures (such as faults, folds, joints, intrusive bodies, ect.), how these structures form, their significance to the geologic history of an area, and their relationship to plate-tectonic motions. In my opinion, a basic course in structural geology should: (1) enable you to evaluate a suite of geologic structures to draw conclusions about their formation and their significance to the geologic history of an area, (2) enable you to apply basic structural-analysis techniques to solve problems in a variety of geoscience disciplines, and (3) help you develop the three-dimensional thinking skills needed to evaluate subsurface geology using two-dimensional, surficial data sets. In addition to these three primary goals, this course also aims to improve your graphical and written communication skills.

4. Course structure

4.1. Lecture periods

The lecture portion of this course will cover some of the most important and useful topics in the field of structural geology. To encourage you to be active learners in the lecture periods, I will frequently pause and have you apply the concepts covered in the lecture and the assigned reading by interpreting maps and photographs of geologic structures or by having you work through problems. I encourage you to ASK QUESTIONS AT ANY POINT. Some field trips will leave at the beginning of the lecture period on Tuesdays. Bring pencils, colored pencils, a ruler, a protractor, and a scientific calculator to EVERY class meeting.

4.2. Laboratory periods

The laboratory part of this course is designed to: (1) help you develop a set of structural-analysis skills that you can apply to geologic problems in a variety of disciplines, (2) help you develop good data recording and geologic observation skills, (3) improve your three-dimensional thinking skills, and (4) improve your graphical and written communication skills by

presenting your data and interpretations in a concise, effective manner. The in-class laboratory exercises will primarily address items one and three above. The field trips will address all of these items by having you collect data, analyze your data using basic structural analysis-techniques, interpret your data, and produce a short geologic report wherein you outline your data and interpretations in writing and illustrations. Bring pencils, colored pencils, a ruler, a protractor, and a scientific calculator to EVERY class meeting.

When I defended my M.S. thesis, one of my good buddies (a geochemist) circulated an e-mail for the post-defense party. In this e-mail he said "Billy has just defended his Masters in Coloring". His comment reflects one of the fundamental aspects of structural geology. That is, many of the graphical techniques you will learn in this course such as cross section construction and geologic map preparation require careful, precise drafting and, yes, coloring. In many cases, the accuracy of your results in these exercises depends on how carefully you draft the geometric constructions. Therefore, NEATNESS COUNTS!

5. Field trips

Weather permitting; there will be four field trips. For the Pemaquid Point and Two Lights trips, we will return late in the evening. Please show up on time with all required gear. At the end of each trip I will collect your field notebooks, evaluate them, and return them ASAP. I expect to see improvements in your note taking with each trip. NEATNESS COUNTS!

For field trips you will need hiking boots, sunscreen, a hat, rain gear, and a warm sweatshirt or fleece. You will also need to BRING LUNCH AND WATER. Please check the weather forecast and dress appropriately. When in doubt, bring an extra layer.

There are no make-up field trips. If you miss one of the trips for an *excused* absence, I will have to find something else for you to do that requires the same amount of time and effort as the field trip and the geologic report you would have written.

6. Assessment

There are 500 total points possible. Grades are based on:

- Fold description quiz (10 points)
- Midterm exam (75 points)*
- Final exam (110 points)*
- Six in-class laboratory exercises (total 85 points)
- Four field trips including reports and field notebooks (total 200 points)
 - Field notebooks (5 points x 4 = 20 points)
 - Pemaquid Point paper and figures (80 points)
 - Two Lights fault and fracture analysis (20 points)
 - Waterville Formation paper and figures (80 points)
- Homework assignments (20 points)

*Lecture exams may also involve laboratory methods.

To earn an A in this class you will have to impress me with well-above-average comprehension of the material; efficient, creative implementation of structural analysis methods; and unusual insights and original thinking in your geologic interpretations.

7. Attendance, late work, and academic dishonesty policies

Attendance of all lectures, labs, and field trips is required. Unless other arrangements are made prior to the due date, all assignments are due by 4PM of the day given. After 4PM, I will deduct 10% of the total grade from your score for each 24-hour period the assignment is late. If I find you working on an assignment from a previous class meeting in class on the day

the assignment is due, I will consider it late and deduct 10% of the total grade from your score. Don't cheat. I am really intolerant of academic dishonesty. I will follow College policies on attendance and academic dishonesty. These can be found in the College Catalogue and the Student Handbook.

8. Cell phone policy

Cell phones are to be turned OFF during class meetings and when visiting me in my office. If your cell phone rings or you are sending or reading text messages in class or while visiting me in my office, you will be asked to leave.

9. Tentative course schedule

Week 1

9/8: Introduction to structural geology: *D&R Preface (vii–ix) and p. 2–37*

Week 2

9/13: Surfaces and lines: *D&R p. 662–669*

- Strike and dip, trend and plunge, rake/pitch
- Measuring surfaces and lines in the field

Lab: Stereonets-I — Plotting planes, lines, poles to planes, and finding orientation of line in a plane using pitch/rake. 10 points ****Bring a piece of cardboard to class****

9/15: Geologic maps and primary structures and: *D&R p. 645–662, 626–644*

- Geologic contacts and primary structures
- Introduction to geologic maps and map symbols, Geologic map homework

Week 3

9/20: Foliations and lineations: *D&R p. 424–476* AND Folds, descriptive: *D&R p. 372–397*

- Types of foliations and their formation
- Types of lineations and their formation

Lab: Waterville formation **field trip 1** — **Bring lunch**

Introduction to the Waterville formation, basic geologic contacts, and recording data in the field. ****Read D&R 626–644 before trip****

9/22: Fold mechanics: *D&R p. 397–423*

- Class will begin with a **fold terminology quiz**

Week 4

9/27: All-day **field trip** to Pemaquid Point — **Bring lunch**, plan on being back late.

9/29: Intro to scientific writing, fold analysis techniques

Week 5

10/4: Joints and veins: *D&R p. 204–226*

- Joint formation and morphology
- Vein formation and morphology

Lab: Lab will be cut short for the Geological Society of America meeting. We will finish the joints and veins lecture, begin the faults lecture, and have Q&A time for the Pemaquid Point paper.

10/6: Class canceled for the Geological Society of America meeting.

Week 6

10/11: Fall Break

10/13: Faults, descriptive----Pemaquid Point rough drafts due?

- Basic fault terminology: *D&R p. 269–286, 292–303*
- Reverse faults: *D&R p. 219–335*
- Normal faults: *D&R p. 340–357*
- Strike-slip faults: *D&R p. 357–371*

Week 7

10/18: Second Waterville formation **field trip**, all day — **Bring lunch**

10/20: Faults, descriptive continued

Week 8

10/25: Two Lights State Park **field trip**, all day — **Bring lunch**, plan on being back late.

10/27: Midterm exam, cumulative

Week 9

11/1: Fault mechanics

- Mohr-Coulomb failure: *D&R p. 226–245*
- Brittle rupture vs. slip on a pre-existing fracture
- Homework dealing with Mohr-circle analysis
- Andersonian faulting: *D&R p. 304–317*
- Exceptions to Andersonian faulting (Hubert and Ruby experiments): *D&R p. 345–351*

Lab: Stereonets-II, rotations and net-slip problems.

11/3: Fault mechanics continued

Week 10

11/8: Fault mechanics continued

Lab: Apparent dip calculations, three-point problems, and geologic map interpretation. 15 points

11/10: Strain theory: *D&R p. 51–67, 477–485*

- Types of strain
- The strain ellipsoid
- Quantifying strain in deformed rocks

Week 11

11/15: Strain theory continued

Lab: Structure contours. 15 points

11/17: Rheology and deformation mechanisms: *D&R p. 143–148; Handout from van der Pluijm and Marshak*

- Relationship between stress, strain, and strain rate
- Linear rheologies
- Nonlinear rheologies
- Deformation mechanisms and rheology: *D&R p. 150–202*

Week 12

11/22: Rheology and deformation mechanisms continued

11/26: No class, Thanksgiving

Week 13

11/29: Plastic high-strain zones: *D&R Chapter 9*

Lab: Geologic mapping using air photos — Seminoe Dam area, Wyoming. 20 points

12/1: Plastic high-strain zones continued

Week 14

12/6: TBA or overrun from earlier topics

Lab: Cross sections. 10 points

12/8: TBA or overrun from earlier topics

Final Exam: Cumulative. Day and time.

10. Important dates

9/22: Fold terminology quiz

10/27: Midterm exam

12/19: Final exam