Overview

99% of fresh liquid water on our planet is groundwater supplying greater than 50% of the US population with their drinking water. Groundwater supplies are constantly under attack from over-use, abuse, and contamination. The geology of a particular region exerts a first-order control on the fluid movement in the subsurface and an even stronger role on contaminant transport. This course provides an in depth look into the subsurface geological world of groundwater flow and transport.

We will cover the application of field techniques, analysis of field data, and use of numerical models in the investigation of groundwater problems. Introduction to Visual MODFLOW and other groundwater models, including development of conceptual models from geologic data, laying out grids handling boundaries, sources and sinks, transience, calibration and sensitivity.

Details

The syllabus is subject to change based on class reaction and projects selected by the students. The Text book that will be used for this class is the book by Mary Anderson and Bill Woessner titled Applied Groundwater Modeling: Simulation of Flow and Advective Transport, ISBN:0-12-059485-4, Academic Press, 2002. Resources will undoubtedly be drawn from a variety of basic hydrogeology texts (such as Fetter, Freeze and Cherry, Swartz and Zhang), class notes, and scholarly journals. Your access to a decent computer will make your life much easier as we will focus a majority of the semester on advanced modeling techniques of groundwater flow using computer-based numerical models.

Field Project

We will perform a salt tracer test out at the hydrogeology well field site during the last week of October. More details will follow, but it is anticipated that a half day test will be necessary. Right now it is scheduled for Saturday October 30th.

Class Project

This semester we will have a class project that focuses on a topic of the students interest that involves groundwater modeling. The student will work with me to choose a project that is suitable for completion during the semester. Any type of groundwater flow model (physical, analytical, analog, or numerical) can be used. More details will follow.

Course Grading

There will be no written exams for this course. Grading will be based on problems sets (25%), class and field projects (45%), and a final oral evaluation (25%) at the end of the semester. Class participation is a must in this course and will be reflected in a (5%) of your grade.
Problem Sets

Problem sets will be handed out weekly and are due exactly 1 week from the time they are handed out. Approximately 12 problem sets will be given during the semester.

Course Schedule

1. Week (September 8\textsuperscript{th} and 13\textsuperscript{th}): Review of Basics and the Groundwater Flow Equation
   
   Readings: Handouts and basics from standard Hydrogeology texts, Anderson and Woessner (AW) 2.1

2. Week (September 15\textsuperscript{th} and 20\textsuperscript{th}): Solutions to the Groundwater flow equation (analytical and numerical) and overview of numerical methods
   
   Reading: AW 2.3
   
   Project: Discussion of potential topics for semester project

3. Week (September 22\textsuperscript{th} and 27\textsuperscript{th}): Conceptual Models and collecting the necessary information for modeling groundwater flow in geologic systems, hydrologic boundaries
   
   Reading: Handouts and AW chapter 3
   
   Project: Begin design of the conceptual model for the problem of interest

4. Week (September 29\textsuperscript{th} and October 4\textsuperscript{th}): Finite difference methods, sources and sinks, and handling boundary conditions
   
   Reading: Sections of AW chapters 3, 4, and 5
   
   Project: Selection of Numerical method used to solve your groundwater problem

5. Week (October 6\textsuperscript{th} and 11\textsuperscript{th}): Finite Element Method and other numerical methods used for simulating groundwater flow
   
   Reading: Reserved reading from Fitts, section 8.3 through 8.5

6. \textit{Note that the Annual GSA meeting is from October 14\textsuperscript{th} to 19\textsuperscript{th}, thus we will have a guest lecturer for class on the 18\textsuperscript{th}}

   Week (October 13\textsuperscript{th} and 18\textsuperscript{th}): Contaminant Hydrogeology, review of governing equations (dispersion and diffusion) and properties of contaminants,
   
   Reading: Handouts from Fetters Contaminant Hydrogeology
   
   Project: Preliminary report due on the groundwater problem of interest. Details will follow.

7. Week (October 20\textsuperscript{th} and 25\textsuperscript{th}): Modeling of contaminant and mass transport
   
   Reading: Handouts from Fetters Contaminant Hydrogeology
8. Week (October 27th and November 1st): Contaminant hydrogeology case studies and the Woburn, MA site study

9. Week (November 3rd and 8th): Fractured Rock Hydrogeology
   Field Trip: Mirror Lake Fractured Rock Hydrology Site

10. Week (November 10th and 15th): Modeling flow through fractured Rock

11. Week (November 17th and 22nd): Contaminant Transport in Fractured Rock

12. November 24th is a holiday, therefore no class
   Week (November 29th and December 1st): Coupled Processes in Hydrogeology

13. AGU in San Fransisco is December 5th through December 9th, therefore these classes may be cancelled or postponed.
   Week (December 6th and December 8th): Coupled groundwater and deformation, subsidence, earthquakes, fractures

14. Week (December 13th): Project presentations and class review