Required field trip April 20-22, leave at 11 AM

Structural Geology

Dr. Martha Growdon
214 Science I

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OFFICE HOURS:
T 2-3, Th 11-12

Psst…you **will** *need to see me outside of class for help on course topics.*

Basic Course Information
Credits: 4 *CRN*: 325
Prerequisite: GEOL 242 and 275 (*Mineralogy* and *Data and Analysis*)
Course meets: MWF 11-12, Th 2-3:50 Science I, room 205
Required course field trips: **Sunday, April 1, 8-5; April 20-22 (Fri-Sun) leave at 11 AM**

Required Materials – you must have and bring *all* these materials to class *every day*!

- *Structural Geology* by Haakon Fossen, Cambridge University Press, 2010. ISBN: 978-0-521-51664-8
- *Structural Analysis and Synthesis*, 3rd ed. by Rowland, Duebendorfer, and Schiefelbein, Blackwell publishing, 2007. ISBN: 1-4051-1652-8 – ***MUST BE NEW!***
- *Communicating Rocks: Writing, Speaking, and Thinking About Geology* by Peter Copeland. Pearson Publishing, 2012 ISBN: 9780321689672
- 1 neck lanyard for your hand lens
- 1 water-resistant field notebook (Rite in the Rain recommended-only needed on field trips)
- 1 Structure kit (available from the SGE GeoStore), contains the following:
  - 6" engineers protractor ruler
  - 12" engineers ruler
  - double-tipped red sharpie
  - double-tipped black sharpie
  - green felt-tip pen
  - hand lens
- Colored pencils (at least 12 different, *usable*, colors – white doesn't count…)
- Plenty of erasers and pencils (NO PENS!)
- 1 calculator with trigonometric functions (sine, cosine, tangent, etc)
- 1 book tracing paper
- 1 book graph paper (small divisions, faint lines works best)
- stereonet (will be provided in class in a few weeks)
- 1 portable container to keep all this stuff in so you can bring it to EVERY CLASS!
- You may also find it helpful to bring a laptop to class, if you have one. Laptops will be provided during class but many students work more comfortably on their own computers.

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Additional recommended materials – you may also find it helpful to have:

- Drafting compass
- Digital Camera (to record complex drawings on the board)
- Voice recorder (You may record lectures for your own use only. You may not sell, publicly share, or otherwise compromise my intellectual property without my written consent.)

Resources on reserve at the Library

- *Structural Geology* by Haakon Fossen
- *Geologic cross sections* by Cynthia Shauer Langstaff, David Morrill
- *Structural concepts and techniques* compiled by Norman H. Foster and Edward A. Beaumont
- *Basic Methods of Structural Geology* by Stephen Marshak and Gautam Mitra
- *Structural Analysis and Synthesis*, 3rd ed. by Rowland, Duebendorfer, and Schiefelbein
- *Rock Fractures in Geologic Processes*, by Agust Gudmundsson

What is Structural Geology?

Catalogue Description: *An introduction to common structural features-folds, faults, foliations, lineations, unconformities, geologic contacts - their geometry and origin. Examination of basic concepts of stress and strain; laboratory application of basic geometric techniques used in structural analysis, including orthographic and stereographic projection, construction of cross-sections, and interpretation of structure from geological maps.*

Structural geologists observe, describe, and interpret rock geometries formed in response to stresses in Earth. Throughout this course you will re-learn how to objectively observe rocks in the field and the laboratory (when we cannot go to the field), you will learn how to use analogue and numerical models and scaled representations of rock geometries to interpret and describe structural and tectonic histories of rocks. Structural geology is used in oil and gas exploration (petroleum geology), mapping of groundwater aquifers and flow conduits (hydrogeology), exploration of new geological resources (mining or quarry geology, exploration geology, field mapping), and mapping of existing resources, but the applications of structural geology and its usefulness and applicability to your daily lives are endless. For example, would you rather go rock climbing on the east or north face of a granite dome (maybe Half Dome) riddled with north striking fractures? Would you rather live on a canyon rim above a river that flows along A) fractures in a conjugate fracture set or B) the trough of a cylindrical syncline? Though structural geology may often seem esoteric, difficult, and irrelevant to your geological education and future career, the skills that you develop in this class will make you a better geologist both in the field and in the laboratory. Learning structural geology will make you more able to objectively approach and creatively solve problems throughout your life.

What should students expect of this class?

YOU SHOULD EXPECT TO SPEND UP TO 20 HOURS/WEEK OUTSIDE OF CLASS FOR THIS COURSE

(That's the equivalent of a part-time job!)

The lecture and lab portions of this class will be focused on learning (or re-learning!) how to objectively observe and interpret bedrock structures. Class time will be primarily activity-based; the best way to learn Structural Geology is through doing it, not through listening to someone tell you about it. That being said, I will fill in information in a talk-as-you-work manner during activities and **you are expected to read the assigned readings *before* you come to class**. You may already be minimally familiar with many of the topics we will study including folded, faulted, and dipping strata. Many of the words will be familiar but much of what else you learn will be totally new, yet ***will be presented at an accelerated rate and a high level***. This makes Structural Geology **very frustrating** for geology students,

many of whom take Structure at the end of their undergraduate careers and who are used to "just getting" course content. While structural geology may be intuitive for some of you, many of you may struggle with spatial-thinking tasks that require you to recognize the three-dimensionality of structures you cannot see in 3-D, or to flip, spin, slide, squeeze, and stretch rocks in your head. We will do lots of visual experiments, activities, and demos to help with this. Even still, **I guarantee that you all WILL be challenged in this class**, you will struggle at times, and you will, I repeat, **you WILL need to come to me for help**—you likely will not succeed in this class unless you attend office hours. We will rely heavily on the two textbooks for this class, both as resources and as manuals for daily activities; as such you will need to bring them both to every class in addition to your other required materials.

Goals for Geol 330 Students:

Upon completion of this course, students will be able to:

1) Observe and interpret patterns on bedrock geologic maps;
2) Observe and interpret structures in field outcrops;
3) Take meaningful, well-organized field notes that will help future structural geology students see what you saw;
4) Interpret structural histories from observations of rocks and manipulations of data.
5) Manipulate structural datasets to produce and interpret equal area nets;
6) Recognize, draw, and restore balanced cross sections.

Student Learning Outcomes for the Geology Major addressed by this course:

- Students will demonstrate understanding of processes that occur on and within the Earth and interactions among Earth's systems (SLO 5)
- Students will demonstrate their ability to collect and analyze geologic information in field and laboratory settings (SLO 6)
- Students will demonstrate their ability to apply scientific reasoning to solve geologic problems (SLO 8)
- Students will demonstrate their skills in presenting geologic information (SLO 11)

What does Dr. Growdon expect of Geol 330 students?

I expect my students to try.

I expect the very best of my students. I have very high standards for you. *This is not a punishment*, but a compliment to your intelligence and your potential. You all achieved the honor and responsibility of being accepted to college and I firmly believe you can do whatever you are determined to do. I know that all of my students are capable of success and I am available to help when you reach out for it. I will expect you to read, think, discuss, speak, and write critically. Again, this is not to punish you, but to push you beyond the limits where you might otherwise choose to go. Here, beyond the safety of your comfort zone, is where you can learn more than you thought possible! But you have to try, you have to struggle, to achieve this amazing reward!

I expect my students to be respectful.

In this classroom we have diversity. I expect all of my students to handle this diversity with aplomb and be models of respectful behavior to the rest of the department. If you have issues with each other I expect you to solve them quickly so that we can continue to learn effectively—you will struggle enough in this class without the added stress of unresolved personal issues. If these issues cannot be worked out between you, then I expect you to come see me to work through them. I will not tolerate disrespectful, hurtful, derisive, and/or derogatory comments, gestures, or implications towards other students or myself. If you participate in actions that demean another persons' abilities or personality I will ask you to leave the classroom and you will receive a zero on the day's work.

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I expect my students to be responsible.

Each person is responsible for his or her own words, actions, work, and behaviors. It is each person's responsibility to turn in work on time, notify me of expected or unexpected absences, make arrangements to get extra help if needed, and adhere to his or her course obligations. I am not a babysitter and you are all adults. I may not always remind you when things are coming due—all deadlines are on the syllabus, or will be announced in class, and you are responsible for remembering them.

I expect my students to read the books.

Class time will revolve around activities and demonstrations meant to help you learn the concepts of structural geology about which you are reading. I will not always "lecture" in a traditional sense yet I DO expect you to keep up with the reading and I will rely on you recognizing the reading concepts when we practice them in class.

I expect my students to want to learn.

I put a lot of time and effort into designing and teaching this class to make it relevant and interesting and to facilitate your learning of the material. I expect you to be equally invested in *learning* the material by showing up to class and actively participating. You will receive a daily class participation grade that will reflect my perception of your level of involvement and contribution to the day's work. Unexcused absences are counted heavily against you and I will be reluctant to spend more of my time out of class to help you make up the material if you consistently miss classes. ***Come to class prepared to participate in your learning***.

I expect my students to turn in work on time.

All assignments are due at the beginning of the class after which they are assigned unless otherwise directed. I may not remind you that assignments are coming due. I expect you to maintain a schedule of due dates when I assign work. *You must arrive to class on time to turn in your work on time!* Turning in work late will seriously affect your abilities to complete future work on time in this class. All homework assignments and projects will build on previous work and it is imperative that you complete your work on time and not fall behind in this class. As such, ***late work will not be accepted for a grade***. Due dates are firm and you are expected to be responsible for turning in your work on time. If unexpected circumstances arise, please talk to me BEFORE your work is late.

I expect students to attend all field trips.

We will spend time on Saturdays outside on field trips when the weather allows and we will go on one longer field trip in this class. All field exercises are ***mandatory***. Please mark the dates on your calendars NOW and get permission from jobs and other professors to be absent. Your participation on field trips is a large portion of your final grade because field trips are where you get to observe actual structures and make active interpretations that are immediately applicable!

I expect students to challenge themselves.

You will succeed in this class if you challenge yourself to think in new ways, to take baby-steps from observations to interpretations, and to be intrigued by new problems.

I expect students to act with integrity.

Academic dishonesty of any type will not be tolerated in this classroom. Plagiarism is broadly defined (see Plagiarism.ppt on Angel) but uniformly addressed: all instances of plagiarism or other forms of academic dishonesty result in a zero on the assignment and a forfeiture of the rubric component of the grade to which that assignment belongs. Furthermore, academic dishonesty during this class precludes a student's ability to pass this class—i.e., you will not pass this class if you cheat. All instances of academic dishonesty will be reported to the dean.

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Emergency Evacuation/Shelter-in-Place Procedures

In the event of an emergency evacuation (i.e. fire or other emergency), classes meeting in Science I are directed to **reassemble at Chase Gymnasium** so that all persons can be accounted for. Complete details of the College's emergency evacuation, shelter-in-place, and other emergency procedures can be found at http://www.oneonta.edu/security.

ADA (Americans With Disabilities Act) Statement

All individuals who are diagnosed with a disability are protected under the Americans with Disabilities Act, and Section 504 of the Rehabilitation Act of 1973. As such, you may be entitled to certain accommodations within this class. If you are diagnosed with a disability, please make an appointment to meet with Student Disability Services (SDS), 209 Alumni Hall, ext. 2137. All students with the necessary supporting documentation will be provided appropriate accommodations as determined by the SDS Office. It is your responsibility to contact SDS and provide the teacher with your accommodation plan before a test.

Office Hours Attendance Policy

You will not succeed in this class unless you see me during office hours to get help when you are confused about assignments, projects, lecture, etc. As such, I will hold MANDATORY office hours during the first two weeks of the semester. You MUST sign up for and attend a 20-minute office hour session with me to discuss strategies for success in this class and to ensure that you understand my policies and expectations.

Spring 2012 Calendar

Jan 22-24	Sun – Tues	New student arrival and orientation
Jan 25	Wed	Classes Begin
Jan 31	Tues	Add/Drop period ends
Feb 7	Tues	Last day to add a full semester class
Mar 17-25	Sat-Sun	Spring Break
Mar 26	Mon	Classes Resume
Mar 30	Thurs	Last day to drop with W
April 10	Tues	Last day to change P/F to letter
May 9	Wed	Study Day
May 10-16	Thurs-Wed	Finals

Grades

Class participation/daily work	25%
Field component (field notes, participation)	15%
Term lab project	35%
Exams	25%

Grade distributions:

A > 92%	B > 82%	C > 72%	D > 62%
A- > 88%	B- > 78%	C- > 68%	D- > 58%
B+ >85%	C+ > 75%	D+ > 65%	F < 58%

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Class calendar

Readings should be completed BEFORE class of the week indicated (F = Fossen, RDS = Rowland, Duebendorfer, and Schiefelbein)

Monday	Wednesday	Thursday	Friday	**Corresponding Readings**
	25-Jan	26-Jan	27-Jan	
	PRE TEST		**HW 1, 2 GE maps + xsections**	
	Intro to policies, intro to Appalachian geology	Basic map skills in Google Earth	Strike and Dip, lab 1 problems	**RDS 1-3**
30-Jan	1-Feb	2-Feb	3-Feb	
	HW 2 (Lab 1) due	**HW 3 (GE map set 3) due at end of lab**	**HW 4 (LAB 2) DUE**	
3 pt problem review, Lab 2 assigned	vertical and horizontal units	continue working on vert/hor units	Lab 3 - interpreting other information from geologic maps	**RDS 1-3**
6-Feb	8-Feb	9-Feb	10-Feb	
HW 5 (LAB 3) DUE				
Overview of Appalachian tectonics	Overview of Appalachian tectonics	Stereonet introduction + problems	Overview of Appalachian tectonics	**F1, RDS 5**
13-Feb	15-Feb	16-Feb	17-Feb	
Recognizing structures - folds	**TP PART 1 DUE**	**HW 6 (GE folds) DUE**	**HW 7 (Lab 6/7) DUE**	
Type of folds	GE fold mapping	Lab 6, 7	folding mechanisms	**F11, RDS 6-8**
20-Feb	22-Feb	23-Feb	24-Feb	
Recognizing structures - fractures and brittle failure	**TP PART 2 DUE**			
Types of fractures	Failure criteria	Lab 13	***Exam 1***	**F7, RDS 13**
27-Feb	29-Feb	1-Mar	2-Mar	
HW 8 (Lab 13) DUE	**TP PART 3 DUE**	**HW 9 (GE faults) DUE**	**HW 10 (lab 9/10) DUE**	Recognizing structures - faults, shear zones, and kinematics
types of faults and shear zones	GE fault mapping	lab 9/10	Kinematics	**F8, 9, 15, RDS 9, 10**
5-Mar	7-Mar	8-Mar	9-Mar	
Balanced Structure Sections			**HW 11 (Lab 4) DUE**	
Ramp-Flat geometries and structure sections	Ramp-Flat geometries and structure sections	Lab 4, MM 14 (assign 1 balanced cross section from MM 14)	Ramp-Flat geometries and structure sections	**F20, RDS 4**
12-Mar	14-Mar	15-Mar	16-Mar	
Recognizing structures - Boudinage and lineations	**TP PART 4 DUE**			
lineations	boudinage	Work on structure section for TP	What do lineations and boudinage tell us?	**F13-14**
26-Mar	28-Mar	29-Mar	30-Mar	
Recognizing structures at the microscale - deformation and cleavage			**HW 12 (thin section lab) DUE**	
Microstructural deformation and crystal defects	recognizing microstructural deformation in thin sections	thin section analysis of microstructures	Cleavage development	**F10, 12, RDS 16**
2-Apr	4-Apr	5-Apr	6-Apr	
What causes structures? Deformation	Understanding deformation	Work on Structure sections	Understanding deformation	**F2**
9-Apr	11-Apr	12-Apr	13-Apr	
What causes structures? Strain and Stress			**HW 13 (Lab 14) DUE**	
Strain analysis	Introduction to stress	Lab 14	Stress in Appalachian tectonics	**F3-5**
16-Apr	18-Apr	19-Apr	20-Apr	
What causes structures? Rheology	**TP PART 5 DUE (Xsec)**			
Rheology of rocks	Rheology of rocks	***Exam 2***	Leave for VT field trip	**F6, RDS 12**
23-Apr	25-Apr	26-Apr	27-Apr	
			HW 14 (Lab 12) DUE	
Structural history of the Appalachians	Structural history of the Appalachians	Lab 12	Structural history of the Appalachians	
30-Apr	2-May	3-May	4-May	
	TP PART 6 DUE			
Structural history of the Appalachians	Structural history of the Appalachians		Structural history of the Appalachians	
7-May				
TP FINAL REPORT DUE				
Review day for final				
14-May				
FINAL EXAM 11-1:30				

These dates are subject to change. Changes that affect due dates will be announced during class and you are responsible for hearing these announcements and modifying your syllabi schedule to reflect them. You are encouraged to ask for clarification should you need it.