Fall 2022
GEO 382D / Unique ID 27950: Crustal GeoFluids

M-W, 2:00-3:30 p.m., EPS 2.136

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Office Hours:
Tues. at 4:00 pm, Friday at 9:00 am, and by appointment (also happy to answer questions by email).

Text: Flemings, P. (2021). A Concise Guide to Geopressure: Origin, Prediction, and Applications, Cambridge Press.

Additional reading on reserve:

1. Ingebritsen, S., Sanford, W., and Neuzil, C., 2007, Groundwater in Geologic Processes, 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.

Overview:
Develops the technical foundation and physical insight to explore how stress and pressure drive geologic- and human-induced processes. Applications include CO_2 sequestration, hydraulic-fracturing, faulting, geopressure development, hydrocarbon entrapment, subsidence and compaction, slope stability, and borehole stability. Field trip to study natural hydraulic fracturing. I practice problem-based learning and I will provide exercises that build your theoretical understanding and illustrate the remarkable ways that we can use data to characterize fluid 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. I'm here to help you learn this material.**

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*
   A wonderful part of this course is the field trip to northern California to study examples of flow in geological systems. This is scheduled for November 3rd-7th. Costs are covered.

7. *Prepare Homework Assignment or Research Application*
   After the midterm, you should select either a homework to prepare or a small personal research experiment to be presented at the end of the course.

   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 your assignment.

   Alternatively, you may choose to do a small independent project that is related to your research (and ultimately could constitute part of your thesis). The "final" assignment will include a brief (5 page or less) write-up of your project and a brief (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 troubleshooting. 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	40%
Exam 1	15%
Class/Discussion participation	10%
Exam 2	15%
Project	20%

Schedule

1. Aug. 22: Stresses and Pressures in Sedimentary Basins
    a. M: Overview—Pressure and Stress in Basins
    b. W: Overview—Pressure and Stress in Basins
    c. Problem Set: Macondo Stress/Pressure Profiles

2. Aug. 29: 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

3. Sept. 5: Material Behavior
    a. M: No Class
    b. W: Mohr's Circle & Mohr-Coulomb failure
    c. Problem Set: Stress State

4. Sept. 12: Material Behavior
    a. M: Earth Stress States
    b. W: Compaction & Lateral stress ratio
    c. Problem Set: Stress State

5. Sept. 19: The Origins of Overpressure
    a. M: Undrained and Drained Loading
    b. W: Consolidation
    c. Problem Set: Timescales of Pressure behavior

6. Sept. 26: Pressure Prediction
    a. M: Pressure Prediction
    a. W: Pressure Prediction
    b. Problem Set: Pressure Prediction

7. Oct. 3: Least Principal Stress
    a. M: Interpreting Least Principal Stress
    b. W: Models for Least Principal Stress
    c. Problem Set: Stress States

8. Oct. 10: Hydraulic Fracturing
    a. M: Hydraulic Fracturing models
    b. W: Geometry of Hydraulic Fractures
    c. Problem Set: Calculating hydraulic fracture aperture:

9. Oct. 17: Trap Integrity & CO_2 Sequestration.
    a. M: Exam 1
    b. W: Capillary Sealing

10. Oct. 24: Trap Integrity & CO_2 Sequestration
    a. M: Mechanical Sealing
    b. W: Flow Focusing
    c. Problem Set: Sealing

11. Oct. 31: Flow Focusing in Sedimentary Basins
    a. M: Flow Focusing: Case Studies
    b. W: Field Trip!

12. Nov. 7: Protected Trap Systems
    a. M: Definition
    b. W: Case Studies
    c. Problem Set: Protected Traps

13. Nov. 14: Exam 2 & Hydrate Systems
    a. M: Exam 2
    b. W: Hydrate Systems
    c. Problem Set: Hydrate HW

14. Nov. 21: Thanksgiving Week:
    a. No Classes

15. Nov. 28: Slope Stability & Breaching
    a. M: slope stability & Breaching
    b. W: Class Presentations
    c. Problem Set:

16. Dec. 5: Individual Presentations
    a. M: Last Class Day