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## Course Outline for GEOL 1

### PHYSICAL GEOLOGY

Effective: Fall 2010

#### I. CATALOG DESCRIPTION:

GEOL 1 — PHYSICAL GEOLOGY — 3.00 units

The Earth, its materials, its internal and external processes, and its development through time. Emphasis is placed on a thorough global understanding of Plate Tectonics as a framework and foundation for subsequent geologic topics and concepts. Topics include volcanoes, earthquakes and seismology, the Geologic Time Scale and the formation of the earth, rocks and minerals, hydrology, erosion, beach systems, environmental geology, glaciation, groundwater, etc. Course content includes the difference between theory and fact and the historical development of key geologic concepts. This is the foundation course for almost all subsequent geology courses for both geology majors and non-majors.

3.00 Units Lecture

#### Grading Methods:

Pass/No Pass

#### Discipline:

	<u>MIN</u>
<b>Lecture Hours:</b>	54.00
<b>Total Hours:</b>	54.00

#### II. NUMBER OF TIMES COURSE MAY BE TAKEN FOR CREDIT: 1

#### III. PREREQUISITE AND/OR ADVISORY SKILLS:

#### IV. MEASURABLE OBJECTIVES:

**Upon completion of this course, the student should be able to:**

1. explain the scientific method; and to be able to differentiate facts from theories;
2. describe the basic features of the earth including the tilt, the seasons, the size of the earth, the basic features of the atmosphere, the oceans and the basic layers inside the earth;
3. discuss the common theories regarding the formation of the Earth, its atmosphere, oceans and internal layers;
4. identify the basic fundamental geologic features of the Earth; examples include the mid-oceanic ridge, trenches, etc.;
5. explain and discuss the emergence of Plate Tectonic Theory in the history of geologic science;
6. analyze and discuss the evidence for Plate Tectonics and to apply plate tectonics to the interpretation and analysis of basic geologic features
7. explain what minerals are and how they are formed;
8. categorize the three basic rock groups and the common rock types in each group; to explain their origin and classification system;
9. discuss volcanoes and volcanism; to explain where and why volcanoes occur, to differentiate types of volcanoes, to explain how volcanoes relate to plate tectonics, to discuss eruption prediction, etc.;
10. demonstrate a knowledge of the Geologic Time Scale, to describe the fossil record and to explain radiometric dating and to calculate geologic ages;
11. explain the basics of stratigraphy and to analyze relative age-dating geologic configurations;
12. explain the formation of oil, gas and coal;
13. discuss, identify and analyze the processes and features formed by surficial processes such as weathering/erosion, mass-wasting, rivers, coastlines, glaciers, groundwater, wind, etc.;
14. identify and explain the basics of structural geology; including folds and faults and their relationships to plate tectonics;
15. discuss and describe the science of seismology and earthquakes; including how to read seismogram, how to locate earthquakes, the current state of earthquake prediction, and remote sensing of the interior of the earth;
16. apply the basic geology learned in this course to the interpretation of the basic geology of other planets.

#### V. CONTENT:

##### A. Fundamental Basic Features of the Earth

1. Tilt & Seasons
2. Size: radius and circumference
3. Atmosphere (size, thickness, density variation with height, average composition)
4. Oceans
  - a. Areal % of globe; depth; maximum and average
  - b. Major oceans
5. Solid Earth: Interior; crust, mantle, core

##### B. Formation of the Earth and the Universe

1. Concept of Theory vs. Fact

2. The Big Bang
  3. The formation of the Solar System
  4. The formation of the Earth's
    - a. Early crust, continents and ocean floors
    - b. Early mantle and core
    - c. Early atmosphere
    - d. Early oceans (where did the water come from?)
  5. The Interior of the Earth
    - a. Features of Each Layer:
      1. Chemistry: sialic or mafic
      2. Density, solid, molten, rigid or brittle, plastic solids, etc.
    - b. Crust features
    - c. Mantle
      1. Upper mantle features
      2. Middle mantle features
      3. Lower mantle (mesosphere) features
    - d. Core
      1. Outer Core features
      2. Inner Core features
    - e. Lithosphere
    - f. Asthenosphere
- C. Plate Tectonics
1. Evidence for and evolution of Plate Tectonic Theory
    - a. Evidence for Continental Drift
      1. Continents as jigsaw puzzle
      2. Fit along continental shelves
      3. Evidence from rocks
      4. Evidence from fossils
      5. Evidence from paleoclimates
      6. Evidence from mountain ranges
    - b. Ocean Floor evidence & discoveries
      1. Bathymetry: Mid-Oceanic Ridge (MOR)
      2. Magnetic stripes
      3. Apparent Polar Wandering
      4. 1968 Deep Sea Drilling Project
      5. Ocean floor rocks too young
      6. 90% of sediment missing
      7. MOR is a volcano
      8. MOR is rifting
    - c. Sea Floor Spreading
  2. Impact of Plate Tectonic Theory to the fundamentals of global geologic interpretations
    - a. Three Types of Plate Edges and their geologic features: volcanoes, earthquakes, etc.
      1. Convergent
        - a. Divergent
        - b. Transform
      2. Hot Spots
      3. Identification and analysis of global geologic features using Plate Tectonic Theory
        - a. Trenches
        - b. Mountains
        - c. Volcanoes
        - d. Earthquakes
        - e. Plate edges
      4. Theories of Driving Mechanisms for Plate Tectonics
        - a. Mantle Convection, etc.
        - b. Discussion of Theory vs. Fact in science
      5. Crustal deformation and mountain building
      6. Supercontinents and Plate Tectonic reconstructions
- D. The Geologic Time Scale
1. Eons, Eras and Periods
  2. What geologic event occurred at the beginning/end of each Eon and Era
  3. Radiometric Age Dating
    - a. Radioactive decay and half-lives
    - b. Commonly used elements, including radiocarbon and other commonly used radioactive elements
  4. Basic Fossil Record through Time
    - a. Trace fossil
    - b. Prokaryotes
    - c. Stromatolites
    - d. Iron Banded Formation; accumulation of oxygen in atmosphere
    - e. Eukaryotes
    - f. Metazoans; Ediacara fauna
    - g. Cambrian explosion
    - h. Trilobites
    - i. Age of Invertebrates
    - j. Age of Fishes
    - k. Age of Amphibians
    - l. Age of Reptiles (including dinosaurs)
    - m. Age of Mammals
    - n. Mass extinctions
    - o. Humans
- E. Minerals
1. What are Minerals?
  2. How do Minerals Form?
- F. Basic Rock Types and Processes
1. The Rock Cycle
  2. Igneous rocks and igneous activity
    - a. Basic igneous rock types
    - b. Where and how these rocks are formed
    - c. Igneous rocks within Plate Tectonic settings
    - d. What causes the rock to melt?
    - e. Bowen's Reaction Series

- f. Basic Igneous Rock Features/Formations (e.g., batholiths, dikes, sills, etc.)
  - g. Volcanoes and Vulcanism
    - 1. Types of Volcanoes
    - 2. Volcanoes within Plate Tectonic Settings
    - 3. Features of Volcanoes and their eruptions
    - 4. Hot Springs, geysers, geyserite, fumaroles
    - 5. Volcanic Hazards
    - 6. Eruption Prediction
- 3. Sedimentary rocks and their deposition
  - a. Basic Types of Sedimentary Rocks
    - 1. Clastic
    - 2. Chemical
    - 3. Lithification
    - 4. Limestone Formation
  - b. Formation and Types of Coral Reefs
  - c. Formation of Oil, Gas and Coal
  - d. Stratigraphy
    - 1. Relative Age Dating
    - 2. Law of Horizontality
    - 3. Law of Superposition
    - 4. Depositional Environments
    - 5. The Present is the Key to the Past
    - 6. Sedimentological Features such as cross-bedding, graded bedding, mudcracks, etc.
- 4. Metamorphism and metamorphic rocks
  - a. Basic Types of Metamorphic Rocks
  - b. How do Metamorphic Rocks Form?
  - c. Where do Metamorphic Rocks form; Plate Tectonics settings
- G. Weathering & Erosion
  - 1. Basic Types of Weathering
    - a. Mechanical; ice-wedging, sheeting, exfoliation, etc.
    - b. Chemical
      - 1. Water; Universal Solvent
      - 2. Oxidation
  - 2. Rates of Weathering; Bowen's Reaction Series
  - 3. Joints
  - 4. Spheroidal Weathering
  - 5. Soils
- H. Mass-Wasting
  - 1. Driving forces and mechanisms
  - 2. Angle of Repose
  - 3. Types of Landslides and Mass Wasting
- I. Hydrologic Systems
  - 1. The Hydrologic Cycle
  - 2. River Systems
    - a. Basic Features of River Systems
    - b. Drainage Patterns
    - c. Stream Load
    - d. Meander Migration
    - e. Floodplains and their features and processes
    - f. Deltas
  - 3. Coastal Systems
    - a. Erosional cliff coastline features and processes
    - b. Depositional beach features and processes
      - 1. Longshore Transport
    - c. Comparison of East and West Coasts of the United States
  - 4. Glacial Systems
    - a. Basic Glacial Features and Processes
    - b. Types of Glaciers
    - c. The Ice Ages and Historic Global Climate Changes
  - 5. Groundwater
    - a. Basic Groundwater Features and Processes
    - b. Aquifers and Aquicludes
    - c. Artesian Wells and Aquifers
    - d. Environmental Issues
      - 1. Cone of depression
      - 2. Ground subsidence
      - 3. Saltwater encroachment (intrusion)
      - 4. Groundwater contamination (landfills, septic tanks, etc.)
    - e. Speleology and Karst Topography
      - 1. Basic processes and features of caves and cave formation
      - 2. Sinkholes
- J. Eolian Systems (Wind and Deserts)
  - 1. Basic Processes and Features of Eolian Systems
  - 2. Types of Sand Dunes and Wind Direction
- K. Geomorphology
  - 1. Processes of Formation of basic surficial landforms
  - 2. Identification of basic geology from the geomorphology
  - 3. Including plateaus, mesas, buttes, cuestas, hogbacks, flatirons, cap rocks, types of volcanoes, types of mass-wasting, types of glaciation, beach processes, types of dunes and wind directions, etc.
- L. Structural Geology
  - 1. Folds
  - 2. Faults
    - a. Normal
    - b. Reverse
    - c. Strike-Slip; Right and Left Lateral
    - d. Identification of Faults from surface geology and geomorphology
  - 3. Plate Tectonic Settings
    - a. Extensional Tectonics; Horst and Graben, Listric Normal Faults
    - b. Compressional Tectonics; Folds and Reverse Faults
    - c. Block Faulting/Rotation and the California Sierra Nevada

#### M. Seismology and Earthquakes

1. Historic Earthquakes
2. Where and Why Do Earthquakes Occur?
3. Basic Seismometers
4. Types of Earthquake Waves
5. Typical Seismic Record
6. Locating the Earthquake Epicenter and Hypocenter
7. Intensity and Magnitude Scales
  - a. Rossi-Forel and Modified Mercalli Scales
  - b. Richter Magnitude, Moment Magnitude, etc.
8. Seismic Remote Sensing of the Interior of the Earth
  - a. P & S Wave Shadow Zones
  - b. Global Seismic Network
9. Earthquake Prediction?
  - a. Common ideas of earthquake predictors (e.g., "earthquake weather", animal behavior, etc.)
  - b. Has an Earthquake ever been accurately predicted?...China....
  - c. Earthquake Cycle – Parkfield, CA
  - d. Was the Loma Prieta Earthquake predicted?

#### N. The Geology of Other Planets

1. Applying the geologic processes and features learned in this course to the interpretation of the geology of other planets

### VI. METHODS OF INSTRUCTION:

- A. **Lecture** -
- B. **Discussion** -
- C. CD-ROM images and animations
- D. Textbook and textbook CD-ROM
- E. **Demonstration** -
- F. Video clips
- G. Internet
- H. 35mm and PowerPoint slides

### VII. TYPICAL ASSIGNMENTS:

- A. Read Chapters 1 thru 4. Look up the vocabulary words in these chapters and complete online Vocabulary Quiz
  1. Use the textbook glossary and index, the Geologic Dictionaries available in the Science Center, and Internet search engines such as Google.
- B. Memorize the Eons, Eras and Periods of the Geologic Time Scale
- C. Complete the Study Guide questions for Exam 2.
- D. Locate the following geologic features and learn how to find them on geomorphic maps. Yellowstone, The Grand Canyon, Hawaii, Midway, The Marianas Islands, Devil's Tower, Gui Lin, China, etc. Use the textbook CD-ROM, the maps in the textbook and the Internet – National Geographic Map Machine and Google Image searches.
- E. Read Chapter 15 in the textbook.
  1. Look up all vocabulary for this chapter.
  2. Learn to identify the geomorphic features in this chapter in satellite images and regular aerial and ground photos.
  3. Make sure that you understand the basic geologic processes discussed in this Chapter.
  4. Complete the questions in the Study Guide that refer to the topics in this chapter.
- F. Research Paper. Submit a 5-10 page 12-point paper on a geologic topic approved by the instructor.
- G. Presentation. Create and present a 5-10 minute presentation on a geologic topic approved by the instructor.

### VIII. EVALUATION:

#### A. **Methods**

1. Other:
  - a. Homework – includes vocabulary, geography, geologic time scale, textbook CD-ROM, and textbook material not covered in class presentations
  - b. Quizzes and Midterms– includes short answer, multiple choice, and essay questions; includes geologic interpretation of satellite, aerial and standard photos, identification and interpretation of geologic features from geomorphic maps
  - c. On-Line Quizzes and/or Essays – may use the textbook website quizzes and/or Blackboard Quizzes – online quizzes are at the discretion of the instructor
  - d. Term Paper or Student Presentations (instructor's option)
  - e. Final examinations – comprehensive, similar layout to quizzes and midterm examinations

#### B. **Frequency**

1. Homework can be assigned daily, weekly or all at the beginning of the term or only as needed, at the discretion of the instructor
2. Quizzes will be given daily, weekly, bi-weekly or at the discretion of the instructor
3. Quizzes/Midterms/Final Exam/Term Paper – at least 3 or 4 total. For example, there may be 2 midterms, one final exam and one term paper. Or, there may be 4 on-line quizzes, 3 in-class midterms and one in-class final exam.
4. The comprehensive Final Exam will be given at the end of the semester on the day specified in the campus Final Exam schedule.

### IX. TYPICAL TEXTS:

1. Hamblin, W.K. and Christiansen, E.H. (2007). *The Earth's Dynamic Systems* (10th ed.). Upper Saddle River, New Jersey: Prentice-Hall Publishers.
2. Monroe, J.S. and Wicander, R (2006). *Physical Geology* (5th ed.). Pacific Grove, CA: Brooks/Cole Publishers.
3. Press, F. and Siever, R (1986). *Earth* (4th ed.). New York: : WH Freeman Publishers.
4. Grotzinger, J., Press, F (2006). *Understanding Earth*, (5th ed.). New York: WH Freeman Publishers.
5. Tarbuck, E.J. and Lutgens, F.K. (2008). *Earth, An Introduction to Physical Geology* (9th ed.). Upper Saddle River, New Jersey: Prentice-Hall Publishers.
6. Plummer, C.C., McGeary, D., and Carlson, D.H. (2007). *Physical Geology* (11th ed.). San Francisco, CA: McGraw-Hill Publishers.

### X. OTHER MATERIALS REQUIRED OF STUDENTS:

- A. A. Access to the internet and computers, through the LPC Computer Center, or access to a personal computer at home with an internet connection
- B. A small booklight for taking notes while satellite and slides are discussed in class
- C. A set of colored pencils
- D. Study guides as made available by the instructor