Environmental Geology
GEOL 2390

Syllabus

Contacting your instructor

For information on contacting your instructor as well as other important information from your instructor see the Instructor Letter link in your course website.

Course description

The University of Manitoba *Undergraduate Calendar* describes GEOL 2390 as follows:

> Examination of geological processes and material as they interact with human activities, environmental planning, and management. Also available by correspondence. Prerequisite: university geology or GEOG 1290 or GEOG 1291 (or 053.129) (C) (or GEOG 1200 or GEOG 1201 (or 053.120) (C)), or consent of instructor.

Geology is the science of the Earth. Environmental geology is that subject area that relates the science of geology to human activities. This is obviously a very broad subject, much too broad to adequately cover in detail in just a single, one-term (thirteen weeks) course. The major emphasis of our studies during this term will be on the impact that humans and society have on the natural geoenvironmental systems and how the science of geology can help mitigate problems associated with society's activities. We will strive to understand the importance of geological sciences in environmental affairs and to show the close relationship between it and everyday human activities. A second important area of environmental geological investigation, namely the geoscience of natural hazards, will only be *reviewed* and rather briefly discussed here. A more complete handling of the geoscience of natural hazards is done in the course Environmental Earth Sciences GEOL 1360, which you may have already taken.

Course objectives

Why do we study environmental geology? It is clear that the environment and environmental problems have become matters of intense concern on local, national, and international levels. With this increasing awareness, the need for rational, informed decision making by the public and by policy makers is imperative. Environmental Geology GEOL 2390 has three main goals:

1. to present and discuss the role that natural geologic processes play in creating conditions that are detrimental to human activities;
2. to assess how human activity can negatively affect the natural geoenvironmental setting on local, regional, and global scales; and
3. to examine how the impact of these natural and human-induced processes—human suffering, property damage, and economic disruption—can be mitigated by proper consideration of geologic factors in planning.

As you systematically progress through the course material, you will:

1. define the relationship between environmental geology and other branches of physical, chemical, biological, and social science;
2. demonstrate how nearly all of our major environmental concerns and hazards are rooted in basic geological processes;
3. describe how environmental geology is a collage of many different geological subdisciplines, from hydrology to geochemistry, from economic geology to geomorphology;

4. outline how our perception of geologic hazards, environmental and resource conservation, and human interaction with geological processes has evolved over time and is different in various other cultures;
5. describe human's role in aggravating normally nonhazardous geologic processes to the point that a threshold is exceeded, resulting in rapid and often catastrophic changes; and
6. show how the organization, control, and coordination of new industrial and urban development can be integrated with a basic knowledge of geological processes to protect environmental, cultural, and aesthetic characteristics of the land.

Course materials

Required text

Bookstore

The following required materials are available for purchase from the University of Manitoba Bookstore. Please order your materials immediately, if you have not already done so. See your *Distance and Online Education Student Handbook* for instructions on how to order your materials.

Pipkin, B. W., D. D. Trent, Hazlett, R. and Bierman, P. *Geology and the Environment.* (6th ed.). Belmont, CA: Brooks/Cole—Thompson Learning, 2011.

Course overview

Environmental geology is a very broad branch of *applied* geology that focuses on the entire spectrum of possible interactions between people and the Earth's environment. Obviously no single course can fully cover the wide range of topics germane to environmental geology as modern professional geoscientists view it. The topics you will cover in this course represent an overview of only a few *selected* concepts, processes, problems, and solutions of critical importance to a practising environmental geologist today. The selection and coverage of these topics are based not only on the traditional view of environmental geology as a "corrective" science (the treating of environmental problems after they occur), but also on its role as a "preventative" science (anticipating the problems induced by human interaction with the geologic environment). An important objective of geoenvironmental work and study should be to determine which types of construction and resource extraction methods minimize damages to the land-water ecosystem. This objective must be linked to attempts to understand and find solutions to the environmental problems that exist, whether natural or the result of human activity.

Just a word of advice concerning the use of the course materials: these course notes are intended to **supplement** your textbook reading. I strongly suggest that you spend as much time (and probably even more) reading and understanding the textbook assignments as you do on these course notes. There are many aspects of the course that are not covered in detail in these notes but are discussed at length in the textbook.

I will assume you have already successfully completed one of the introductory first-year courses in geological sciences (e.g., Physical and Historical Geology, Earth and Planetary Science, Environmental Earth Sciences, Dynamic Earth, etc.) or a course in Physical Geography. If you are attempting to take this course concurrently with one of the first-year introductory courses, consult with me to get a supplementary reading list. You will frequently be using the concepts, information, and techniques learned in the introductory course(s) to better grasp the fundamentals of environmental geology. Finally, some comments directed specifically to those who have already taken Environmental Earth Sciences GEOL 1360: you will undoubtedly recognize several areas of overlap between the two courses, notably in the discussion of endogenic and exogenic hazards. This is necessary and unavoidable because not everyone taking GEOL 2390 will have had the benefit of the introduction to environmental Earth sciences via GEOL 1360. Nonetheless, this overlap is good in the sense it will at least help to refresh your memory about the key environmental concepts that were introduced in that first-year course.

The course GEOL 2390 is broadly organized in such a way as to present first the developmental history of environmental geology as a modern science, then the Earth processes that influence human

settlements (hazards), and finally with the near-surface and surficial processes that must be understood by planners and policy makers to undertake proper environmental management. Within this broad framework, specific attention will be given to the following topics (in order of coverage):

Module 1 What is Environmental Geology?

Basic concepts and historic development: The general concept, evolution, and perception of environmental geology in science and society.

Module 2 Geologic Hazards

Endogenic hazards: Earthquake and volcanic hazards: mechanisms, potential dangers and sources of damage, prediction, and mitigation.

Exogenic hazards: Flood, mass movement, and subsidence hazards: types, magnitude and frequency analysis, identification, prediction, and mitigation.

Module 3 Geoscience in Coastal Environmental

Geology of the coastal zone: Types of coastlines, water and sediment dynamics, coastal erosion and problem mitigation.

Tsunami and storm surges: Occurrence, prediction of tsunami; geological impact of large storms.

Module 4 Pollution Geology

Geology of pollution: Introduction to geological and geochemical aspects of common pollution problems; water and soil contamination, liquid waste and disposal systems; solid wastes and landfill geology.

Hazardous wastes: types of hazardous wastes and the geology of their disposal problems; mining and pollution, acid drainage and acid precipitation, radioactive waste disposal.

Module 5 Water Resources and Environmental Geology

Water geoscience: water as a substance, the hydrologic cycle, groundwater geology and hydrology, water supply and use, wetlands systems,

Geology of water resources: water resources control by dams, geology of dam sites and dam impacts.

Module 6 Drought, Desertification, Salinisation, and Problem Soils

Drought: Types of drought; role of human actions versus large-scale atmospheric controls.

Desertification and salinisation: Introduction and differences; sources of problems; the salinisation process and sources of salts; management schemes; expansive soils and related problems.

Evaluation and grading

To meet the course requirements you must complete the following:

- Four assignments of varying weights to be submitted throughout the term. These are worth **40%** of your final grade. Please contact your instructor well in advance if you cannot meet the due dates that are posted below. Marks will be deducted for late assignments unless you have prior permission.
- A final examination that will cover the entire year's work. The final exam will be schedule by the University as indicated in the *Distance and Online Education Program Guide*. The final exam is worth **60%** of your final grade.

Distribution of marks

Assignment	Percentage
1	5
2	8
3	15
4	12
Final examination	60
Total	100

Please note: All final grades are subject to departmental review.

Grading scale

Letter grade	Percentage range	Description
A+	90 – 100	Exceptional
A	80 – 89	Excellent
B+	75 – 79	Very good
B	70 – 74	Good
C+	65 – 69	Satisfactory
C	60 – 64	Adequate
D	50 – 59	Marginal
F	49 and below	Failure

Assignments

You will be asked to use the knowledge you have assimilated in the course to examine, evaluate, and solve a variety of practical environmental geology problems. There will be four assignments that will help you to bridge the gap between the theoretical aspects of the science and the practical application of these concepts. Most of the questions posed in the assignments are straightforward short-answer type of queries requiring that your recall some key points or information from your textbook or course material. Some, however, require more extended thought and/or actual manipulation of data to arrive at a suitable response. It is very important that you think about and work through these “practical” problems as completely as possible. Environmental geology is very much a practical, applied, and pragmatic science whose goal is to generate viable and reasonable solutions to perceived or anticipated problems. Your ability to *apply* what you have learned is the single most critical factor in successful completion of this course. Although the problems you will be solving are based on real-world data and situations, in order to complete the tasks asked for in a reasonable amount of time, simplifying conditions and constraints are often built into the exercises.

My philosophy about assignments/exercises (and even examinations) is that they should be learning experiences. If you submit an answer that is subsequently marked incorrect or there are points taken off, please do take the time and make the effort to sort out what went wrong. However, please accept that in no cases will I simply give you the 'correct' answer. But I will try to point you in the right direction and will work with you in order to get a more acceptable approach to the particular problem.

Finally, you should be aware that the four exercises/assignments are not intended to cover all aspects of the course. In particular, the final three units of the course (Units 10, 11, and 12) are not covered in any of the assignments.

In total, the problem sets and exercises you are assigned during the term are worth **40%** of your final mark. Please note that marks will be deducted for late assignments (unless you have prior permission from the instructor); see below.

Assignment due dates

Assignment	Sept.–Dec.	Jan.–Apr.	May–Aug.
1	October 10	February 8	June 10
2	October 24	February 26	June 24
3	November 7	March 8	July 7
4	November 21	March 22	July 21

Note: If you are unable to submit an assignment on time, contact your instructor well in advance of the due date. Marks will be deducted for late assignments (unless you have prior permission): 35% penalty for up to one week and additional 25% for each week (or fraction) thereafter.

Examination

Note: If you need to write the final exam at a location other than the University of Manitoba Campus, please submit the "Application Form for Examination at a Location Other than the University of Manitoba Campus" immediately.

This examination will be designed to test not only your grasp of the theoretical concepts of environmental geology, but also the more practical critical evaluation and problem-solving abilities you have acquired. Questions for the final examination are taken from both the study notes and from the textbook reading assignments. The format of the final examination will be a combination multiple choice and long answer/essay type. For the essay part, you will be given a choice of questions (i.e., respond to 3 of 4 or 4 of 6, etc.)

A word of caution about the assignments and the final examination

Some students find that they do very well on the assignments, but they do not do nearly as well on the final examination. While your grades on the assignments will give you some idea of how well you are mastering the material, they may not indicate how well you will do on the examination because the examination is written under very different circumstances. Because the assignments are open book, they do not require the amount of memorization that a closed-book examination requires nor are they limited to a specific time period. Some students have told us that, based on the high marks they received on the assignments, they were overconfident and underestimated the time and effort needed to prepare for the final examination.

Please keep all this in mind as you prepare for the examination. If your course has a sample exam or practice questions, use them to practice for the examination by setting a time limit and not having any books available. Pay careful attention to the description of the type of questions that will be on your final examination. Preparing for multiple choice questions involves a different type of studying than preparing for essay questions. Don't underestimate the stress involved in writing a time-limited examination.

Plagiarism, cheating, and examination impersonation

You should acquaint yourself with the University's policy on plagiarism, cheating, and examination impersonation as detailed in the General Academic Regulations and Policy section of the University of Manitoba *Undergraduate Calendar*. Note: These policies are also located in your *Distance and Online Education Student Handbook* or you may refer to Student Affairs at http://www.umanitoba.ca/student.

Distance and Online Education (DE) Student Resources

In your course website there are links for the following:

- Contacting Distance and Online Education Staff
- Distance and Online Student Handbook
- Distance and Online Education Website

Acknowledgments

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Bill Last was born in Illinois and immigrated to Canada shortly after receiving his B.Sc. degree in Geology from the University of Wisconsin in 1971. After four years as a petroleum exploration geologist with Shell Canada Ltd., he moved to Winnipeg where he completed his Ph.D. at The University of Manitoba. He worked as a research officer in the Tar Sands/Heavy Oil Division of the Alberta Geological Survey until 1980 when he joined the faculty at The University of Manitoba in the Department of Geological Sciences.

Professor Last's main research interests lie in the fields of sedimentology, environmental geology, and global change. With over 150 publications to his credit, he has maintained a long research involvement in environmental geoscience in North and South America, Australia, and Asia. His research efforts are currently directed mainly at geolimnology and paleolimnology in western and northern Canada, northern United States, South America, and Australia. He is editor-in-chief of the *Journal of Paleolimnology*, associate editor of *Sedimentary Geology, International Journal of Salt Lake Research, International Journal of Lakes and Rivers*, and *Environmental Reviews,* and past associate editor of the *Bulletin of Canadian Petroleum Geology* and *the Prairie Forum*. He has written or edited six books on paleolimnology and geolimnology, and is the Series Co-Editor of the book series *Developments in Paleoenvironmental Research*. He teaches undergraduate courses in environmental geology, Earth system science, petroleum geology, sedimentology, energy resources, and basin analysis. His graduate course offerings include advanced clastic sedimentology, petroleum geology and geochemistry, and evaporite sedimentology and geochemistry.

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