Knowledge Base and Textbook Readings for Geology 02, Historical Geology
Spring 2009

The following is a list of topics, ideas, and vocabulary that you are responsible for learning in this class. Much of this material will be discussed in lecture, but you must read the textbook for the remainder, as well as a more detailed treatment of the lecture topics. Chapter numbers refer to Wicander and Monroe, *Historical Geology*, 5e Ed.

1. Introduction and Deep Time
Wicander (Ch.1)
Age of the Earth (4.6 GA) – Geologic or "deep time" vs. human timescale
Principle of Uniformitarianism

2. A Brief History of Historical Geology
Archbishop Ussher – biblical age of the Earth
Nicholas Steno – 3 principles (superposition, original horizontality, lateral continuity) and the principle of cross-cutting relationships
William Smith – correlation of rocks using fossils
Georges Cuvier – proof of extinction, successive ages of animal life separated by catastrophes.
Abraham Werner – neptunist theory of the formation of the Earth.
James Hutton – plutonist theory for the development of the Earth.
Unconformity at Siccar Point – significance to Hutton and geology.
Charles Lyell – uniformatarianism, *Principles of Geology*

Lab 1 – Geologic Timescale
Lab 1, Historical Geology Laboratory Manual
Wicander (Ch.4)
Development of the modern geologic timescale in the late 1700's and early 1800's.
Geologic systems – correlation of systems based on fossils (William Smith).
Principle of faunal succession (extinction is forever).
Eons, Eras, Periods, Epochs, law of superposition, correlation
Relative dating (putting events in order) vs. absolute dating (measuring age in years)

3. Charles Darwin and the Origin of Species
Wicander (Ch.7)
Evolution vs Creation as an explanation for the existence of different species.
Larmarckian Evolution – inheritance of acquired characters
Darwinian Evolution – evolution by natural selection
Darwin's voyage on the Beagle, influence of the Galapagos Islands on his ideas.
Natural selection is analogous to artificial selection, variation, adaptation, differential survival and reproduction, reproductive isolation, homologous structures

Lab 2 Paleontology
Lab 2, Historical Geology Laboratory Manual
Wicander (Ch.5)
Marine invertebrate fossils, major groups:
Foraminifera (microfossils)
Porifera – sponges
Cnidaria, Anthozoa – corals, rugose and tabulate corals (Paleozoic), scleractinian corals (modern, reef-forming)
Bryozoa
Graptolites
Brachiopoda (lamp shells – common in the Paleozoic)
Echinodermata – starfish, sea urchins, sand dollars, and crinoids
Mollusca – pelecypods (clams, oysters, scallops), gastropods (snails), cephalopods (ammonites, nautiloids – shelled squids)
Arthropoda (insects, crustaceans, trilobites)
How fossils form: death, decay, burial, lithification of sediment
Hard parts (often fossilized), soft parts (rarely fossilized), plant tissue (sometimes)
Modes of preservation: original hard parts, recrystallized hard parts, replacement (silicification, pyritization), carbonization
Trace fossils – footprints, trackways, burrows, eggs, nests, coprolites

4. Evolution and Extinction
Wicander (Ch.7)
Modern synthesis: how was Darwin's theory modified by modern genetics?
Sexual reproduction: why bother? – generates variability in offspring
Evidence for evolution: fossil record of evolutionary transitions – examples (origin of the tetrapod limb in the Devonian, evolution of birds from dinosaurs in the Jurassic, evolution of whales from land mammals in the Eocene), pattern of molecular similarity among organisms, homology, vestigial structures, embryonic history, biogeography.
Adaptive radiation: different causes of.
Extinction, causes of mass extinctions. Major mass extinctions – End Permian, End Triassic, End Cretaceous.

5. Plate Tectonics and the Rock Record
Wicander (Ch.3)
Tectonic plates: lithosphere (upper mantle + crust) supported by asthenosphere
Plates are driven by mantle convection, new ocean floor forms from rifting and old ocean floor is recycled by subduction
Divergent margins, continental rifting: geologic evidence for rift valleys – faults, lava flows, lake deposits. Evidence for passive margin – thick carbonate deposits.
Convergent margins, ocean-ocean, ocean-continent, and continent-continent collisions
Geologic evidence for plate collisions: metamorphism, granite plutons, filling of foreland basins with eroded sediment

Lab 4 Clastic Sedimentary Rocks
Wicander (Ch.6)
Clastic sedimentary rocks – how do they form?
Depositional environments
Sediment maturity
Sedimentary structures: ripple marks, mudcracks, trace fossils
Color in sedimentary rocks: red = oxidized iron, black = unoxidized carbon
Sediments, conglomerate, sandstone, mudstone

Lab 4 Chemical Sedimentary Rocks
Wicander (Ch.6)
Chemical sedimentary rocks – how do they form?
Carbonates – limestone and dolostone, evaporates (halite, gypsum), organic rocks (coal)
How are carbonate sediments produced? (corals, algae, marine organisms)
Chemical precipitation, grainstone, packstone, wackestone, lime mudstone

6. Radiometric Dating
Wicander (Ch.4: 63-69)
Lord Kelvin's estimate of the age of the Earth based on cooling rate.
Radioactivity – what is it and how can it be used to date rocks? Isotopes, radioisotopes, mass spectrometer, half life, parent isotope, daughter isotope, uranium-lead decay series, potassium-argon dating. Concordant ages.
C14 dating – how it works and how it is different from other types of radiometric dating.
Henri Bequerel, Marie and Pierre Curie, Ernst Rutherford, Bertram Boltwood