Overall Course Learning Goals -- Geology 1020, Fall, 2009 (Dr. Budd)

ATTITUDES TOWARD GEOLOGY AND LEARNING GEOLOGY:

A1. Students will gain an understanding of the dynamic and cyclic nature of the earth and appreciate that the landscapes we see today were not necessarily present in the past nor will they necessarily be present in the future.

A2. Students will value how scientific knowledge is produced and used, and will personalize the applicability of scientific thinking in their everyday lives.

A3. Students will develop an appreciation for what the depth of time means for Earth's history, and comprehend how the physical, atmospheric, and biological features of the Earth are the result of processes interacting with one another over billions of years.

A4. Students will reflect on their role in the earth system and orient themselves to their place in earth history.

BIG IDEAS :

B1. Students will explore how the Earth and all of its spheres (e.g. biosphere, geosphere, atmosphere, and hydrosphere) have changed over time.

B2. Students will be able to analyze some of these changes by using observations from the rock record and comparisons to modern Earth processes.

B3. Students will study the interactions between various chemical, biological and physical components that can change in rate and manner over the immensity of geologic time.

SCIENTIFIC WAYS OF THINKING

C1. Students will demonstrate the use of the scientific method by developing hypotheses that are based on observations and can be tested against independent evidence. Students will evaluate competing hypotheses, understand the role and limitations of scientific models, the difference between observation and inference, and be able to distinguish between an inductive approach and deductive approach to scientific reasoning.

C2: Students will be able to take a logical approach to problem solving and be able to analyze a variety of data using qualitative and quantitative approaches.

C3. Students will apply their growing scientific understanding, previous experiences, and personal value system to solve problems and reach informed decisions regarding topics of importance in their lives and/or to society.

Specific Lecture-Level Learning Goals (Objectives) – Fall, 2009

- **Fundamental Assumptions and Principles**
  - *State* the Principle of Actualism (aka, uniformitarianism) and e*xplain* its importance to interpreting Earth history
  - *State* the steps of the scientific method (both inductive and deductive approaches)
  - *Explain* what is unique about the testing of hypotheses in the Geosciences

- Be able to *recognize* applications of the Principle of Actualism (aka uniformitarianism) and the scientific method in the analysis of geologic information and interpretation of earth history

- **Relative Ordering of Geologic Events**
  - *Define* the various Principles used to determine relative ordering
  - *Recognize* the sedimentary structures that determine superposition
  - *Interpret* relative ordering of geologic features using those Principles & sedimentary structures

- **Missing Time in the Rock Record**
  - *Define* "hiatus" and the three types of unconformities
  - *Recognize* the three types on schematic figures or outcrop photos
  - *Interpret* unconformities within a relative ordering sequence

- **Relative Dating with Fossils**
  - *List* the various types of fossil preservation and *explain* what each type of fossil preservation represents
  - *State* the Principle of Fossil Succession
  - *List* the qualities a fossil must have to define a biozone
  - *Interpret* biozones in a vertical sequence of rocks given fossil distributions
  - *Define* the difference between rock units, time units, and time-rock units
  - *Memorize* the geologic periods of the relative time scale
  - *Interpret, predict, and infer* geologic ages of geologic features (rock bodies, sedimentary layers, unconformities, faults, folds) from ordering figures.

- **Absolute Dating by Radioactive Decay**
  - *Define* radioactive decay, half-life, parent isotope, daughter isotope
  - *Summarize* how an age can be derived if % parents and half life are known
  - *List* the requirements a rock must meet to yield a reliable age
  - *Apply* those requirements to choose which rocks to date
  - *Compute* absolute ages from a decay curve given % parents or daughters
  - *Compute* % parents given an age from a decay curve

- **Pleistocene glaciation – An icehouse world**
  - *List* the evidence on the North American continent for Pleistocene glaciation, and *explain* what its distribution tells us about the extent of the glacial events and the nature of the world away from the ice?
  - Be able to *interpret* proxy records of glaciation in terms of the number, timing, magnitude, and periodicity of glacial and interglacial events.
  - *Define* what is meant by a "proxy record" for glaciation and *explain* why the marine oxygen isotope record is such a good proxy relative to the sedimentary record on land?

- **The causes and controls of glaciation – orbital parameters and the climate system.**
  - *Define* the characteristics of the three Milankovitch orbital parameters and *explain* how they relate to the record of Pleistocene glacial events.

- *List* the components of the atmospheric energy system and *describe* how those components (including albedo and greenhouse gasses) affect the heat balance in the atmosphere, and hence determine global climate.
- *Describe* how the modern ocean redistributes heat and the role that process plays in modulating climate.
- Be able to *analyze* the patterns of climate change in terms of potential causes of climate change and positive and negative feedbacks in the climate system.

(Exam #1)

- **The carbon cycle & carbon isotopes**
  - *List* the short- and long-term reservoirs of carbon and *explain* the processes that transfer carbon within the short- and long-term reservoirs and between the short and long-term carbon cycles.
  - *Explain* how the burial and weathering of organic carbon in sediments determines the carbon isotopic composition of the global ocean and limestones formed in that ocean.
  - *Interpret* the relative balance of organic carbon burial and weathering from carbon isotopic data.

- **The Cretaceous greenhouse**
  - *List* the evidence for the Earth being warmer in the Cretaceous period than it is today.
  - *Explain* how a warmer ocean affects global circulation of that ocean.
  - *Explain* what black shale means in terms of organic carbon burial and oxygen levels in the world's oceans.
  - *Describe* the differences between circum-equatorial ocean circulation in a greenhouse world versus a circum-polar ocean circulation in an icehouse world.
  - *Predict* attributes of global circulation, carbon burial, ocean oxygenation and climate given an ocean circulation scenario.

- **From greenhouse to icehouse**
  - *List* the major changes in plate positions that affected Cenozoic ocean circulation.
  - *Explain* how those changes affected the redistribution of heat.
  - *Explain* the potential feedback mechanisms during the Cenozoic between global climate and mountain building, weathering of all rocks, global albedo, & the position of continents.

- **Sedimentary Environments and Facies**
  - *Describe* the general characteristics of facies.
  - *Explain* the difference between a facies and a depositional environment.
  - Be able to *associate* specific facies characteristics with specific depositional environments
  - *Analyze and interpret* ancient continental, shoreline, and marine environments from descriptions of sedimentary facies.

(Exam #2)

- Use sedimentary facies to *make or interpret* paleogeographic maps of the Earth's surface.
- *Demonstrate* comprehension of paleoenvironmental reconstruction by the analysis of the Cretaceous system of rocks in North America

- **Transgressions & Regressions**
  - *Define* a transgression and regression, and *explain* the difference between them.
  - *Explain* how transgressions and regressions cause environments to shift through time over the face of the Earth, and thus produce the vertical changes in the facies observed in vertical rock sequences.
  - *Analyze and interpret* ancient transgression and regressions from a vertical sequence of sedimentary rocks, multiple vertical sequences from different places, and maps of ancient environments.
  - *Discuss* the potential causes of a transgression and regression in terms of processes and time scales.

- **History of Life**
  - *Describe* the patterns of invertebrate diversity thru time and *discuss* the potential causes of those patterns.
  - *Describe* what happened during the "Cambrian Explosion and explain why this event is so important in studying the overall history of life on Earth.
  - *Define* extinction and mass extinction, *explain* the difference between them, *list* the 5 major mass extinction events in Earth history.
  - *Describe* the three patterns of declining fossil abundance associated with mass extinctions and explain how these patterns relate to possible causes of mass extinction.
  - *Discuss* various potential causes of the Permian-Triassic and Cretaceous-Tertiary mass extinctions.
  - List the sequence and age (geologic period) of first occurrences for different types of life through geologic history, starting with the earliest evidence of life and proceeding through the first multicellular animals, shelled invertebrates, and the major types of vertebrates.
  - *List* examples of anatomical evidence that support the evolution of one vertebrate type to another (fish → amphibians → reptiles → mammals).
  - *Contrast* the timing of vertebrate evolutionary advances with plant evolution and changes in the geosphere through time.

- **The Early Earth**
  - *Explain* why stromatolites are evidence for life even when we find no fossil life within them.
  - *Describe* the difference between a prokaryotic and eukaryotic organism and *explain* the importance of those differences to the evolution of life.
  - *List* the attributes of the early Earth's ocean and atmosphere and the supporting geologic evidence.
  - *Explain* the significance of photosynthetic prokaryotic organisms in changing the chemistry of the Earth's ocean and atmosphere.

(Exam #3)