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Preface to the electronic version of this document

This electronic version of the course proposal lacks a few items contained in the hardcopy version which was submitted to the Assistant Provost's Office: (1) the Hazard City CD which was included as Appendix 2 and forms the basis of the semester-long project, and (2) screen captures taken from the Hazard City CD which form the basis of three homework exercises and comprise the bulk of Appendices 3-5.

INTRODUCTION

The course herein submitted for approval for the new general education curriculum, "Endangered Planet: An Introduction to Environmental Geology" (GLY 110), is a modification of an existing course taught by the Department of Earth and Environmental Sciences (EES) for several years. The course description for GLY 110 from the current 2009-2010 Bulletin is as follows:

> GLY 110 ENDANGERED PLANET: AN INTRODUCTION TO ENVIRONMENTAL GEOLOGY. (3)
> An introductory course that applies basic geological concepts to current environmental issues including the availability and use of water and soil resources, pollution causes, effects and solutions, and causes and prediction of environmental hazards including floods, landslides, subsidence, earthquakes and volcanoes.

GLY 110 is the department's most popular undergraduate course by far, and enrollments have been following an upward trend for at least the last decade (Fig. 1). Since 2005, the course has consistently attracted more than 800 students per year. This large annual enrollment is serviced in several lecture sections taught by 2-3 EES professors and/or lecturers. Large sections of 300 students are usually taught in the White Hall Classroom Building, mid-sized sections of 50-100 students are usually taught in Slone 303, and small sections of 15-20 students are usually taught in Slone 303 during the summer months. One TA has typically been assigned to support the work of the instructor in each section taught during the fall or spring.

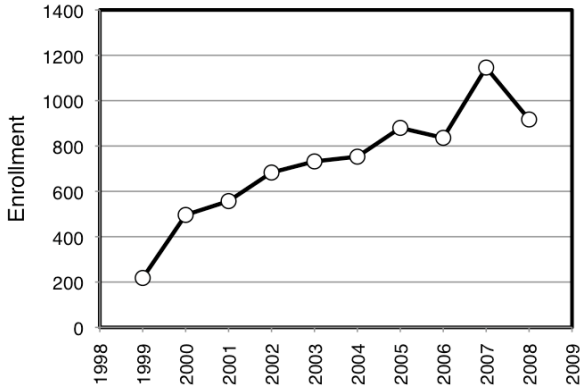

Figure 1.
Annual enrollment for GLY 110 from 1999-2008.

The educational techniques and products described in this packet form the basis of an interactive, lecture-based, non-lab course that is heavily supplemented by active-learning exercises (in class and out), a semester-long project divided into modular exercises, and required readings from sources outside the required textbook forming the basis of online discussions. Its purpose within the new general education curriculum is to satisfy 3 credits within the "Intellectual Inquiry" area within the Natural/Physical/Mathematical Sciences.

MODIFIED COURSE

Syllabus

A detailed syllabus for the modified GLY 110, designed to be taught as a pilot course during the Fall semester of 2010, is included in Appendix 1 of this packet. This document contains a detailed description of course policies, a grading scale, and a schedule of all lectures, assignments, and other activities related to the course.

Supporting materials

As listed on the attached syllabus, the supporting materials for this course include the following:

Textbook
Keller, E.A., 2008, Introduction to environmental geology, 4th edition: Upper Saddle River, NJ, Pearson Prentice Hall, 661 p. This textbook finds widespread use in similar courses taught at other institutions throughout the country.

Student website
A student website supplementing the 3rd edition of the textbook is found at http://www.prenhall.com/keller and contains chapter objectives, self-tests, images, links to web resources, regional updates, news articles, and other features.

Hazard City CD
"Hazard City: Exercises in Applied Geology" is a CD packaged with the textbook containing a variety of student exercises which will form the basis of the semester-project for this course. The publishers of this CD have informed me that it is their aim to provide these exercises on the Internet within the next 1-2 years or so. This new format will allow the exercises to be automatically graded and the results sent to the instructor directly upon submission by students.

The Hazard City project is described in more detail in the "Implementation of Learning Outcomes" part of this report, and supporting materials are included in Appendices 2-6.

Blackboard course page
The course page for GLY 110 on the university's Blackboard website will contain the following resources: a copy of the syllabus, lecture PowerPoints (uploaded <1 day after each class), project assignments, study sheets, an online grade book, and discussion forums for the assigned readings. With the new version of Blackboard, students are able to access their current grade in the course at any time in the semester. The instructor and TA's will also use the Blackboard page to communicate important announcements to the class, monitor online discussions, and to email individual students.

Readings and online discussion forums
Six readings from non-technical media (newspapers, magazines, websites, etc.) that deal with timely environmental issues related to geology will form the basis for online discussion forums

scheduled throughout the semester (see syllabus). These readings will probably change from semester to semester, but representative articles are: Jewell (1994), Hodges (1995), Munton (1998), Piasecki (1998), Schildgen (1999), Schmandt (2003), Chowdhury and Mushtaque (2004), Deutch and Moniz (2006), Hawkins et al. (2006), Kamen (2006), Socolow and Pacala (2006), Collins et al. (2007), Wolf (2007), Best (2008), Royte (2008), and Little (2009). For each reading, students will be divided into 25-student discussion forums by the letter of their last name. Students will be given specific instructions regarding the protocol for posting and replying to threads (Appendix 10). The quality of their online discussion forum will be based on a rubric modified from Gilbert and Dabbagh (2005) and graded by a TA who may enter the discussion.

Class size and TA support

In its proposal to the University Senate, the General Education Steering Committee made it clear that the infusion of resources for this initiative "address issues of instructional technology, course design, and effective pedagogy in *courses with small or large enrollments*" (General Education Reform Steering Committee, 2008). The important test provided by the GLY 110 pilot course is whether these reforms can, in fact, be achieved for courses with a large enrollment. I believe that the use of digital supporting materials used in GLY 110 (e.g., the Hazard City project and the Blackboard online discussion forums), supplemented by adequate TA support, permit its being taught in a large-lecture setting without sacrificing an active-learning pedagogy. Hence, I proposed to teach the pilot course during the Fall 2010 semester for 100 students in Slone 303, the largest room in the EES Department that has moveable tables and chairs.

Two graduate teaching assistants will be necessary to grade the frequent assignments and to monitor the progress of multiple online discussion sections. I break down the TA work hours per activity and over the course of the semester in the table below. This table assumes that 100 students attend the class, and that each student submits three regular exams, a final exam, nine

Task	**TA minutes / activity/ student**	**TA hours / activity/ class**	**Similar tasks / semester**	**Total TA hrs / class**
Attend classes, proctor exams, and help with in-class exercises	-	1	45	45
Enter exam grades from scantrons into Blackboard gradebook	1	2	4	8
Grade HW's #1-9 and enter results in Bb	5	8	9	72
Grade HW #10 and enter results in Bb	30	13	1	13
Read articles for online discussions	1	-	6	6
Grade online discussions and enter results in Bb	10	17	6	102
Attend TA meetings	-	1	10	10
			Total hours =	256

regular homework assignments (which are easily graded), one longer homework assignment (HW #10, done in collaboration with three other students), and participates in six online discussions.

Assuming a normal TA load of 20 hours/week at 15 weeks/semester (300 hours/semester), and my likely underestimate of the actual TA hours required for this class, my estimate is that a full TA line is required to support the course.

Lesson plans: learning objectives, content, and student activities

The following information is listed for each of the six main topical divisions of this course: (1) selected student learning objectives, (2) an outline of specific content covered in class lectures and discussions, and (3) student activities and assignments related to those specific topics. Each learning outcome is tagged with the highest level within Bloom's taxonomy of learning domains necessary to satisfy the outcome: knowledge, comprehension, application, analysis, synthesis, and evaluation (Bloom, 1956).

Part 1: Foundations

Selected student learning objectives

- learn the names of 3 other students sitting near them in the classroom (knowledge)
- distinguish environmental geology from other branches of geoscience (comprehension)
- distinguish modern natural science from classical *scientia*, non-science, and pseudoscience (comprehension)
- practice formulating testable, multiple-working hypotheses (application)

Lecture outlines

1. Course introduction
    a. personal introductions
    b. syllabus walk-through
    c. what is environmental geology?
    d. why do environmental science? - the stewardship ethic

2. What is science?
    a. historical origins of science
    b. limits of science
    c. philosophical assumptions of science
    d. the scientific method
    e. problems with the simplified scientific method

In-class activities

- *Scientific method demonstration* – this activity, modified from Powner (2006), illustrates scientific methodology by asking groups of 5-6 students to identify small, oddly shaped objects concealed in fabric drawstring bags, first without the aid of direct touch, and then as thoroughly as possible by handling and manipulating the bag to collect data on their object. This activity also illustrates the value of parsimony and falsifiability in constructing good hypotheses and theories.

Out-of-class activities

- *Identification cards (HW #1)* – Students must bring in an identification card, with a picture, before the third week of class (see syllabus for details). I use these cards to learn names and faces.

Part 2: Geology Basics

Selected student learning objectives

- define and distinguish minerals and rocks (knowledge and comprehension)
- discriminate among the three common asbestiform minerals on the basis of their abundance and relative risk to human health (analysis), and evaluate the risk that harmful types of asbestos pose in various occupational and non-various occupational settings (evaluation)
- describe the origins of various types of geologic materials and how they are useful and necessary for modern society (knowledge)
- construct simple cross-sectional diagrams of the three types of plate boundaries (analysis)

Lecture outlines

1. Minerals
    a. what is a mineral?
    b. processes of mineral formation
    c. silicates
        i. importance
        ii. structures
        iii. important examples and relationships to human society
    d. non-silicates
        i. important examples and relationships to human society
    e. minerals and human health
        i. the asbestos controversy

2. Rocks
    a. what is a rock?
    b. igneous rocks and processes
    c. sedimentary rocks and processes
    d. metamorphic rocks and processes
    e. the rock cycle

3. Earth structure
    a. how do we know about the interior of the Earth?
    b. main compositional layers within the Earth
        i. core
        ii. mantle
        iii. crust

4. Plate tectonics
    a. lithospheric plates
    b. plate boundaries
        i. divergent
        ii. convergent
        iii. transform
    c. seafloor spreading

Part 3: Natural Hazards

Selected student learning objectives

- distinguish various types of volcanoes on the basis of their morphology, eruption behavior (explosive vs. effusive), volcanic products (lava flows vs. pyroclastics), and the hazards they pose to human society (comprehension)
- use river profiles to predict whether various natural and man-made changes to a watershed will result in down-cutting (erosion) or deposition of sediment within a river (application, analysis, and evaluation)
- calculate flood recurrence intervals for a real stream or river given discharge data obtained from the USGS National Water Information System (application)
- distinguish the causes, behavior, and hazards to humans posed by floods in the upper and lower parts of river systems (comprehension)
- quantify the risk to human society from an asteroid impact (application)
- assess the relative risk of different locations to landslides based on slope angle and soil characteristics (evaluation)

Lecture outlines

1. Earthquakes
    a. earthquakes, faults, and plate tectonics
    b. seismic waves

c. detection and measurement of earthquakes
d. case study: the New Madrid Earthquake Zone (30-minute video)
e. seismic hazards
f. prediction of earthquakes

2. Volcanoes
   a. magma composition and eruptive behavior
   b. volcanic materials
   c. types of volcanoes
   d. volcanic hazards (30-minute video)
   e. volcanoes and plate tectonics

3. Rivers
   a. importance of rivers to society
   b. river systems
   c. river discharge
   d. changes along river systems
   e. channel patterns of river systems

4. Floods
   a. flood hazards and costs
   b. causes of flooding
   c. flash floods
   d. floodplain floods
   e. flood prediction
   f. flood prevention

5. Coastal processes
   a. video: "The Beaches are Moving"
   b. tsunamis and mega-tsunamis

6. Mass wasting
   a. video: "mass wasting"
   b. mechanisms of slope failure
   c. notable historic landslides

7. Meteorite impacts
   a. extraterrestrial objects
   b. impact craters
   c. impacts and mass extinctions
   d. current risk

In-class activities

- *Flood recurrence exercise* – using 10 years of historical peak discharge data from a location on Rapid Creek (South Dakota), students calculate the discharge of a "50-

year" flood, and compare this value with the discharge measured for the devastating flood on the same river in 1973. This exercise emphasizes the inherent problem of limited data when predicting large-discharge events on streams and rivers.

Out-of-class activities

- *Earthquake damage assessment (HW #2, Appendix 2)* - Students explore the effects of earthquakes on buildings and determine the number of people needing emergency housing given an earthquake of specific intensity.
- *Volcanic hazard assessment (HW #3, Appendix 3)* - Researching volcanic hazards, collecting field information, and decision-making are used to determine the potential impact of a volcanic eruption.
- *Flood insurance rate maps exercise (HW #4, Appendix 4)* - Flood insurance premiums are estimated using a flood insurance rate map, insurance tables, and site characteristics.
- *Landslide hazard assessment (HW #5)* - Students research the factors that determine landslide hazard at five construction sites and make recommendations for development.
- *Tsunami/storm surge assessment (HW #6)* - Helps students understand the impact of a tsunami or storm surge and how to conduct a risk assessment.

Part 4: Non-Energy Resources

Selected student learning objectives

- given a map of water table topography, predict the direction of a plume of contaminated groundwater emanating from a known point source; or conversely, predict the location of a chemical spill given an array of sampling wells and a map of water table topography (comprehension)
- given an administrative code of regulations concerning the disposal of municipal solid waste and a geographic information system containing surface topography, bedrock formations, active faults, wetlands, flood-prone areas, and areas of past and present mining activity, recommend the best site for a solid waste landfill in a geologically-diverse region (synthesis and evaluation)
- distinguish the terms "resources" and "reserves" (comprehension)
- list and describe various environmental problems stemming from the extraction and use of mineral resources, including metallic ores (comprehension)

Lecture outlines

1. Water resources
    a. freshwater reservoirs on Earth
    b. trends in water use
    c. groundwater

i. aquifers
ii. the water table
iii. wells
iv. in-class exercise
v. groundwater usage problems
vi. erosion by groundwater: caves and karst

2. Water pollution
   a. overview
   b. water pollutants
   c. cleanup and treatment

3. Mineral resources
   a. importance for society
   b. resources vs. reserves
   c. types of mineral resources
   d. geology of mineral deposits
   e. environmental impacts of mining (video)
   f. recent improvements

4. Soils
   a. soil formation
   b. soil horizons
   c. expansive soils
   d. soil erosion: problem spots, rates, and prevention

5. Solid waste disposal
   a. how much is there?
   b. what's in it?
   c. what can we do with it?
   d. how can a knowledge of geology help?

In-class activities

- *In-class groundwater contamination exercise* - as practice for a similar digital exercise (HW#7), students are given a map of an area in which a contaminated water well has been found. Using their knowledge that groundwater flows perpendicular to the hydraulic gradient, the students use water table elevations to predict where the contaminant was introduced into the groundwater.

Out-of-class activities

- *Groundwater contamination exercise (HW #7)* - Students use field and laboratory data to prepare a contour map of the water table, determine the direction of ground water flow, and map a contaminated area.
- *Landfill siting exercise (HW#8)* - Students use maps and geological data to determine

if any of five proposed sites meet the requirements of the State Administrative Code for a landfill site.

Part 5: Energy Resources

Selected student learning objectives

- list and describe benefits and problems associated with the use of various energy sources (coal, oil/gas, nuclear energy, geothermal energy, solar energy, hydropower, wind, and biomass) (knowledge)
- given information on the depth, thickness, and lateral extent of coal underlying a property, appraise an appropriate royalty rate for leasing the property for mining and compare this value with an offer submitted by a coal company (evaluation)
- quantify and evaluate the long-term risks to the Yucca Mountain Nuclear Repository posed by earthquakes and volcanic eruptions in the region (evaluation)

Lecture outlines

1. Fossil fuels
    a. coal
        i. energy use in the U.S.
        ii. use and importance of coal
        iii. origin and geology of coal
        iv. distribtution and reserves
        v. problems and environmental impacts
        vi. “clean coal” technologies
    b. oil and gas
        i. video: “Crude: The Story of Oil”
        ii. hydrocarbon traps
        iii. distribution and reserves
        iv. new developments in the oil/gas industry
        v. problems and environmental impacts
        vi. how long will oil last? the “peak oil” debate

2. Non-renewable alternative energy
    a. economics of alternative energy sources
    b. nuclear energy
        i. use and economics
        ii. isotopes and radioactivity
        iii. nuclear fission
        iv. geology of uranium deposits
        v. nuclear reactors
        vi. disposal of nuclear wastes

c. geothermal energy
    i. hydrothermal systems
    ii. systems for power generation
    iii. systems for heat exchange

3. Renewable alternative energy
    a. hydropower
        i. use
        ii. benefits
        iii. problems
    b. solar energy
        i. photovoltaic cells
        ii. solar collectors
        iii. benefits
        iv. problems
        v. use
    c. wind energy
        i. geologic controls and distribution
        ii. benefits
        iii. problems
    d. energy from biomass
        i. types
        ii. problems

Out-of-class activities

- *Coal property exercise (HW #9)* - The potential economic value of a property is estimated by learning about coal mining methods and property evaluation. Given information on the depth, thickness, and lateral extent of coal underlying a property, students appraise an appropriate royalty rate for leasing the property for mining and compare this value with an offer submitted by a coal company.

Part 5: Global climate change

Selected student learning outcomes

- apply geologic techniques for analyzing climate history and understand how geologists define climate change (application)
- give examples of arguments for and against human-induced climate change during the last century (comprehension)
- given paleo-climate records of temperature and atmospheric CO_2, evaluate the strength of the evidence for human-induced climate change during the last century (evaluation)

Lecture outlines

1. Global climate change
   a. video: "NOVA: What's Up With the Weather?"
   b. variables affecting long-term climate change
      i. plate tectonics
      ii. orbital variations (Milankovitch cycles)
   c. variables affecting short-term climate change
      i. solar variations
      ii. volcanic eruptions
      iii. anthropogenic factors

Out-of-class activities

- *Final report to the Hazard City Council (HW #10, included as Appendix 5)* – "Environmental consulting firms" composed of 4 students prepare 3-page reports to the Hazard County Council, summarizing results of investigations carried out throughout the semester. The centerpiece of this report will be a series of geologic hazard maps, in which the level of risk is qualitatively and/or quantitatively evaluated for various sectors of the city. Students will also determine which geologic hazard(s) is/are the most dangerous, which is/are the most frequent, and which is/are the most amendable to mitigation. Included within this report will be recommendations for how the residents of Hazard City can best use their limited resources to mitigate high-risk areas and plan for future growth. Recommendations will be discussed with the recognition that diversity of opinions on political, economic, and social values exists within the community (e.g., individual freedom versus government control). This assignment does not appear on the Hazard City CD, but is meant to be an open-ended writing assignment in which the students work together to synthesize what they have learned throughout the semester, making connections involving the intersection of geology with human society.

Assessment

The modified GLY 110 course will take a two-pronged approach to assessing student learning and attainment of course goals. First, methods of *formative assessment* will be used frequently during class lectures in the form of short (3-5 minutes) exercises or problems that the students will work on collaboratively in small groups. Such formative assessment methods are useful for identifying and correcting misconceptions immediately after learning, promote active learning in class, and provide a way for instructors to receive and respond to student feedback (McConnell et al., 2003). I anticipate using a variety of formative assessment methods, including conceptests, Venn diagrams, image analysis, and open-ended questions in my class:

Conceptests. Used widely in physics courses and successfully adapted to other disciplines (Mazur, 1997; Crouch and Mazur, 2001), conceptests are short conceptual multiple-choice questions generally corresponding to the comprehension level of Bloom's taxonomy (McConnell

et al., 2003). Conceptests may be employed in this manner: after being given 30-60 seconds to think about the question, students record their answer, perhaps with an electronic clicker. Then students would be allowed to discuss their answers with a peer, and answers would be tallied again. The instructor would use the results to determine the level of comprehension for some topic for the entire class.

Venn diagrams. Venn diagrams employ graphical methods to compare and contrast related entities or phenomena. For example, after presenting the characteristics of stratovolcanoes and shield volcanoes, students may be asked to draw a Venn diagram illustrating their similarities and differences (McConnell et al., 2003).

Image analysis. In image analysis, students are shown a photograph, map, or diagram and asked to identify features or make interpretations (Reynolds and Peacock, 1998). Image analysis complements the visual nature of geology and typically requires cognitive activity on the knowledge, comprehension, and analyis levels (McConnell et al., 2003).

Open-ended questions. During the course of lecturing, I occasionally ask divergent or open-ended questions that do not necessarily have a correct answer. For example, after presenting different viewpoints by oil industry experts on the subject of the Peak Oil problem, I will ask students what they would do and where they would go for information to form their own opinion on the matter. An alternative to eliciting student responses for class discussions (which I have found to be difficult), is to assign an open-ended question as a one-minute paper writing assignment. Answers to open-ended questions may involve almost all levels within Bloom's taxonomy.

The second part of my assessment strategy is to schedule *summative assessments* (assignments and exams) at various times throughout the semester. As explained in the syllabus, half of the course grade from GLY 110 is based on active-learning and inquiry-based exercises, including the Hazard City project (30%) and the online discussions of the assigned readings (20%), which use higher-order cognitive skills (application, analysis, synthesis, and evaluation). The other half of the course grade is based on exams testing mastery of knowledge and skills learned during class. Because of the proposed large class size for this course (100 students), multiple-choice will be the format used in the exams (Exam 1 is given in Appendix 9). While the majority of the questions on these exams will test learning on the knowledge and comprehension levels, at least 10% of the multiple-choice questions will require use of higher-order cognitive skills (application and analysis; Fuhrman, 1996). I include a few examples of these types of multiple-choice questions include the following:

1. Which statement below is a testable scientific hypothesis?
    a. "The universe was created by God"
    b. "The extinction of the dinosaurs was caused by an asteroid impact"
    c. "Degrading the environment is wrong"
    d. "Because biological evolution is random, there is no purpose or meaning to life"
    e. all of the above statements are testable scientific hypotheses

The correct answer is "b". This question requires the student to apply the definition of a scientific hypothesis to a number of specific cases, and to determine which, if any, meets that

definition.

2. For which of the examples below would a knowledge of geology NOT be very useful?
    a. Farmer Fred wants to know how deep to drill for water under his property
    b. Harriet Homeowner wants to know if her house is at risk from landslides or floods
    c. Investor Ike wants to know whether to financially support the oil well that his brother-in-law is drilling in his back yard
    d. all of the above (i.e., geology IS NOT useful for any of the above cases)
    e. none of the above (i.e., geology IS useful for all of the above cases)

The correct answer is "e". This question requires the student to apply their knowledge about the topics included within environmental geology to specific situations encountered by people within modern society, and to determine which, if any, of the situations may benefit from knowledge provided by geologists.

3. A stream has a discharge of 100 m^3/s and a velocity of 10 m/s. What is the cross-sectional area of the stream?
    a. 1000 m^2
    b. 100 m^2
    c. 10 m^2
    d. 0.1 m^2

The correct answer is "c". This question requires the student to apply their knowledge of the continuity equation (discharge = velocity × area) to solve a problem concerning fluid flow in rivers.

4. You own a piece of beachfront property in North Carolina. You decide to protect your property from coastal erosion by installing a groin. The longshore current moves from northeast to southwest along the shoreline in this part of Georgia. Which of your neighbors is probably going to suffer MORE erosion on their property as a direct result of your decision to install the groin?
    a. Hank, your neighbor to the northeast
    b. Harriett, your neighbor to the southwest

The correct answer is "b". This question requires the student to apply their knowledge of how sand moves in the long shore current to the practical situation of protecting seafront property from coastal erosion.

IMPLEMENTATION OF LEARNING OUTCOMES

In this section, I explain how the six learning outcomes (LO's) required by the new general education requirements for inquiry in the natural sciences are met by this course. In addition to these six learning outcomes, goals of information literacy and human diversity achieved in the course are also discussed.

LO 1. Describe methods of inquiry that lead to scientific knowledge and distinguish scientific fact from pseudoscience.

The origins, structure, and practical operation of the scientific method are introduced and discussed for the entirety of the second day of the course. Previous versions of this course taught by myself introduced these concepts early in the course by way of a 50-minute lecture that focused on the historical origin, definition, limits, philosophical assumptions, and methodologies of natural science. This lecture was followed by a 15-minute collaborative exercise in which the students, working in small groups, were asked to formulate multiple-working hypotheses for the formation of Yosemite Valley in California. The revised course will substitute the Yosemite Valley example for a 10-minute in-class exercise in formulating hypotheses just after introducing the scientific method. This activity, modified from Powner (2006), illustrates scientific methodology by asking groups of 5-6 students to identify small, oddly shaped objects concealed in fabric drawstring bags, first without the aid of direct touch, and then as thoroughly as possible by handling and manipulating the bag to collect data on their object. This activity also illustrates the value of parsimony and falsifiability in constructing good hypotheses and theories.

The difference between science and non-science will be covered a few times during the course. During the "What is Science" lecture, students will be shown quotes from various scientists and asked to comment whether what was said was "scientific". For example, I use the following quote by Rachel Carson to illustrate the fact that scientists are flesh-and-blood humans who may speak "unscientifically" by making ethical or moral judgments:

> "The most alarming of all man's assaults upon the environment is the contamination of air, earth, rivers, and sea with dangerous and even lethal materials. This pollution is for the most part irrecoverable; the chain of evil it initiates not only in the world that must support life but in living tissues is for the most part irreversible. In this now universal contamination of the environment, chemicals are the sinister and little-recognized partners of radiation in changing the very nature of the world—the very nature of its life (Carson, 1962)."

The important difference between science and pseudoscience is brought up during the lecture on earthquakes in which I briefly describe the case of Iben Browning's fallacious prediction in 1990 of a magnitude 6.5 earthquake in the New Madrid region of Missouri.

LO 2. Explain fundamental principles in a branch of science.

Fundamental principles underlying the theory and practice of geological and environmental science are emphasized in the second and third parts of the course: "Fundamentals" and "Geology Basics". Some of the fundamental principles and concepts covered during these and latter parts of the course are the following:

- *the stewardship ethic* – this fundamental ethical principle motivates many working in the environmental sciences to share the responsibility to care for the Earth's natural resources, both for themselves and future generations.
- *the earth as a system* – viewed in this manner, the Earth is seen as a complex system

composed of multi-component parts (water, land, atmosphere, and life); these parts mutually adjust to function as a whole, with changes in one component bringing changes in other components (Keller, 2008).

- *environmental unity* – "The principle of environmental unity, which states that one action causes other in a chain of actions, is an important principle in the prediction of changes in the Earth system. For example, if we constructed a dam on a river, a number of changes would occur. Sediment that moved down the river to the ocean before construction of the dam would be trapped in the reservoir. Consequently, beaches would be deprived of sediment from the river, and the result of that deprivation may be increased coastal erosion. There being less sediment on the beach may also affect coastal animals such as sand crabs and clams that use the sand. …The dam would also change the hydrology of the river and would block fish from migrating upstream (Keller, 2008).
- *sustainability* – this important concept in environmental science takes a long-term view of Earth resources: a sustainable practice of resource use ensures future generations equal access to the resources the planet offers (Keller, 2008).
- *uniformitarianism* – often summarized by the phrase "the present is the key to the past", this fundamental assumption of historical science allows the study of past events using observations made in the present.
- *the rock cycle* – this fundamental principle (Figure 2) organizes the geologic materials and processes which operate on Earth and other planets to produce igneous, metamorphic, and sedimentary rocks.

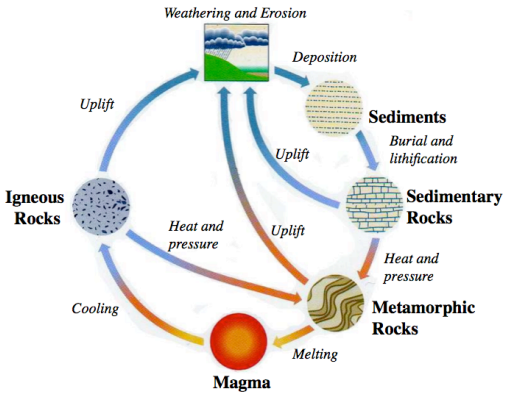

Figure 2. The rock cycle.

- *plate tectonics* – this fundamental concept of geology brings into a single unifying theory many diverse phenomena previously thought to be unrelated. Based on the principle that the Earth's lithosphere is broken into plates that are in relative motion, it explains how most of the Earth's volcanic and seismic activity originates and why it occurs where it does.
- *the continuity equation* (discharge = area × velocity) – this fundamental relation explains the inverse relationship between velocity and cross-sectional area for fluids flowing through a confined channel. In GLY 110, this equation is introduced during the lecture on streams, and is later applied to the flow of groundwater in underground aquifers and to the siting of wind power in areas of constricted flow (ridge tops and mountain passes).
- *geohazards as natural processes* – a fundamental theme running through the "Natural Hazards" part of the course is the idea that flooding, earthquakes, landslides, and other geohazards are not random, unexplained disasters, but are natural processes which are expected to occur on a life-sustaining planet with active plate tectonics and a water-rich atmosphere. Understanding where and under what conditions these hazards normally occur is important to avoid their negative consequences.

- *resource distribution as controlled by natural processes* – a fundamental theme running through the parts of the course dealing with natural resources is the idea that industrial minerals, coal, and oil do not occur randomly throughout the Earth's crust, but are controlled by geologic processes operating in specific geologic environments during specific periods of geologic history.
- *timescales of Earth processes* - the principle that Earth processes, including formation of natural resources and climate change, occur over specific timescales is crucial to understanding their role and impacts in human civilization. For example, when studying global climate change it is important to distinguish between "weather" (short-term changes in climate) and various scales of longer-term climate change (e.g., El Nino Southern Oscillations, astronomic Milankovitch cycles controlled by changes in the Earth's orbit and rotational axis, and changes controlled by the position of the Earth's continental landmasses and rates of plate motion).

LO 3. Apply fundamental principles to interpret and make predictions in a branch of science.

With my Socratic question and answer style of lecturing, I routinely ask the students in class to use their knowledge to interpret diagrams or photos, and to predict the result of some action that occurs in the environment. This is typically done at least once every class period in a "think-pair-share" format in which small groups of students work together to solve the problem at hand, after which I rove about the classroom getting their feedback. For example, after the students are taught about long-shore drift in coastal environments (the process that moves sand along the length of a beach), I show them a picture of a groin or jetty installed on a beach and ask them to predict which side of the structure will trap sand and which side will experience erosion. In the in-class groundwater contamination exercise, students use their knowledge of groundwater flow to predict the direction of a contaminant plume. During the lecture on streams and rivers, I ask the students to predict the future changes that occur along river profiles initiated by changes in land use (forest to agriculture, or agriculture back to forest), tectonic activity (faulting), and dam construction.

Making predictions concerning the likely severity and impact of geohazards is the central purpose of the Hazard City exercises. Students are asked to predict the timing of flooding events on a floodplain, the locations of areas likely impacted by volcanic activity, landslides, and tsunamis, and the relative mobility of contaminants within municipal landfills sited in different areas.

Making predictive interpretations from geologic data plays an important role in studying the Earth's resources. For example, students in GLY 110 apply fundamental geologic principles of hydrocarbon formation and fluid flow to predict where oil and gas deposits might exist within the Earth's crust. Principles of fluid flow are applied to predict the fate of contaminants within nuclear waste disposal sites, as well as what types of rock formations are potentially suitable for the sequestration of carbon dioxide produced from fossil fuels.

LO 4. Demonstrate an understanding of at least one scientific discovery that changed the way scientists understand the world.

Plate tectonics, the idea that the Earth's lithosphere is broken into about a dozen major pieces whose relative motions are powered by heat flow within the Earth's interior, has brought fundamental changes to the way geologists see the world since the theory was developed during the mid-20th century. Plate tectonics has profound relevance to environmental geology since many geologic hazards (earthquakes, volcanoes, tsunamis, etc.) are closely linked to processes occurring at plate boundaries. Plate tectonics is also of great importance in the study of Earth resources: geologic processes at zones of convergent plate motion (subduction zones) are responsible for generating a variety of economically-important mineral deposits, and tectonic processes (continental rifting, continental collision, etc.) are responsible for the formation of much of the Earth's major fossil fuel deposits.

Because of its central importance as a unifying theory in the earth sciences, the theory of plate tectonics and geologic processes associated with plate boundaries are highlighted throughout this course. During the introductory "Geology Basics" part of the course, an entire class period will be devoted to summarize the geologic evidence for plate tectonics, as well as how this evidence was assembled from diverse studies of rock magnetism, fossil distributions, and geophysical explorations of the Earth's seafloor during the mid-20th century. During these lectures, students will appreciate how the discovery of plate tectonics elegantly explained a variety of geologic data and changed our perception of Planet Earth as a much more dynamic system.

LO 5. Give examples of how science interacts with society.

A popular website defines environmental geology as "the branch of geology that deals with the ways in which geology affects people" (Answers.com, 2009). Environmental geology applies the principles of geological science to examine the effect of geohazards such as earthquakes, volcanic eruptions, landslides, and tsunamis, upon human civilization. Conversely, this branch of geoscience also examines the degree to which human society is dependent upon geology and the natural environment for its well-being and very survival, and studies the host of problems created by man's occupancy and exploitation of the physical environment. This two-way interaction between man and the environment forms the basis of the three-fold structure of GLY 110: (1) an introduction to the fundamental principles of geological science, (2) the application of these principles to geohazards, and (3) the application of geological principles to the use and abuse of earth resources.

As listed by the Answers.com website, examples of the interaction between environmental geology and society (all of which are covered within GLY 110) include "(1) the ways that fertile soils develop from rocks and how these soils can become polluted by human activities; (2) how rocks and soils move down-slope to destroy roads, houses, and other human constructions; (3) sources of surface and subsurface water supplies and how they become polluted; (4) why floods occur where they do and how human activities affect floods; (5) locations of earthquakes and volcanic eruptions and the dangers they pose; (6) location of mineral resources such as copper, oil and gas, and uranium, and how mining these resources can pollute the environment; (7) how

human activities can pollute the atmosphere and cause global warming, sea-level rise, and ozone depletion" (Answers.com, 2009).

LO 6. Conduct a hands-on project using scientific methods to include design, data collection, analysis, summary of the results, conclusions, alternative approaches, and future studies.

The project for this course is a complete geologic hazards and resources assessment of the fictional town of "Hazard City" featured in the CD that accompanies the textbook. This project is completed during the course of the semester in the form of nine self-contained assignments, each of which deals in detail with a separate geologic issue, and culminates with a three-page written report to the Hazard City Council prepared by "consulting firms" of four student geologists. Each team will summarizes the findings from the detailed assessments, c create geologic hazard maps, qualitatively and quantitatively evaluate the level of risk for various sectors of the city and its surrounding regions, rank the various geohazards according to intensity and frequency, and issue recommendations for how Hazard city can best use its limited resources to mitigate high-risk areas and plan for the future.

These assignments place students in the role of practicing geologists who gather and analyze data, deal with uncertainty, evaluate risk, and make assessments and recommendations. While the exercises are based on fictional information, they are designed to engage students in active problem solving related to practical, real-world issues which impact human society, many of which are relevant to Kentucky and the southeastern United States. The worksheets produced by the students for the nine geologic assessments are easy to grade, and the exercises will serve as the basis for class discussion during the semester. While requiring more time and effort to grade, the final written report offers the students a chance to work together in groups, improve writing skills, and synthesize knowledge obtained throughout the semester.

The exercises used in this class are listed below in the order in which they occur during the course. A copy of the CD is enclosed as Appendix 2. The instructions, CD screen-captures, and student worksheets for three of the exercises are printed out and included as Appendices 3-5 in this course packet.

Part 1 - Earthquake damage assessment (HW #2, Appendix 3)
Students explore the effects of earthquakes on buildings and determine the number of people needing emergency housing given an earthquake of specific intensity.

Part 2 - Volcanic hazard assessment (HW #3, Appendix 4)
Researching volcanic hazards, collecting field information, and decision-making are used to determine the potential impact of a volcanic eruption.

Part 3 - Flood insurance rate maps (HW #4, Appendix 5)
Flood insurance premiums are estimated using a flood insurance rate map, insurance tables, and site characteristics.

Part 4 - Landslide hazard assessment (HW #5)
Students research the factors that determine landslide hazard at five construction sites and make recommendations for development.

Part 5 – Tsunami/Storm Surge assessment (HW #6)
Helps students understand the impact of a tsunami or storm surge and how to conduct a risk assessment.

Part 6 - Ground water contamination exercise (HW #7)
Students use field and laboratory data to prepare a contour map of the water table, determine the direction of ground water flow, and map a contaminated area.

Part 7 – Landfill siting exercise (HW#8)
Students use maps and geological data to determine if any of five proposed sites meet the requirements of the State Administrative Code for a landfill site.

Part 8 - Coal property evaluation (HW #9)
The potential economic value of a property is estimated by learning about coal mining methods and property evaluation. Given information on the depth, thickness, and lateral extent of coal underlying a property, students appraise an appropriate royalty rate for leasing the property for mining and compare this value with an offer submitted by a coal company.

Part 9 – Final report to the Hazard City Council (HW #10, Appendix 5)
"Environmental consulting firms" composed of four students prepare three-page reports to the Hazard County Council, summarizing results of investigations carried out throughout the semester. The centerpiece of this report will be a combined geologic hazard map, in which the level of risk is qualitatively and/or quantitatively evaluated for various sectors of the city. Students will also determine which geologic hazard(s) is/are the most dangerous, which is/are the most frequent, and which is/are the most amendable to mitigation. Included within this report will be recommendations for how the residents of Hazard City can best use their limited resources to mitigate high-risk areas and plan for future growth. Recommendations will be discussed with the recognition that diversity of political, economic, and social values exists within the community (e.g., individual freedom versus government control). This assignment does not appear on the Hazard City CD, but is meant to be an open-ended writing assignment in which the students work together to synthesize what they have learned throughout the semester, making connections involving the intersection of geology with human society.

LO 7. Recognize when information is needed and demonstrate the ability to find, evaluate and use effectively sources of scientific information.

This learning outcome is accomplished in every one of the nine Hazard City exercises described above. In these exercises, students are asked to obtain the data they need from the CD files to solve a particular problem. This is usually not a simple “plug-and-crank” operation, but rather the students are often required to dig for the information they need within documents that closely approximate those encountered in real life (e.g., a complicated geologic information system, a

lengthy list of municipal regulations, and a flood insurance rate map), and then to evaluate its usefulness and applicability to the problem at hand.

Other sources of scientific information used in this class include the textbook and the six required readings.

Additional learning outcomes

Relevance to students' potential fields of specialization

One of the stated aims of general education reform at UK is that the new courses will have relevance both to the students' potential fields of specialization and to the real-world problems and decisions that students will confront as educated citizens of the twenty-first century (General Education Reform Steering Committee, 2008). This course contributes toward achieving this goal by exposing students to critical issues surrounding the environment and our use of resource and energy use that are increasingly finding their way into the headlines. The environmental sustainability of fossil fuel use, nuclear waste disposal, global water supplies, and global climate change are all topics covered by this course which confront educated citizens of the twenty-first century. Finally, environmental geology connects with other fields (economics, political science, business, law, sociology, environmental science, biology, physics, philosophy, etc.) that are the major fields of study for many of our students.

Information literacy

One of my goals for students taking GLY 110 is for them to become informed citizens on a variety of issues related to geology and the environment. This aim necessarily requires students to comprehend and use scientific information from a variety of sources. Examples where this goal is achieved in GLY 110 include:

- *Flood insurance rate maps exercise (HW #3)* – a realistic flood insurance rate map (FIRM), similar to those available from the Federal Emergency Management Agency (FEMA, 2009), is provided to the students in this exercise. The exercise provides a tutorial for reading and interpreting a FIRM, explaining relevant symbols and terminology (e.g., "100-year floodplain").
- *Required readings* – a number of readings from popular media sources (*Scientific American*, newspaper articles, etc.) will be used to broaden the course material and incorporate current issues within the course. Articles with a strong point of view, and perhaps controversial conclusions, will be included within this list so as to encourage critical evaluation on the part of the students.

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Human diversity

While not a central focus of this course, links between environmental geology and human diversity are made at several points in the lectures during the semester:

- *Supervolcanic eruptions and the origin of human genetic diversity* – During the lecture on volcanic hazards, mention will be made of an intriguing and controversial theory published in 1998 linking the genetic divergence within the human population to a severe period of "volcanic winter" 71,000 years ago brought on by the eruption of the Mount Toba in Sumatra (Ambrose, 1998). According to this theory, much of the genetic diversity within the human population is due to a "bottleneck" during which only 15,000 to 45,000 individuals survived.
- *Diversity and geohazards* – An understanding of geological processes and the specific locations affected by them results in the conclusion that socioeconomic status correlates, to some degree and in interesting ways, to the risk from geologic hazards. For example, natural hazards such as floods, volcanic eruptions, hurricanes, and storm surges, and even some seismic hazards preferentially effect low-lying areas, many of which house members of lower socioeconomic classes having few resources of their own to mitigate these hazards. This relationship was illustrated by the pattern of devastation brought on by Hurricane Katrina in 2005. In other areas of high risk, such as expensive beachfront properties, negative consequences preferentially affect members of higher social class.
- *Diversity and resource use* – Consumption of resources, particularly energy, directly correlates to socioeconomic status, with more developed nations enjoying higher standards of living and lower rates of mortality and disease. The Earth's resources are not distributed equally, but are instead controlled by geologic processes that operated in the distant geologic past, and the competition for their extraction and use occurs over a backdrop of socioeconomic and ethnic diversity.

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APPENDIX 1

GLY 110 – Endangered Planet: Introduction to Environmental Geology

Class time	MWF 11:00-11:50 AM	**TA:**
Location	Slone Research Building 303	Sally Sandstone Slone 101 (859) 257-0000 sally.sandstone@uky.edu
Instructors	Dr. Kent Ratajeski Slone 301 (859) 257-4444 kent.ratajeski@uky.edu Th 12:00 – 4:00 PM F 8:30 – 10:00 AM or anytime I'm not busy	

Course description and objectives

Environmental geology combines an introduction to basic earth science with a practical treatment of how geology processes have produced and continue to shape the environment in which we live. The interconnections between Earth materials and systems, human interactions with Earth processes, geologic hazards, and human stewardship of Earth resources will all be given special emphasis in this course.

This class will take a focused effort, but by taking it and applying what you have learned, you will be able to

- avoid hazardous geologic situations in your daily life (e.g., knowing where *not* to buy your first home!)
- become an informed citizen on a variety of issues related to geology and the environment (water resources, energy, waste, pollution, climate change, etc.)
- understand the operation of geologic processes (such as plate tectonics, volcanism, sedimentation, erosion, mountain building, glaciation, and flooding), how they have shaped our planet over geologic time, and how they affect environmental and social systems.
- gain practical analytical and critical thinking skills
- develop a deeper appreciation of the beauty, order, and complexity within nature

Prerequisites

There are no prerequisites for this course, but a basic knowledge of some high school geography, chemistry, and math will be useful.

Blackboard course page

You can access the Blackboard page at https://elearning.uky.edu. The course page will eventually contain a copy of this syllabus, lecture PowerPoints (uploaded <1 day AFTER each class), homework assignments, study sheets, and other information. I will also use Blackboard to communicate important announcements to the class and for emailing individual students.

Textbook

One text is required: *Introduction to Environmental Geology*, 4th Edition, by Edward A. Keller. Check out the student website for the 3rd edition http://www.prenhall.com/keller which contains chapter objectives, self-tests, images, links to web resources, regional updates, news articles, and other features. While my lectures may not always come directly from this text, there will be a large amount of overlap between the two sources of information. If you have a used copy, make sure it has the "Hazard City" CD which you will need to do the homework assignments.

Policies

Attendance

Regular class attendance and active participation are expected; while they are not factored into your final grade, the best way to succeed in this class is to actively attend most every class. If you miss a lecture, get the PowerPoint

lecture from Blackboard and any other missed notes from one of your classmates; *you do not need to notify me about absences from regular lectures.*

Missed quizzes and regular exams can be made up only for excused absences related to:

1. Significant illness of the student or serious illness of a member of the student's household (permanent or household); formal verification must be furnished to allow a makeup.
2. The death of a member of the student's household (permanent or campus) or immediate family; formal verification must be furnished to allow a makeup.
3. Trips for members of student organizations sponsored by an academic unit, trips for University classes, and trips for participation in intercollegiate athletic events. When feasible, the student must notify the instructor prior to the occurrence of such absences, but in no case shall such notification occur more than one week after the absence. Formal notification from appropriate university personnel is required to document the student's participation in such trips and to allow a makeup.
4. Major religious holidays; students are responsible for notifying the instructor in writing of anticipated absences due to their observance of such holidays no later than the last day for adding a class.

Please direct all requests for makeup quizzes and exams by email to your assigned TA. This request must be made within one week of the missed quiz or exam (except where prior notification is required). Be sure to mention the course number (GLY 110), the specific quiz or exam you missed, and the reason you are requesting a makeup. If the reason fits one of the criteria above, the TA will arrange for you to take the makeup during his office hours, or at another time if you have a time conflict. You must bring the necessary documentation with you to the makeup or you will not be allowed to take it.

Classroom behavior and academic integrity
Disruptive behavior such as cell phone use and loud talking are not allowed during class. Cheating of any type will not be tolerated. Cheating is defined in the Student Handbook of Rights and Responsibilities, but in particular for this course, includes relying too much on another student's work (i.e., simply copying another student's work). The following protocol will be followed should there be evidence of cheating on an assignment:

1. Instructor will discuss the matter confidentially with the student(s) involved; if not satisfactorily resolved,
2. Instructor will discuss the matter confidentially with Department Chair and the student; if not yet resolved,
3. Instructor will discuss the matter confidentially with the Academic Ombud and the student.

Based on the outcome of this procedure, instances of cheating may result in a grade of "0" for the assignment and possibly additional penalties including a failing grade for the entire course.

Exams
Everything discussed *in class*, regardless of whether it appears in the PowerPoint presentations, is fair game for exams. Exams will not include material from the textbook unless it was covered in class. No quantitative problems requiring calculators will occur on the exams, and calculators are not permitted. A study sheet will be made available on Bb about a week before the exam to help you identify the most important concepts and skills to focus on for your study. The final exam is comprehensive and will cover all of the material discussed in lecture.

Before each exam, all personal items including backpacks, purses, notes, calculators, iPods, headphones or earplugs, and cell phones must be brought to the front of the classroom. Cell phones may be kept in your pocket, but if you are seen looking at it or operating it in any way (even to check the time), you will receive a zero grade for the exam.

Online discussions
Six online discussions (on Blackboard) based on assigned readings will occur throughout the semester. Instructions regarding the discussions will be distributed later. The purpose of these discussions is to include current issues related to the course and to encourage critical thinking and the exchange of ideas related to these issues within the class.

Homework exercises
You can work on the homework in small groups (≤ 3), but you must submit a copy with just your name on it. Do not let someone else do all the thinking for you or copy someone else's work; the aforesaid rules on cheating and plagiarism apply. I strongly suggest you start these assignments soon after they are assigned; some may require as much as 1-2 hours to complete (or more if you are having trouble). I will not answer questions about them in the 24

hours before an assignment is due. Homework may be turned in anytime before the due date, either in class, or by dropping it in my mailbox in Slone 101. Late homework will not be accepted and cannot be made up at a later time.

Getting additional help
Please ask questions at any time during lecture. I have an open-door policy, but I may have to turn you away if it is not a good time for me outside of office hours. Don't count on me answering emails in the evenings, and don't wait until right before an exam or assignment due date to get help.

If you have a documented disability that requires academic accommodation(s), please see me as soon as possible during my scheduled office hours. In order to receive accommodations in this course, you must provide me with a Letter of Accommodation from the Disability Resource Center. The center is located in Room 2, Alumni Gym. If you have not registered with the Disability Resource Center for coordination of campus disability services, please contact the Center by calling 257-2754 or by email to the center director, Jacob Karnes, jkarnes@email.uky.edu.

Identification cards
By the start of the third week of classes I need a 3x5 card from you with the following information:

(Front)

(Back)

- name
- where is home?
- year & major (e.g., 2nd-year Art major)
- interests/passions/goals/hobbies
- why are you in this class?
- what will you do when you graduate?
- anything else about you I should know?

The picture of you should be securely affixed (no paper clips) to the back of the card, and can be any photo that will make it possible for me to recognize you. Grades on the first exam will be withheld until I have an ID card.

Grading

Final grades will be calculated as follows:

40%	Regular exams (3)
10%	Final exam
20%	HW's #1-9
10%	HW #10
20%	Online discussions (6)

A running weighted grade will be made available throughout the semester on the Blackboard gradebook, so you can check your grade at any time.

The calculated percentage will be rounded to the nearest whole number and assigned a letter grade according to the following scale: A = 85-100, B = 75-84, C = 65-74, D = 55-64, and E (or F) = 0-54. No curves will be applied in the grading.

Schedule

Date	Lecture schedule (tentative)	HW assigned	HW due	Readings assigned	Online discussion due
	Foundations				
Aug. 25	Introduction	#1 (8/25)			
Aug. 27	What is science? (Ch. 1)				
	Geology Basics				
Aug. 30	Minerals (Ch. 3.1-3.2)			#1 (8/30)	
Sept. 1	Rocks (Ch. 3.3-3.9)		#1 (9/1)		
Sept. 3	"				
Sept. 6	NO CLASS (Labor Day)				
Sept. 8	Earth structure (Ch. 2)				
Sept. 10	Plate tectonics (Ch. 2)				
Sept. 13	"			#2 (9/13)	#1 (9/13)
	Natural Hazards				
Sept. 15	Earthquakes (Ch. 6)	#2 (9/15)			
Sept. 17	"				
Sept. 20	Volcanoes (Ch. 7)	#3 (9/20)	#2 (9/20)		
Sept. 22	"				
Sept. 24	"		#3 (9/24)		
Sept. 27	**EXAM 1**			#3 (9/27)	#2 (9/27)
Sept. 29	Rivers and floods (Ch. 8)	#4 (9/29)			
Oct. 1	"				
Oct. 4	Mass wasting (Ch. 9)	#5 (10/4)	#4 (10/4)		
Oct. 6	"				
Oct. 8	Coastal processes (Ch. 10)	#6 (10/8)	#5 (10/8)		
Oct. 11	"				#3 (10/11)
Oct. 13	Meteorite impacts (Ch. 11)		#6 (10/13)		
	Non-Energy Resources				
Oct. 15	Water resources (Ch. 12)	#7 (10/15)		#4 (10/15)	
Oct. 18	"				
Oct. 20	Water pollution (Ch. 13)		#7 (10/20)		
Oct. 22	**EXAM 2**				
Oct. 25	Mineral resources (Ch. 14)				
Oct. 27	"				#4 (10/29)
Oct. 29	Soils (Ch. 16)				
Nov. 1	Solid waste disposal (Ch. 17)	#8 (11/1)			
	Energy Resources				
Nov. 3	Fossil fuels (Ch. 15.1-15.5)	#9 (11/3)	#8 (11/3)	#5 (11/3)	
Nov. 5	"				
Nov. 8	"				
Nov. 10	"				
Nov. 12	"		#9 (11/12)		
Nov. 15	Alternative Energy (Ch. 15.6-15.10)				
Nov. 17	"				#5 (11/17)
Nov. 19	"	#10 (11/19)			
Nov. 22	**EXAM 3**			#6 (11/22)	
Nov 24, 26	NO CLASS (Thanksgiving)				
	Global Climate Change				
Nov. 29	Global climate change (Ch. 19)				
Dec. 1	"				
Dec. 3	"				
Dec. 6	"				#6 (12/6)
Dec. 8	"				
Dec. 10	Review		HW#10		
TBA	**FINAL EXAM** (10:30 AM-12:30 PM)				

APPENDIX 3

GLY 110 - Homework Exercise #2
Earthquake Damage Assessment

Due at the end of class on Sept. 22

Instructions

1. Put the "Hazard City" CD that came with your textbook **(make sure the front of your CD says "3e")** into your computer and click on the "Walkthrough" button at the top left to orient yourself to these activities.

2. Click on "Earthquake Damage Assessment". Complete **version 1** of this assignment. It should take less than half an hour. Your goal in this exercise is to estimate (1) the percentage of homes that will be rendered uninhabitable during a IX Mercalli earthquake, and (2) the number of people needing emergency housing from this event.

    a. You can find the population of each neighborhood by clicking that neighborhood on the city map and reading the community profile. This profile also contains information about the types of houses present in the neighborhood.

    b. Clicking on "Building Response" allows you to look up the percentage of different building types that would be uninhabitable after a IX Mercalli event.

    c. Finally, multiplying the percentage of uninhabitable dwellings by the population of the neighborhood will give you an estimate of the percentage of people needing emergency housing in that area.

3. Print out the worksheet with your data on it. This page is the only thing you have to turn in for this assignment. **I will not accept this homework by email.**

4. You are free to turn in your print-out at any time before the due date by putting it in my mailbox in the Department office in Slone 101, or you can turn it in at class. Remember, I will not answer questions about the homework during the 24 hours preceding the due date.

5. Have fun!

APPENDIX 4

GLY 110 - Homework Exercise #3
Volcanic Hazard Assessment

Due at the end of class on Sept. 27

Instructions

1. Put the "Hazard City" CD (make sure it's the 3rd edition) into your computer and click on "Volcano Hazard Assessment".

2. Complete **version 1** of this assignment, which should take less than an hour. Your goal in this exercise is to evaluate the threat of five (5) volcanic hazards upon neighborhoods in the town: tephra (ash), lahar (mudflow), pyroclastic flow, lava flows, and volcanic gas. To complete this task, you should also learn about the volcanic deposits in the area and the topography of Hazard City.

    a. For **tephra** check out the prevailing wind and the location of the Lava Mountain. Also check out the thickness of the ash deposits, from the drill cores, on either side of the Lava Mountain.

    b. For **lahar**, check the drill cores for mudflow deposits. Lahars follow areas of low elevation (e.g., valleys and stream channels).

    c. For **pyroclastic flow**, check the drill cores for ash deposits with charred trees and other debris. Pyroclastic flows usually follow areas of low elevation (e.g., valleys and stream channels).

    d. For **lava flow**, check the drill cores for volcanic rocks emplaced as lava flows. Lava flows tend to follow areas of low elevation (e.g., valleys and stream channels).

    e. For **volcanic gas**, see if Hazard City is upwind or downwind.

    For all of the above hazards, check to see if Hazard City is within range of being affected, or if it is too far from the mountain.

3. Print out the worksheet with your data on it. This page is the only thing you have to turn in for this assignment. **I will not accept this homework by email.**

4. You are free to turn in your print-out at any time before the due date by putting it in my mailbox in the Department office in Slone 101, or you can turn it in at class.

APPENDIX 5

GLY 110 - Homework Exercise #4
Flood Insurance Rate Maps

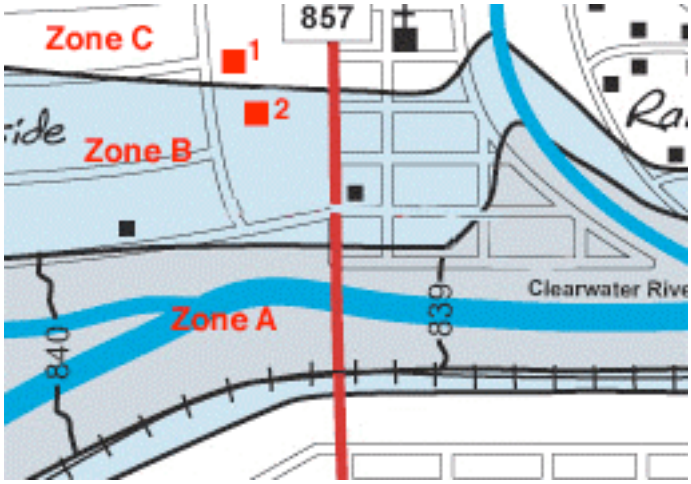
Due at the end of class on Oct. 4

Instructions

1. Put the "Hazard City" CD (make sure it's the 3rd edition) into your computer. Click on the "Flood Insurance Rate Map" activity. Complete versions 1 and 2 of this assignment (print and fill out two report sheets). It should take you < 1 hour. To solve this activity, you need to locate the property on a flood insurance rate map, and gather information about the property such as its elevation, presence of a basement, and information about any previous flooding that has occurred at the site.

2. Here are some free tips:

   a. Learn what these flood zones represent. As you work through the material in the exercise, you will learn that the 500-year floodplain extends up to the boundary between Flood Zones B and C. If a particular site is located exactly on the black line between these flood zones, its chances of being flooded are about 1/500 each year. In the example provided here, Site #1 lies off this boundary on higher ground (away from the river), so its chances of being flooded are less than 1/500. Site #2 lies just off this boundary on lower ground (towards the river), so its chances of being flooded are over 1/500. The closer you get to the river, the higher the risk from flooding.



   b. The first time I did this assignment, I forgot that elevation information is critical for assigning flood insurance rates to homes in the "A" flood zone. Don't forget this!

3. Print out the two worksheets with your data on them and **staple them together**. These pages are all you have to turn in for this assignment. **I will not accept this homework by email.**

4. You are free to turn in your print-out at any time before the due date by putting it in my mailbox in the Department office on the first floor of Slone Research Building, or you can turn it in at class.

APPENDIX 6

GLY 110 - Homework Exercise #10
Final Report: Integrated Geologic Hazards and Resource Assessment of Hazard City and Surrounding Region

Due at the end of class on Nov. 19

Instructions

The purpose of this assignment is to put together what you have learned about the potential geologic hazards affecting Hazard City and its surroundings, as well as identify potential geologic resources existing within area.

Please follow these guidelines for this project:

1. You will be assigned to work in groups of four for this project. Each group represents an environmental consulting firm specializing in geologic hazards and resource issues. First, come up with a creative name for your consulting company!

2. Write a report summarizing your findings from your individual hazard assessments (earthquakes, volcanic hazards, flooding, landslides, and tsunami/storm surge) in Hazard City and surrounding areas. For each hazard, mention areas that were especially at risk of being affected.

3. Your report should include a title page and at least 3 additional pages of double-spaced text (in addition to a series of maps, explained below), in 12-point Times font, with 1" margins on all sides). The report should be addressed to the Hazard City Council.

Part 1: Geologic Hazards

4. You will use the result from your previous Hazard City exercises and the attached three base maps to prepare a series of geologic hazard maps of the city and its surroundings (Hazard County and Ocean Village). These maps should show areas at risk from the various types of hazards. You may elect to show multiple geologic hazards on one map, differentiating the various hazards by symbols or colors, or alternatively, you can make a separate map for each geologic hazard.

5. Using the city and county maps provided, make two more maps of geologic hazards, this time, showing areas of high, medium, and low risk from ALL geologic hazards. In other words, you are combining your previous maps into a single product for citizen of Hazard City and its surroundings to quickly ascertain their level of risk of living in certain areas. This part will be somewhat subjective, and you will have to make some assumptions and inference concerning areas you have not studied in depth. There is no one correct answer.

6. Mention the following in the Geologic Hazards part of your report:

    a. Which of the geologic hazards has/have the potential to cause the most injuries and deaths?
    b. Which of the geologic hazards has/have the potential to affect the greatest area?
    c. Which of the geologic hazards has/have the potential to affect
    d. Which areas of Hazard City and its surroundings are most at risk from geologic hazards?
    e. Which geologic hazard(s) should the City Council make a priority to prepare for, and what steps should the community do?

Part 2: Geologic Resources

7. Prepare a single map of Hazard County, showing the locations of potential geologic resources, again demarked by symbols or colors. Use the Geologic Map feature of the Geographic Information System in the "Landfill Siting exercise" to complete this part of the report. Read the descriptions of the geologic formations, and mark areas where you would expect the occurrence of useful geologic resources (oil, gas, coal, rock types useful for construction, etc.)

8. Summarize the results of your findings in the report.

Staple all materials together and submit in a sealed manila envelope with the names of the authors on the front. You are free to turn in this assignment any time before the due date by putting it in my mailbox in the Department office in Slone 101, or you can turn it in at class. Remember, I will not answer questions about this assignment during the 24 hours preceding the due date.

Grading rubric

9-10 pts all maps show a good amount of thought and integration of material learned in GLY 110; legends are included to explain symbols or colors; maps are neatly drawn and legible; writing is excellent and grammatically correct with few spelling errors; report shows mastery of course content at the application, synthesis, and analysis levels (not just a recitation of facts, but an integrated use of acquired knowledge and skills to the problem at hand).

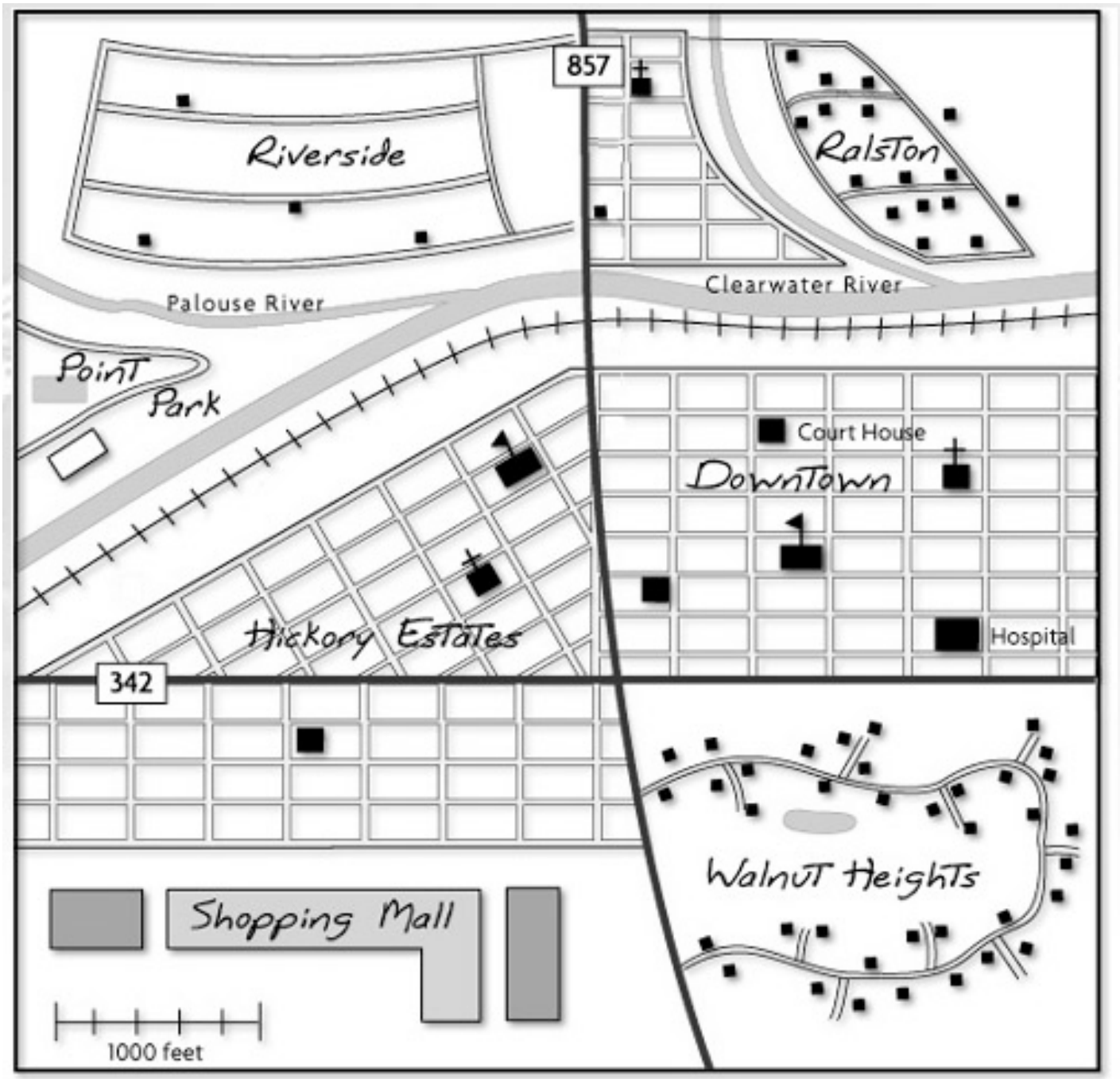
7-8 pts some maps show thought and integration of material learned in GLY 110; legends are not included, or maps are somewhat messy; writing is good with only a few grammatical or spelling errors; report cites lots of facts, but doesn't necessarily show mastery at the application, synthesis, and analysis levels.

5-6 pts all or many maps do not show much thought and integration of material learned in GLY 110; legends are not included, or maps are somewhat sloppy; writing is poor with frequent grammatical or spelling errors; little evidence of mastery of course content at the application, synthesis, and analysis levels.

0-4 pts significant amounts of required material is missing from the report; maps are missing or illegible; demonstrates no synthesis or application of acquired knowledge; report not typed or submitted by deadline.

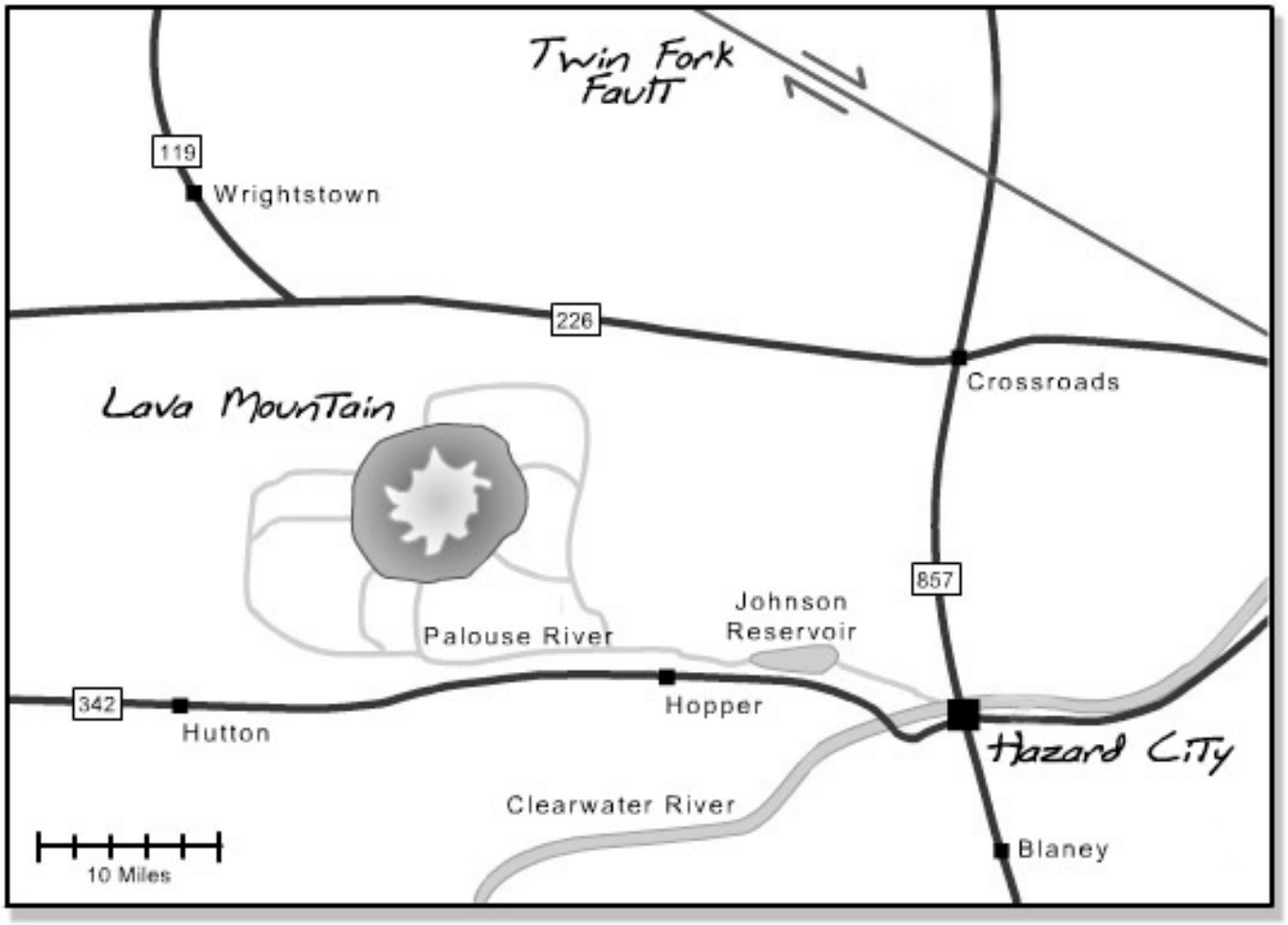
APPENDIX 6

Hazard City



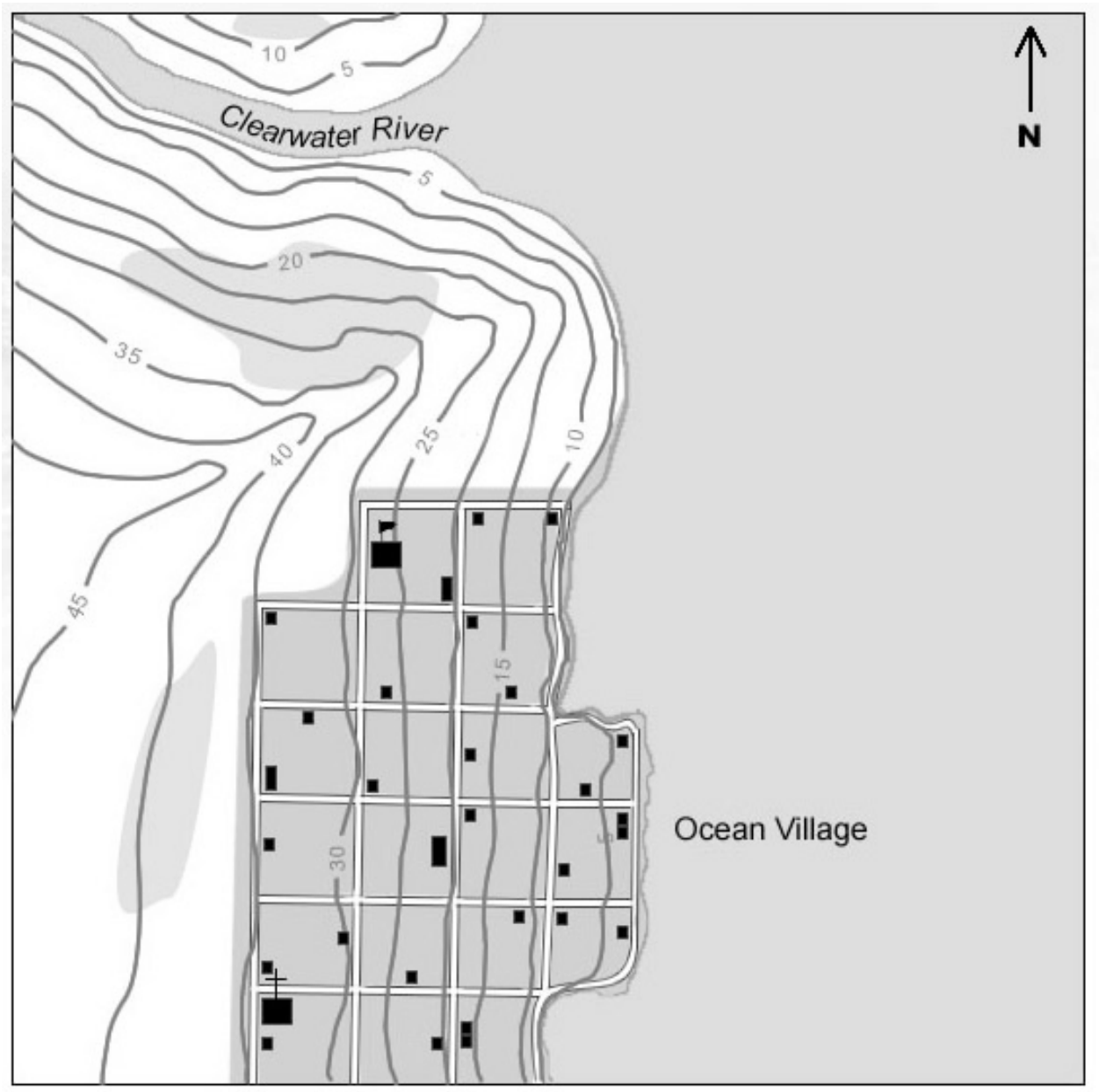
APPENDIX 6

Hazard County



APPENDIX 6

Ocean Village



APPENDIX 7

GLY 110 In-Class Exercise
Flood Recurrence on Rapid Creek, SD (15 minutes)

The following table shows streamflow hydrograph data obtained from Rapid Creek just upstream from Rapid City, South Dakota. "Peak discharge" is defined as the highest discharge event observed during the year. Assuming that the magnitudes of these peak discharges are largely controlled by weather-related processes that operate randomly from year to year, then these data can be used to estimate the flood recurrence intervals (RI's) for various magnitude events on this stream.

Year	**Peak discharge (cfs)**	**Rank Order (M)**	**RI = (N+1)/M (yrs)**
1955	326		
1966	140		
1967	439		
1976	92		
1977	194		
1981	132		
1997	1050		
1998	503		
1999	642		

1. First, rank the peak discharges in our limited dataset. The highest discharge gets a rank order (M) of 1, the next highest gets M=2, and so on.

2. Next, calculate the recurrence interval (RI) for each peak discharge event in our dataset. Recurrence interval is defined as RI = (N+1)/M, where N is the number of years of records (in this case, N = 9).

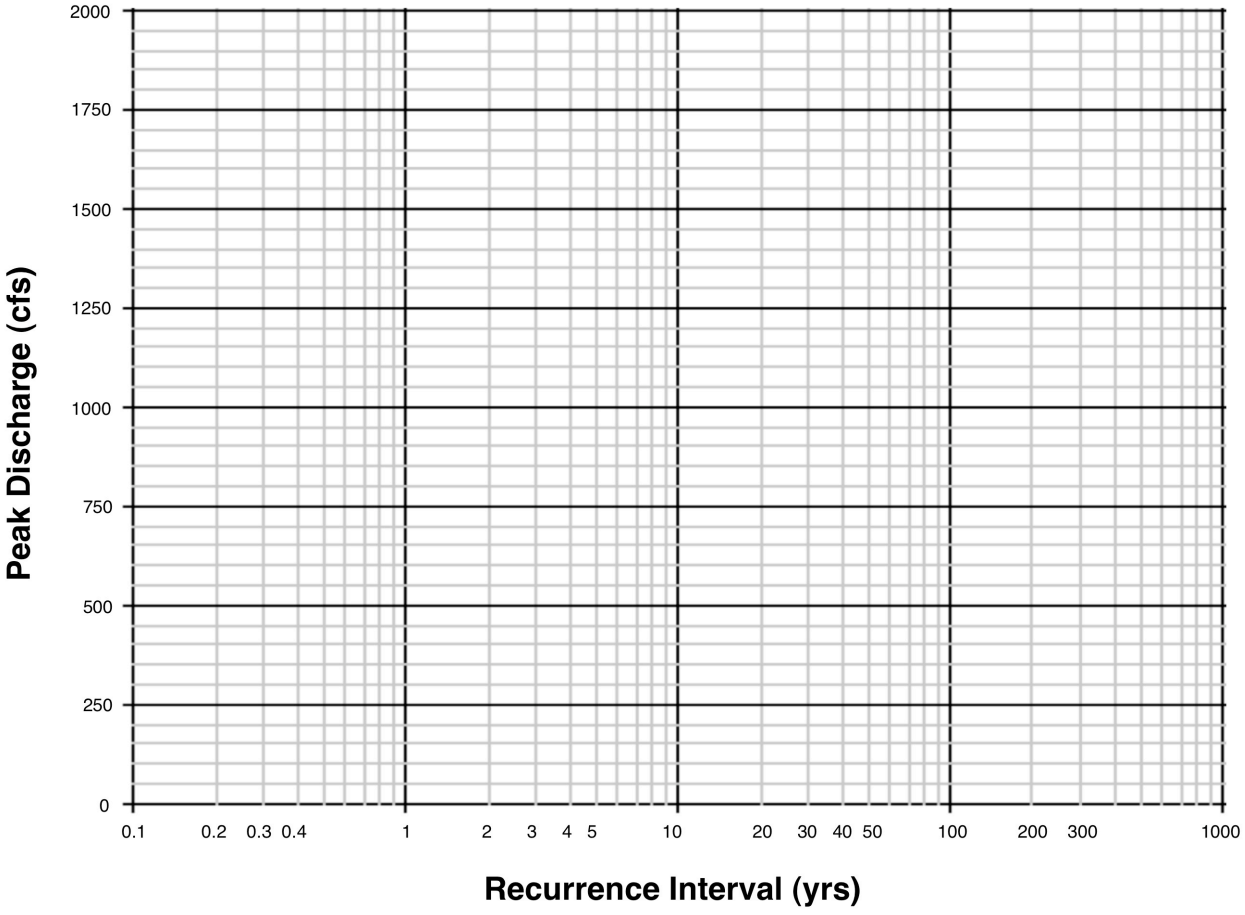
3. Plot the RI data you have determined on the semi-log graph paper provided. Draw a "best fit" straight line by eye through the data.

4. By extrapolating your line beyond the data points, estimate the discharge of a 50-year flood on Rapid Creek.

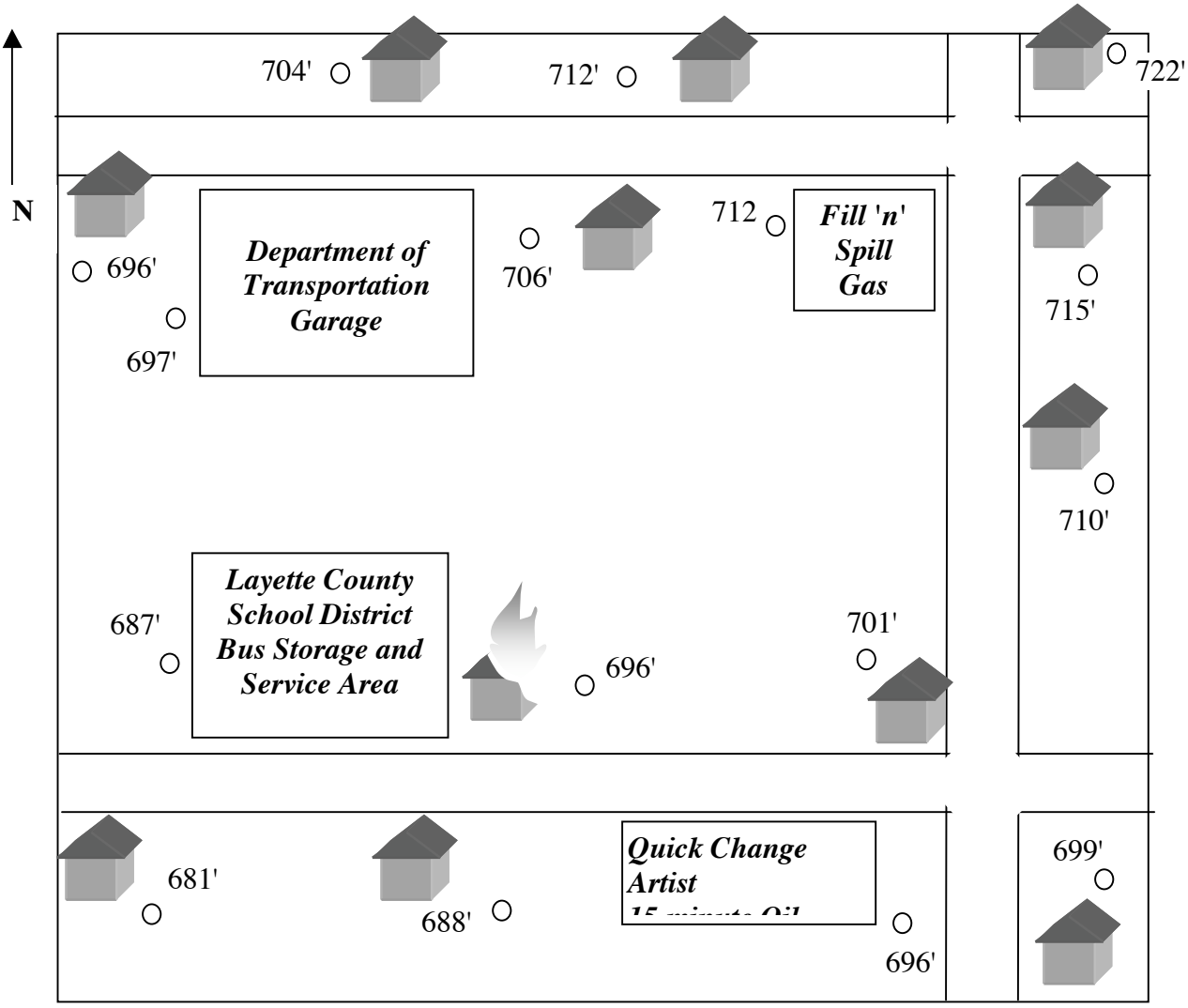
5. The streamflow data for this site on Rapid Creek extends back to 1947. If the entire dataset were used for the above exercise, the Flood of 1972 would have been found to be a 50-year flood. However, the discharge in this event was 30,000-50,000 cfs!!! Explain the vast difference in peak discharge between the Flood of 1972 and your answer for #4.

6. What is the probability that a 50-year flood will occur on this creek in 2007?

7. Assume that a 50-year flood occurred on Rapid Creek in 2006. Will this change your answer for #6? Why or why not?



GLY 110: IN-CLASS EXERCISE
CSI: Geology Edition - "The Case of the Torched Toilet"



This is a map of a section of Layette County showing 12 houses and four commercial/government sites along three roads (with the water wells for each marked). Actually, there are now only 11.5 houses, because one of them blew up. A guy woke up one morning, staggered into the bathroom, and smoked a cigarette. When he threw it into the toilet, hydrocarbon fumes gathering there exploded, taking him out along with the bathroom and part of the roof. It seems the ground water from the well he uses became contaminated, probably from somewhere in the neighborhood. A quick check by state agencies found no one else's water wells in the neighborhood to be contaminated (yet). So they hired you, a hydrogeologist, and star on the nationally syndicated TV show "CSI: Geology Edition" to solve the problem for them.

You've found that it was gasoline or oil in the toilet that exploded (and there are four sites out there that use gasoline or oil frequently). You also measured water levels for each of the wells in the neighborhood. Use this data to draw *contours* on the map (lines that connect points with

equal values [of hydraulic head, in this case] or separate points of different values). Here you are mapping the elevation of the water table.

Follow these steps to solve this mystery within the brief time allotted for this episode.

1. Contour the map (draw lines across the map at these elevations: 685', 690', 695', 700', 705', 710', 715', 720'). Check your work: every point between two contours must be lower in elevation than one contour line and higher than the other.

2. Draw arrows to show the direction of groundwater flow.

3. Which site is located directly up the flow path (up the hydraulic gradient) from the house that blew up? This will be the most likely source of the pollution.

4. Why aren't any of the other wells contaminated?

5. Which wells are in most danger of contamination upon further movement of the contaminant plume?

GLY 110: Environmental Geology
EXAM 1 – Fall, 2010

Choose the best answer.

1. The silica tetrahedron which forms the basic building block of silicate minerals is composed of silicon and what other element?
    a. magnesium
    b. iron
    c. carbon
    d. oxygen

2. The magnetic field of the Earth is believed to originate from flow of molten iron in the
    a. inner core
    b. outer core
    c. deep mantle
    d. mantle lithosphere

3. The oceanic and continental crusts of the Earth have similar thicknesses, but different ages.
    a. true
    b. false

4. During the 17th and 18th centuries, science
    a. was separated from other sources of knowledge
    b. was known as "natural philosophy"
    c. developed rapidly during an age of discovery, industrial revolution, and political revolution
    d. all of the above
    e. none of the above

5. The grain size of an igneous rock imparts important information about
    a. depth of melting
    b. the identity of the rock that melted to form the magma
    c. cooling rate
    d. temperature

6. What type of fault is associated with divergent plate boundaries?
    a. reverse (thrust) fault
    b. strike-slip fault
    c. normal fault

7. By volume, planet Earth is mostly composed of
    a. solid rock
    b. magma
    c. basalt
    d. carbon
    e. granite

8. In the Atlantic Ocean, the youngest sea floor occurs
    a. along the continental margins on either side
    b. at a subduction zone along the western edge of the ocean basin
    c. along the mid-ocean ridge in the middle of the ocean basin
    d. randomly throughout the entire ocean basin

9. Liquefaction is primarily associated with
    a. mantle convection
    b. plate boundaries
    c. basaltic dikes
    d. earthquakes

10. Clastic sedimentary rocks are formed from
    a. minerals precipitated directly from water
    b. fragments of pre-existing rocks
    c. volcanic glass
    d. both a and c

11. The principle of uniformitarianism states that
    a. natural processes have always operated at the same rate or intensity as they do now
    b. the present is the key to the past
    c. the past is the key to the present
    d. having more hypotheses to test is better than just having one
    e. all of the above

12. The history of scientific explanations for the origin of Yosemite Valley illustrates
    a. that observations (data) are not important for the construction of valid scientific explanations
    b. that scientists may sometimes be partial towards a particular explanation for reasons other than the evidence
    c. that the best-trained scientist is always correct
    d. that no scientific hypothesis or theory can be evaluated on the basis of the evidence

13. The distinction between a dike and a pluton is that
    a. dikes are intrusive bodies, whereas plutons are extrusive
    b. dikes are larger than plutons
    c. plutons contain more silica than dikes
    d. none of the above

14. Rocks that undergo recrystallization in response to elevated heat and pressure are
    a. igneous rocks
    b. sedimentary rocks
    c. metamorphic rocks

15. Which of the following igneous rock types has the MOST silica in it?
    a. granite
    b. peridotite
    c. basalt
    d. andesite

16. Quartzite is
    a. a sedimentary rock
    b. an igneous rock
    c. a metamorphic rock
    d. none of the above

17. As an example of a scientific theory, Einstein's General Theory of Relativity is
    a. an educated guess
    b. the unsubstantiated opinion of one scientist with bad hair
    c. a possible answer to a scientific question
    d. a possible answer to a scientific question that has been tested

18. According to the definition given in class, a mineral would NOT include which of the following?
    a. ice within a glacier on the continent of Antarctica
    b. grains of quartz on a beach in Rio de Janiero, Brazil
    c. synthetic rubies made in a laboratory
    d. grains of salt in your saltshaker at home

19. After a large earthquake, there will be extensive regions on the surface of the Earth (located at large distances from the epicenter) that won't receive any S waves from that earthquake. Why?
    a. because S-waves resulting from the earthquake cannot travel through the Earth's inner core
    b. because S-waves cannot travel through the Earth's mantle, which is almost entirely molten
    c. because S-waves from that earthquake cannot travel through the Earth's outer core
    d. because S-waves significantly decrease in intensity as they move through the interior of the Earth

20. Strike-slip faults are caused by
    a. tensional stress
    b. compressional stress
    c. shear stress

21. Diamond and graphite have drastically different physical properties because
    a. they have different compositions
    b. they have different crystal structures
    c. they have different origins
    d. all of the above
    e. none of the above

22. Surface waves
    a. travel more rapidly than body waves
    b. are the first waves initially produced in an earthquake
    c. are the first waves to arrive at a seismograph station after an earthquake
    d. are generated at the eathquake'e focus
    e. are generated at the eathquake's epicenter

23. P-waves
    a. are a type of body wave
    b. propagate through rocks outward from the focus of an earthquake
    c. involve compressive motions of particles within rock materials
    d. travel faster than Love waves
    e. all of the above

24. Which type of asbestos is thought to pose the greatest health hazard?
    a. chrysotile ("white")
    b. crocidolite ("blue")
    c. amosite ("brown")
    d. barneyite ("purple")

25. Which mineral in human teeth becomes harder with increased amounts of Fluorine in its crystal structure?
    a. calcite
    b. quartz
    c. fluorite
    d. crystalline DNA
    e. none of the above

26. What type of silicate structure does the non-silicate mineral graphite most closely resemble?
    a. isolated tetrahedra
    b. double chains
    c. sheets
    d. 3-dimensional frameworks
    e. none of the above

27. Most earthquakes on Earth occur
    a. within the interiors of continents
    b. in California
    c. above mantle hotspots
    d. at plate boundaries
    e. deep in the Earth's mantle

28. The minerals olivine, pyroxene, amphibole, and biotite are darkly-colored because they all contain
    a. aluminum
    b. magnesium
    c. iron
    d. silicon

29. The Richter magnitude for an earthquake is computed on the basis of
    a. the amount of shaking as reported by observers
    b. the length of time between the P and S wave arrivals at the seismometer
    c. the intensity of the largest body wave recorded by the seismometer
    d. both a and b
    e. both b and c

30. Which of the below lists the correct sequence of geologic processes (as listed on the rock cycle) that are required to change igneous rocks originating deep in the Earth into sedimentary rocks?
    a. weathering→deposition→burial→heat + pressure
    b. uplift→erosion→deposition→burial→melting
    c. weathering→erosion→deposition→burial→lithification
    d. uplift→erosion→weathering→burial
    e. uplift→weathering→erosion→deposition→burial→lithification

31. The Reelfoot Rift under the Mississippi River valley
    a. no longer poses a serious seismic hazard
    b. is unrelated to earthquakes in the New Madrid Seismic Zone
    c. formed in the past during several attempts to split the North American continent
    d. is responsible for producing earthquakes with epicenters as far away as southern Canada

32. Which city is most at risk from another large earthquake in the New Madrid Seismic Zone?
    a. Cincinatti, OH
    b. Memphis, TN
    c. Charleston, SC
    d. Chicago, IL
    e. Los Angeles, CA

33. The lithosphere
    a. behaves rigidly compared to the deep mantle
    b. does not convect
    c. includes the crust and the uppermost mantle
    d. all of the above
    e. none of the above

34. What part of the Earth is composed of silicate rock and undergoes thermal convection?
    a. inner core
    b. outer core
    c. deep mantle
    d. shallow mantle lithosphere
    e. crust

35. Mesothelioma is a disease that may result from exposure to
    a. spores thrown into the air during an earthquake
    b. high concentrations of fluorine in water
    c. volcanic dust
    d. asbestos
    e. all of the above

36. How can geologists accurately determine the ages of sections of the ocean floor?
    a. by dating igneous rock samples collected from those sections of ocean floor
    b. by dating sediment samples collected from the bottom of those sections of ocean floor
    c. by correlating the striped pattern of magnetic anomalies on the ocean floor with the history of polarity reversals of the Earth's magnetic field
    d. by measuring the depth of those sections of ocean floor below sealevel

37. Which statement below is a testable scientific hypothesis?
    a. "The universe was created by God"
    b. "The extinction of the dinosaurs was caused by an asteroid impact"
    c. "Degrading the environment is wrong"
    d. "Because biological evolution is random, there is no purpose or meaning to life"
    e. all of the above statements are testable scientific hypotheses

38. The 2004 Indian Ocean tsunami was caused by a massive earthquake located
    a. at a subduction zone
    b. at a transform plate boundary
    c. at a mid-ocean ridge
    d. thousands of miles from the nearest plate boundary

39. Which rocks are formed by the evaporation of seawater or saline lake water?
    a. gypsum and rock salt
    b. rock salt and limestone
    c. sandstone and conglomerate
    d. shale and limestone
    e. none of the above

40. The finest-grained sedimentary rock is
    a. sandstone
    b. schist
    c. conglomerate
    d. siltstone
    e. shale

41. For which of the examples below would a knowledge of geology NOT be very useful?
    a. Farmer Fred wants to know how deep to drill for water under his property
    b. Harriet Homeowner wants to know if her house is at risk from landslides or floods
    c. Investor Ike wants to know whether to financially support the oil well that his brother-in-law is drilling in his back yard
    d. all of the above
    e. none of the above (i.e., geology IS useful for all of them)

42. Geology is called a "derivative science" because
    a. society derives many benefits from its study and practice
    b. students derive great pleasure from learning about it
    c. professors derive great pleasure from teaching it
    d. it is partially dependent on more fundamental sciences like physics, math, and chemistry
    e. all of the above

43. It is possible for a rock to contain no mineral grains/crystals.
    a. true
    b. false

44. Igneous rocks
    a. contain more silica than sedimentary rocks
    b. were erupted as lavas on the surface of the Earth
    c. cool from molten rock material (magma)
    d. were recrystallized in response to elevated heat and pressure
    e. were crystallized underground

45. Foliation is a feature produced in
    a. igneous rocks
    b. sedimentary rocks
    c. metamorphic rocks
    d. all of the above
    e. none of the above

46. Which is a chemical sedimentary rock?
    a. rock salt
    b. sandstone
    c. shale
    d. gabbro
    e. basalt

47. The symmetric pattern of linear magnetic anomalies observed in the oceanic crust can be explained by
    a. subduction
    b. strike-slip faulting
    c. movement of lithospheric plates over mantle hotspots
    d. earthquakes along deeply buried faults
    e. seafloor spreading

48. Hawaii, Yellowstone, and Iceland provide examples of
    a. exposed sections of lower crust and upper mantle brought to the surface by tectonic activity
    b. earthquake activity far away from plate margins
    c. volcanic activity above mantle hotspots
    d. seafloor spreading
    e. volcanism associated with subduction zones

49. Evidence for the former existence of Gondwana (a supercontinent) comes from
    a. ancient glacial deposits
    b. the fit of the continents (e.g., South America and Africa)
    c. fossils of terrestrial plants and animals
    d. matching rock units and mountain belts
    e. all of the above

50. Which was NOT discussed in class as a hazard associated with earthquakes?
    a. disease
    b. fire
    c. landslides
    d. flooding of coastal areas
    e. none of the above

GLY 110 – Instructions for Online Discussion Forums

Assignment to an online discussion group

You will be assigned to an online discussion group within the second week of class. This will be your discussion group for the entire semester. For each assigned reading not from your textbook (see the schedule and due dates in the syllabus), you will be given 2 weeks to contribute 3 posts to the relevant discussion forum: 1 post must be a new thread, and 2 must be replies to existing threads.

Protocol for posting threads and contributing to an online discussion are as follows:

Follow these guidelines modified from Guilbert and Dabbagh (2005) when participating in the online discussions:

- Postings should be evenly distributed during the discussion period (not concentrated all on one day or at the beginning and/or end of the period).
- Postings should be a minimum of one short paragraph and a maximum of two paragraphs.
- Avoid postings that are limited to 'I agree' or 'great idea', etc. If you agree (or disagree) with a posting then say *why* you agree (or disagree) by supporting your statement with concepts from the readings or by bringing in a related example or experience.
- Address the questions as much as possible (don't let the discussion stray).
- You are encouraged to reference other sources (use quotes and page numbers) in addition to the assigned article that supports your postings.
- Build on others responses when responding to threads.
- Use related prior knowledge (work or life experiences, prior coursework, readings, etc.)
- Use proper grammar.
- Be respectful of others. This doesn't mean you have to agree with their ideas, but please keep your interactions polite and civil.

Grading rubric

The TA in charge of your discussion group will award you 0-10 points for your participation in each discussion based on the rubric on the next page. Your discussion grade (%) = (points awarded) / (10 possible points) × 100.

If your participation ranks high for some criteria, but low for others, the TA will use his/her judgment to assign you a grade, and will communicate the reasons for their grade assignment to you, so that you can make improvements in future discussions. For example, if you scored an "excellent" for Criteria #1, a "good" for Critera #2, and an "average" for Critera #3, the TA may elect to award you a "good" (8 points) for your total grade.

Criteria	Excellent	Good	Average	Poor
#1 - Timely discussion contributions	3 postings well distributed throughout the 2 weeks	3 postings distributed throughout the 2 weeks	3 postings somewhat distributed	0-2 postings not distributed throughout the 2 weeks
#2 - Responsiveness to discussion and demonstration of knowledge and understanding gained from assigned reading	very clear that readings were understood and incorporated well into responses	readings were understood and incorporated into responses	postings have questionable relationship to reading material	not evident that readings were understood and/or not incorporated into discussion
#3 - Adherence to on-line protocols	all on-line protocols followed	1 online protocol not followed	2-3 online protocols not followed	>3 online protocols not followed
Points	9-10	8	6-7	5 or less

Reference

Gilbert, P., and Dabbagh, N., 2005, How to structure online discussions for meaningful discourse: A case study. British Journal of Educational Technology, v. 36, p. 5-18.