GEOL 3411: STRUCTURAL GEOLOGY, SPRING 2019
MWF 11:00 – 11:50, Lab: T 2:00 – 4:50

GEOL 3411: A study of ways rocks and continents deform by faulting and folding, methods of picturing geologic structures in three dimensions, and causes of deformation. Includes a weekend field trip project. Prerequisite: GEOL 1403 or 1404.

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Office hours
- Monday and Wednesday: 8:00 – 10:00 am, 2:00 – 3:00 pm
- Tuesday and Thursday: 11:00 – 12:00 noon
- Friday: 8:00 – 10:00 am
- Or contact me to set up a convenient time to meet

Required Textbooks

Grading
- 2 exams over lecture, text, and project topics: 12% each
- 1 comprehensive final exam, 16%
- 11 graded lab projects, including one required weekend field trip project: 55% (5% each)
- 1 summary and discussion of a scientific paper, 5%

Required Lab and Field Equipment
1. Geology field book (I will place an order for all interested and pay shipping)
2. Pad of Tracing paper, 8.5 in x 11 in or 9 in x 12 in (Buy at Hobby Lobby or Michaels)
3. Graph paper pad, 5-squares-per-inch grid
4. Set of colored pencils (Buy good ones at Hobby Lobby or Michaels)
5. Small protractor (4 inch)
6. Ruler

Course Webpages
The Angelo State Blackboard site contains PowerPoint slides, web links to scenic areas mentioned in class, practice problems, answers to lab assignments, and your official grades.
Field Trips

1. **Lab 11: El Solitario dome, Big Bend Ranch State Park:** Friday – Sunday February 15 - 17, departing 11:00 am. We will camp two-nights in the South Leyva Campground and drive into the Solitario (4WD required!) to describe outcrop-scale folds, map-scale folds, thrust faults, and pluton-caused structures. Dr. Blaine Hall, former Sul Ross State professor, will join us. Last field trip to this area was in 2015!

2. **Southwest Section AAPG Short Course, Applied Concepts in Naturally Fractured Reservoirs:** Friday, January 25, 8:00 am – 5:00 pm, Abilene, free to Geoscience majors! Opportunity to meet many professional geologists! Register as soon as possible at [SW AAPG Short Course Online Registration](#).

### Schedule

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<tr>
<th>Week</th>
<th>Lecture/Discussion Topics</th>
<th>Lab Projects</th>
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| I: 1/14, 1/16, 1/18 | 1) Nature of Structural Geology (Ch 1)  
2) Opportunities to order field book, other field equipment  
3) Folding block, drawing strike and dip symbols, apparent dip | 1: Dagger Mountain cross-section, Converting true dip to apparent dip (p. 718 – 721) |
| II: 1/23, 1/25 | 1) Useful primary structures: graded beds, crossbeds, load casts  
2) Displacement and strain (Ch 2)  
3) Strain analysis projects (Belemnites, Skolithos, Brachiopods)  
4) 1/25: SW AAPG Short Course, Naturally Fractured Reservoirs | 2: Orthographic Projections (Ragan, Ch 1 and 2) |
| III: 1/28, 1/30, 2/1 | 1) Strain projects reviewed and answers revealed  
2) Shear strain (Ch 2)  
3) Mohr Circle for strain (Ch 2)  
4) Dilation (Ch 2) | 3: Interpreting strike and dip from map patterns; The three-point problem (Ragan, Ch 3) |
| IV: 2/4, 2/6, 2/8 | 1) Simple vs Pure Shear (Ch 2)  
2) Force, Stress, and Strength (Ch 3)  
3) Using stylolites to interpret stresses  
4) Mohr Circle practice problems distributed | 3: Concluded – Constructing and Interpreting Structure Contour Maps |
| V: 2/11, 2/13, 2/15 | 1) Interpreting Principal Stress Directions from faults (Ch 3)  
2) Brief Introduction to stereographic projection (p. 735 – 742)  
3) Intro to Joints and Shear Fractures (Ch 5)  
4) Big Bend structure paper distributed | 4: Basic stereonet techniques |
| VI: 2/18, 2/20, 2/22 | 1) Joints and Shear Fractures, continued  
2) Project: mapping joints with aerial photos  
3) Joints and Shear Fractures concluded (Ch 5) | 5: More stereonet techniques |
| VII: 2/25, 2/27, 3/1 | 1) 2/27: EXAM 1 (Chapters 1, 2, 3, 5)  
2) Ways of identifying subtle faults (Ch 6) | 6: Geologic map 2, cross-section and stereonets |
| VIII: 3/4, 3/6, 3/8 | 1) Slip versus Separation (Ch 6)  
2) Project: Advanced wood blocks  
2) Fault kinematic analysis (Ch 6)  
3) Thrust faults and thrust belts (Ch 6) | 6: Continued |
| 3/11 – 3/15 | SPRING BREAK | |
| IX: 3/18, 3/20, 3/22 | 1) Thrust faults and thrust belts concluded (Ch 6) | PAPER SUMMARY DUE  
Discuss paper in lab |
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| X: 3/25, 3/27, 3/29 | 1) Normal faults, detachment faults, extreme extension (Ch 6)  
2) Project: Interpreting Corsair Trend seismic section  
3) Strike-slip faults and flower structures (Ch 6) | 7: Drawing dip isogons and plotting Ramsay fold classes |
| XI: 4/1, 4/3, 4/5 | 1) More about describing folds (Ch 7)  
2) Finding big folds from S- and Z-folds in Marathon uplift (Ch 7)  
3) Interpreting subsurface structure contour maps (Ch 7)  
4) Basic and strange fold terms (April Fools contest; Ch 7) | 8: Fracture measurement, San Angelo State Park |
| XII: 4/10, 4/12 | 4/7 – 4/9: SW AAPG Annual Meeting, Dallas  
1) Fold geometry: Stereonets and dip isogons (Ch 7)  
2) Kinematic analysis of folds: buckling, flexural slip, flexural flow, passive (Ch. 7)  
3) Project: Folding an Ice Cream Sandwich | No Lab Meeting (Dallas SW AAPG Meeting) |
| XIII: 4/15, 4/17, 4/19 | 2) Causes of Folding (Ch 7)  
3) W: Stereonet Practice  
4) 4/19: EXAM 2 (Chapters 6, 7, and 8) | 9: Geologic map 3: Polyphase folding |
| XIV: 4/22, 4/24, 4/26 | 1) Reactivated faults (Ch 8)  
2) Fault-fold interactions (Ch 8)  
3) Polyphase folding (Ch 9) | 9: Concluded |
| XV: 4/29, 5/1, 5/3 | 1) Review projects  
2) Review field trip (on-campus!)  
3) Subsurface mapping project | 10: Constructing normal profile views of folds, down-plunge method (due at end of lab) |
| XVI: 5/8 | 5/8: FINAL EXAM, 10:30 – 12:30 | NOTE: LAB 11 IS THE SOLITARIO FIELD TRIP PROJECT |

**Late Assignment Policy**
- Ten points will be deducted if you turn in assignment after due date
- Late assignments will not accepted after graded labs returned or key posted. These are ethics issues!

**Student learning outcomes**
1. To learn and practice skills needed for summer field camp, GEOL 3600, a 5- or 6-week field geology course. Look at Sul Ross State University Field Camp, Sul Ross Field Camp information[^3] or Indiana University Field Camp, Indiana University Field Camp information[^4]
2. To recognize and measure linear and planar structural features in rocks, folds, and faults. You will learn how to use a Brunton compass to measure structures in the field.
3. To describe and visualize three-dimensional orientations of folds and faults by constructing cross-sections, stereonets, and orthographic projections.
4. To make interpretations about the forces that deform rocks (dynamic analysis) and the history of deformation (kinematic analysis).
5. To make interpretations about the details of plate tectonics, especially aspects related to the Cordilleran and Marathon-Ouachita orogens exposed in West Texas mountains.

**Field Gear and Camping Gear Sources**
1. Happy Trails, San Angelo, Happy Trails website[^5]
2. ASU, Outdoor Adventures Equipment Rental Information[^6]
3. ASC Scientific, Geology Equipment Website[^7]
Your future career in Geology
The US Department of Labor Occupational Handbook contains information on geology careers, salaries, education needed, and future job outlook in geology.

GEO, the student organization for all interested in geology, meets twice a month, Wednesdays at 6:00 pm. The first meeting is January 23. GEO is a Student Chapter of American Association of Petroleum Geologists.

Academic Integrity
Students are expected to maintain complete honesty and integrity in all work. Any student found guilty of any form of dishonesty in academic work is subject of disciplinary action and possible expulsion from ASU. The College of Science and Engineering adheres to the Statement of Academic Integrity.

Plagiarism
Plagiarism is a serious topic covered in ASU’s Academic Integrity policy in the Student Handbook. Plagiarism is the action or practice of taking someone else’s work, idea, etc., and passing it off as one’s own. Plagiarism is literary theft.

In your discussions and/or your papers, it is unacceptable to copy word-for-word without quotation marks and the source of the quotation. It is expected that you will summarize or paraphrase ideas giving appropriate credit to the source both in the body of your paper and the reference list. Papers are subject to be evaluated for originality via Turnitin. Resources to help you understand this policy better are available at the ASU Writing Center.

Copyright Policy
Students officially enrolled in this course should make only one printed copy of the given articles and/or chapters. You are expressly prohibited from distributing or reproducing any portion of course readings in printed or electronic form without written permission from the copyright holders or publishers.

Student Disability Services
ASU is committed to the principle that no qualified individual with a disability shall, on the basis of disability, be excluded from participation in or be denied the benefits of the services, programs or activities of the university, or be subjected to discrimination by the university, as provided by the Americans with Disabilities Act of 1990 (ADA), the Americans with Disabilities Act Amendments of 2008 (ADAAA), and subsequent legislation.

The Office of Student Affairs is the designated campus department charged with the responsibility of reviewing and authorizing requests for reasonable accommodations based on a disability, and it is the student’s responsibility to initiate such a request by contacting: Ms. Dallas A. Swafford, Director of Student Disability Services, 325-942-2047

Title IX
Angelo State University is committed to the safety and security of all students. If you or someone you know experience sexual harassment, sexual assault, domestic or dating violence, stalking, or discrimination, you may contact ASU’s Title IX Coordinator: Michelle Nicole Boone, J.D., Director of Title IX Compliance, 325-486-6357, michelle.boone@angelo.edu, Mayer Administration Building 204A
Student Absence for Observance of Religious Holy Days
A student who intends to observe a religious holy day should make that intention known in writing to the instructor prior to the absence. See ASU Operating Policy 10.19 Student Absence for Observance of Religious Holy Day for more information.

Incomplete Grade Policy
It is policy that incomplete grades be reserved for student illness or personal misfortune. Please contact faculty if you have serious illness or a personal misfortune that would keep you from completing course work. Documentation may be required. See ASU Operating Policy 10.11 Grading Procedures for more information.

General Policies Related to This Course
All students are required to follow the policies and procedures presented in these documents:

- Angelo State University Student Handbook
- Angelo State University Catalog

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1 https://blackboard.angelo.edu
2 https://www.fwgs.org/
3 http://www.sulross.edu/geology-field-camp
4 http://www.indiana.edu/~iugfs/
5 http://www.happytrailsshop.com/
6 http://www.angelo.edu/dept/university_recreation/Outdoor_Adventures/equipment_rental.php
7 http://www.ascscientific.com/
9 https://www.aapg.org/about/membership/types/student
10 https://www.angelo.edu/student-handbook/community-policies/academic-integrity.php
11 https://www.angelo.edu/dept/writing_center/academic_honesty.php
12 https://www.angelo.edu/content/files/14206-op-1019-student-absence-for-observance-of
13 https://www.angelo.edu/content/files/14197-op-1011-grading-procedures
14 https://www.angelo.edu/student-handbook/
15 https://www.angelo.edu/catalogs/