Fall 2024
GEO 371T / Unique ID 26965: Basin Geomechanics

MW, 9:00-11:00 a.m., EPS 4.104

Instructor: Peter B. Flemings, JGB 5.318
Tel: 512-475-8738
Email: pflemings@jsg.utexas.edu

Website: Canvas & https://www.jsg.utexas.edu/flemings/teaching_courses/geo-371t-basin-geo/

Office Hours:

Text: Flemings, P. (2021). A Concise Guide to Geopressure: Origin, Prediction, and Applications, Cambridge Press. (Available digitally for free through library).

Additional useful reading:

1. Ingebritsen, S., Sanford, W., and Neuzil, C., 2007, Groundwater in Geologic Processses, University Press, Cambridge. ISBN-113 978-0-521-60321-8 paperback
2. Craig, R.F., 2004, Craig's Soil Mechanics, 7th Edition, Spon Press, London, 447 p.
3. Freeze and Cherry, 1979, *Groundwater*, Prentice Hall, 604pp. (ISBN: 0-13-365312-9).
4. De Marsily, G., 2000, Quantitative Hydrogeology, Groundwater Hydrology for Engineers, 1986, Academic Press, Inc., 440 p.
5. Wang, H.F., 2000, Theory of Linear Poroelasticity with Applications to Geomechanics and hydrogeology, Princeton University Press, 287 p.
6. Phillips, O.M., 1991, Flow and Reactions in Permeable Rocks, Cambridge University Press, 285 p.
7. Zoback, M.D., 2007, Reservoir Geomechanics, Cambridge University Press, Cambridge, 449 p.
8. New York Times: https://guides.lib.utexas.edu/nyt

Overview:
This course provides a broad overview of geomechanics and geofluids to the graduate student or upper-level undergraduate with a modest quantitative background. It provides you with the technical foundation and physical insight to explore how fluids drive geologic processes. You will characterize pressure and stress, explore the origin of overpressure, and examine how pressure and stress couple. You will learn how sedimentation generates overpressure, how hydraulic fractures form, how C02 is trapped in the subsurface, and how submarine landslides are generated. You will explore how subsurface fluid injection causes earthquakes. A highlight of the course is a field trip to California to study these processes. I practice problem-based learning and I provide exercises that build your theoretical understanding and illustrate the remarkable ways that we can use subsurface data to characterize pressure and stress in basin systems.

Expectations and Requirements:

1. *General Conduct*

I expect that you will act professionally and honestly. Treat your classmates with respect when they are presenting material in front of the class: don't talk while they are speaking; show up on time for class; complete your own assignments but feel free to work with others. Plagiarism will not be tolerated and will result in a grade of "zero." If you don't do the work, you can't possibly go fully through the learning process.

I expect and hope that you will ask questions during lecture. I prefer that questions are addressed while we cover material, so that everyone is following. **If you are struggling with anything in this course – assignments, reading, your presentations – please stop by during office hours and ask me questions.**

2. *Zoom Protocol & Class Structure*

This class will be in person. However, we may have to do some lectures online. Teaching and learning online is a challenge. I ask that each of you make every effort to keep your cameras on to increase the sense of connectedness for our class.

3. *Class Attendance*

Attendance is important. I will often give out class exercises that will be graded or will track participation. Missing lectures will make it hard to keep up.

4. *Late Policy for Assignments*

I don't accept late homework unless you notify me ahead of time, or there is an extraordinary circumstance. With proper planning, I am happy to work around any scheduling issues you have due to other professional or personal situations.

5. *Problem Sets and Labs*

These are designed to drive home the key points made in lecture. Most of your learning will be accomplished by doing these exercises.

6. *Field Trip*: ***Wed. Oct. 9- Sunday Oct 13.***

A wonderful part of this course is the field trip to northern California to study examples of flow in geological systems. Travel and housing costs are covered. You will be responsible for most meals.

7. *Prepare Homework Assignment or Research Application*

After the midterm, you should select either a homework to prepare or a small personal research project to be presented at the end of the course. Ideally, you would do the latter and it would relate to your research.

If you pursue a homework. You will prepare a homework assignment and an answer sheet. You will also make a brief presentation describing the assignment. Two students will be tasked with reviewing your assignment.

Alternatively, you may choose to do a small independent project related to your research (and ultimately could constitute part of your thesis). The "final" assignment will include a brief (5-page write-up of your project and a 10 minute in-class presentation of your project.

Regardless of which route you choose, you will have limited time for this project. There will be little time for trouble-shooting. The most common problem encountered is that the student tries to do too much! Once you have chosen your project, discuss it with me to make sure it is realistic given time limitations.

Your Grade

Your grade in this course will be determined as follows:

Problem Sets/Labs	50%
Exam 1	15%
Exam 2	15%
Project	20%

Schedule

1. August 26: Stresses and Pressures in Sedimentary Basins
    a. M: Overview—Pressure and Stress in Basins
    b. W: No class
    c. Problem Set 1: Macondo Stress/Pressure Profiles

2. September 2: Earth Stresses
    a. M: No Class-Labor Day
    b. W: Mohr's Circle & Mohr-Coulomb failure
    c. Problem Set: Earth Stresses

3. September 9: Least Principal Stress
    a. M: Earth Stresses
    b. W: Interpreting Least Principal Stress
    c. Problem Set: Interpreting and modeling Least Principal Stress

4. September 16: Hydraulic Fracturing Models
    a. M: Models for Least Principal Stress
    b. W: Hydraulic Fracture Models
    c. Problem Set: Hydraulic Fracture Models

5. September 23: Exam and Field Trip Preparation
    a. M: Hydraulic Fracture Models
    b. W: Field Trip Data Acquisition
    c. Problem Set: Plotting Field Data

6. Sept. 30: Field Trip Preparation
    a. M: Exam
    b. W: Software Mechanics
    c. Interpretation of field Data

7. Oct. 7: Field Trip Week
    a. M: Field Trip Overview
    b. Field Trip: Wed. Oct. 9- Sunday Oct 13.

8. Oct. 14: The Origins of Overpressure
    a. M: No Class
    b. W: Undrained Loading
    c. Problem Set: Timescales of Pressure behavior

9. Oct. 21: Overpressure
    a. M: Consolidation
    b. W: Pressure Prediction
    c. Problem Set: Pressure prediction

10. October 28: Multi-Phase Fluid Statics in Sedimentary Basins
    a. M: Reservoir Pressure at Gravitational and Capillary Equilibrium
    b. W: Capillary Behavior
    c. Problem Set: Stress/Pressure Profiles: multi-phase systems

11. November 4: Trap Integrity & CO2 Sequestration.
    a. M: Exam (PBF Out)
    b. W: Capillary Sealing

12. November 11: Trap Integrity & CO2 Sequestration
    a. M: Mechanical Sealing
    b. W: Flow Focusing
    c. Problem Set: Sealing

13. November 18: Slope Stability
    a. M: slope stability
    b. W: slope stability
    c. Problem Set:

14. November 18: Exam Hydrate Systems
    a. M: Hydrate Systems
    b. W: Hydrate Systems
    c. Problem Set: Hydrate HW

[Reserve!: Nov. 11: Flow Focusing in Sedimentary Basins
    d. M: Flow Focusing: Theory
    e. W: Flow Focusing: Case Studies]

15. November 25: Thanksgiving Week: No Classes

16. December 2: Individual Presentations
    a. M: Class Presentations
    b. W: Class Presentations

17. December 9: Individual Presentations
    a. M: Class Presentations