ENVR 217 PHYSICAL GEOLOGY II - FOR ENVIRONMENTAL SCIENCE

Course Outline Winter 2005 (Mar 23-Apr14)
Prerequisite: English 12,.Chem 120, Envr 107 or Geos 100.
Lectures Wednesday - 2:30-4:20 in Fisher 300 (or 360?)
Lab Thursday – 8:30-11:20 in Fisher 300

1. Instructor

Dr. Tark S. Hamilton Office Fisher 344-A
Phone 370-3331
Office Hours: as posted M, T, F: 10:30-11:20, Tues 1:30-2:20 or by appointment
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2. Intended Learning Outcomes

The focus of this course will be the understanding of ground water hydrology in surface and confined aquifers. Most of our fresh water occurs in the porosity of unconsolidated sediments and sedimentary rocks (aquifers) and is bound or restricted by aquacludes; impermeable sedimentary rocks like shale or salts or low porosity crystalline bedrock. For systems that are open to the surface and taking recharge, there is the possibility of receiving pollutants. Conflict over resource usage arises when aquifers become contaminated, accidentally or on purpose for disposal. We will look at the geological composition (minerals, rock types and pore spaces) and architecture of aquifers as it relates to porosity and permeability and naturally occurring fluids. We will consider aquifer shape, recharge, discharge, flow, production or disposal behaviour, in situ geochemistry, contamination, dispersion and remediation. Of particular interest is the vadose zone (partial saturation) above the permanent water table. Pollutants to be considered include: metals (ionic), radioactive waste and NAPL (non aqueous phase liquids). Other contaminants like bacteria are also important but will not be considered in detail.

All material is presented in the context of Earth materials and physical processes as they relate to the environment. After successfully completing all components of this course students will be able to:

1. Review minerals, physical properties, chemical composition and their properties as they pertain to geological aquifers and reservoirs and aquatards or aquacludes.
2. Subsurface hydrology, Darcy's Law for porous media, fluid mechanics, diffusion and advection, flow and well hydraulics.
3. Review classification of some common sediments and rocks (especially sedimentary) to consider their porosity, permeability, cementation and reactivity with fluids and their behaviour as reservoirs, barriers to flow and chemical substrates for interaction with natural fluids and pollutants.
4. Review the geological forms of layered and fractured rock bodies with respect to their fluid content and properties to fluid flow.
5. Understand the natural settings of geological formations including soils, unconsolidated sedimentary cover, layered bedrock sequences, non layered but

fractured bedrock (layering, faulting, folding, fracturing and the extent and continuity of these properties).

6. Review mineral – water interactions and reactions, oxidation, hydrolysis, hydration, labile ions, ion exchange and chemistry of natural waters
7. Read and interpret geological maps including: stratigraphy, and structure with an eye to water resources, aquifers and environmental sensitivity.
8. Review types of pollutants and introduced fluids: dissolved aqueous phase ions and salts, metals, radioactive waste, brines, non aqueous phase fluids and gases.
9. Consider point and dispersed sources for pollutants, their geological fates and approaches to environmental remediation.

3. Required Materials

(a) Texts

An Introduction to Environmental Geology, 2nd ed., Edward A. Keller, Prentice Hall
Laboratory Manual in Physical Geology, AGI, 6th ed., Ed. Richard M. Busch and Dennis Tasa
These were to be ordered by the bookstore and available as a package for a discount. The lab manual is common to the other Geoscience courses.
Recommended reading of other geology texts such as: Earth, Tarbuck, Lutgens, and Tsujita (Canadian Edition).; a geological glossary (dictionary), a mineral identification book and web based research, readings, real and virtual field trips.

(b) Other

Hand lens, protractor, drawing compass, coloured pencils.

4. References: (most on reserve 2 hour or overnight)

a) Any introductory physical geology textbook for minerals, rocks, geochemistry (weathering), groundwater and reservoir geology eg.
Tarbuck, Lutgens, and Tsujita Earth An Introduction to Physical Geology
Monroe and Wicander, The Changing Earth
Monroe and Wicander, Physical Geology
Plummer, McGeary and Carlson, Physical Geology

b) T.V. Cech Principles of Water Resources

c) P.B. Bedient, H.S. Rifai, C.J. Newell, 1997. Ground Water Contamination, Prentice Hall.

d) R. Boulding, 1995, Practical Handbook of Soil, vadose zone and ground water contamination, Lewis

e) R.J. Charbeneau 2000, Groundwater Hydraulics and Pollutant Transport, Prentice Hall

f) P.A. Domenico 1972, Concepts and Models in Ground Water Hydrology, McGraw Hill

g) P. Pradyot 1997. Handbook of Environmental Analysis: Chemical Pollutants in Air, Water, Soil and Solid Wastes, Lewis

h) J.L. Schoor 1996. Environmental Modelling: Fate and Transport of Pollutants in Water, Air and Soil, Wiley Interscience.

5. Instruction

Classroom 2 hours: Wed 2:30-4:20

Lab 3 hours Thursday – 8:30-11:20 F300 and local field trips during lab time and one weekend ½ day field trip Sunday March 28.

4 weeks (March 17 – April 8)

6. Assessment

(a) Lab exercises 4 X 8%
(b) 1 written exam 30%
(c) 1 short term paper 38%
(d) 1 weekend field trip 5% bonus

7. Grading system

Marking Scheme:

A+	100-95	A	94-90	A-	89-85		
B+	84-80	B	79-75	B-	74-70		
C+	69-65	C	64-60	D	59-50	F	<50

8. Sequence of topics (subject to modification and review):

Week 1: Minerals, rocks, fluids, porosity, permeability. Physical and chemical properties. Geological architecture of rock formations and reservoirs. & ***Lab 1:***

Week 2:

Darcy's Law, Fluid Mechanics, Diffusion, Advection and flow in porous media

& ***Lab 2***

Week 3:

Water-rock interactions, solutes, ion exchange. Gases, Non Aqueous Phase Liquids and Multiphase flow & pollution. Where things go and where they wind up. Environmental reserviors and fate of pollutants. *& Lab 3*

Week 4:Human activities and industrial sources: assessment, containment and remediation. & Field Trip

8. Paper: Due in class Wednesday April 6! Pick a topic involving ground water pollution by a pollutant or related class of pollutants such as gasoline and oil or heavy organic liquids, or particular aqueous solutes (metals, radioactive waste, landfill leachates etc.) Describe the environmental problem outlining its geology as pertains to ground water pollution and transport. Discuss its remediation, treatment or containment. For best effect pick a case history. There must be actual published sources in hard copy and not just unrefereed web materials. 5 pages excluding references. Correct citation procedures for facts and interpretations that are not your original ideas. You will present your papers in class (10 minute brevis).