Environmental Geology - Study Guide for Exams

Here is a guide to help you focus on the important aspects of the chapters and class notes on discussions held in class. Use this guide in conjunction with YOUR NOTES (with luck you have put STARS near the items that were suggested as good exam questions - *these items might not appear below*!) the in-class Quizzes, the Quizzes and the tools within each chapter: the "Consider This...?" questions within the text, the Summary, Key Terms, Study Questions, etc. Study the figures (sometimes a picture is worth a thousand words, and is easier to remember). Don't save studying until the last minute! For all mid-term exams, you MAY bring a ***hand-written*** (BOTH sides), **3x5-inch notecard** with you to the exam. Remember, the Final Exam is COMPREHENSIVE (that means it covers the WHOLE SEMESTER!!); ***for that exam only***, your notecard may measure **5x8 inches**.

Humans, Geology and the Environment

Human existence has become a significant factor in the processes operating on the Earth. There are many ways in which humans interact with the natural environment. Unfortunately, we don't always apply our knowledge base to the best of our ability, or consider what natural processes might affect us or be affected by us. We had discussions about resources and how we need them, and our level of use relative to that of other people in the world.

What is Carrying Capacity, and how is it determined? What does Exponential Growth mean? What is doubling time, and how does this concept apply to populations with various growth rates? What are some of the more serious long-term environmental problems facing us, and how are they related to (or exacerbated by) overpopulation? Thinking about these problems should lead us to some considerations about what a sustainable society might look like. Can you give some insight into what we need or need to accomplish to make society more sustainable? (Don't get TOO involved in answering this question - we'll be driving at these principles for the rest of the semester!)

The Earth System and Climate Change

Earth is pretty much a closed system in most respects (what does this mean?), one important exception being solar energy. We can focus our studies of Earth systems by considering various spheres: lithosphere, atmosphere, hydrosphere, and biosphere. What sources of energy are important in each of these? What is homeostasis, and what kind of feedback mechanism is at work? (Hint: what does “stasis” mean?)

You should by now be well versed in the science behind the Greenhouse Effect (GHE). What are the relative wavelengths and photon energies of the various sections of the electromagnetic spectrum? Since the Sun emits all of them, what happens to these photons on their way to Earth’s surface – which are absorbed by what, where? (Whew! For example, you might say that Gamma rays are absorbed by ions of O and N in the Thermosphere.) I suppose you’d have to know the various layers of the atmosphere to answer that one, eh? And perhaps your answer would help you understand why the various layers have the temperature trends that they do. What do clouds and albedo have to do with the GHE? What are the most important GH gases, and what effect has CO2 on the GHE – is this a positive or negative feedback? How does the amount of water vapor in the air relate to all of this?

Think about the uneven heating of the Earth and its effects on global wind and ocean circulation. Can you piece together what the various wind belts are doing (on a spinning Earth, of course – thank goodness for that Coriolis Effect!)? Why are ocean currents relevant to this course anyway – and what might happen were they to change?

The Solid Earth

Can you outline the steps involved with the Nebular Hypothesis? Give details about important "milestones" and why they are important. Gravity is the principle force that caused the formation of the Earth and other objects in our solar system. Since that formation, the VERY IMPORTANT doctrine of Uniformitarianism has applied; what is it, and how do geologists apply it?

Atoms are made of three different kinds of subatomic particles. What are they, and what distinguishes each? The number of ____ determines the chemical characteristics of a particular atom, thereby defining it as an atom of Element "X" (for example, Hydrogen). Elements are arranged on the Periodic Table such that those in a column tend to behave similarly to one another, since they all have the same number of outer ("valence") electrons. Elements can bond together, if need be, in two ways (that we briefly discussed, anyway): ionic bonds (based on **charge**) and covalent bonds (**sharing** of electron pairs); when they do, they can form **minerals**. What is the definition of a mineral (all 5 parts, as discussed in class)? Be able to list **at least 5** physical properties of minerals - it might be good to know what they mean, too! What is a silicon tetrahedron, and why is it important? What's the most common mineral group in the crust of the Earth? Minerals form when it is appropriate for them to do so - when conditions of Temperature, Pressure, and availability of water are right. After a mineral forms, those conditions might change (as a result of, for example, Plate Tectonic motions). Minerals are combined - bound together - to form Rocks.

Rocks are divided into three main groups: Igneous, Sedimentary and Metamorphic. When we "observe" a rock, we look for three things: the size of the particles, the relationships among them ("Other Features"), and their composition (what minerals are there, and what is their proportion).

Igneous rocks form from crystallization during cooling of magma. There are **intrusive** and **extrusive** igneous rocks - what's the difference? You can tell them apart by their textures: phaneritic, aphanitic, glassy (as in obsidian), porphyritic, pyroclastic. If an extrusive rock is mafic in composition (**M**g- **A**nd **F**e-r**IC**h), then it is called Basalt. If an intrusive rock is felsic then it is called a Granite. Compared to Basalt, Granite is less dense and has lighter-colored, larger mineral crystals in it. Try to recall the samples we looked at! Also, be prepared to show that you know the different rock names and what they mean (as implied by this figure).

Sedimentary rocks are those formed at or near the Earth's surface. The **detrital** (also known as clastic) particles can be divided (on the basis of their sizes) into gravel, sand, silt and clay; these particles can undergo the process of **lithification (compaction and/or cementation)** to become conglomerates, sandstones, siltstones and shales, respectively. Detrital sedimentary rocks usually contain structures that indicate their origin, especially **bedding**. **Chemical sedimentary rocks** are derived from material that was dissolved in water. **Biogenic** sedimentary materials involve an organism in their formation. *Limestone* is an important **Biogenic** sedimentary rock formed from the collection of the shells of organisms, usually at the bottom of the sea. How does it differ from Chert, which is a bit less common?

Metamorphic rocks are formed deep in the Earth's crust from previously existing rocks that are subjected to changes in **Pressure**, **Temperature** and hot solutions (**Fluids**). Differential pressures exerted on a rock of the appropriate composition can result in **foliation**. Foliated rocks are divided on the basis of grain size into **slate, schist and gneiss**. Nonfoliated rocks include quartzite, serpentinite and marble. Hey, wait - why are these nonfoliated? From what type of sedimentary rock are quartzite and marble derived?

Any type of rock from one of the broad groups described above (and many that are not described above!) can become any other type - i.e., an igneous rock can become the particles making up sediments, which can then become metamorphosed, etc. This is known as the *Rock Cycle*. The changes result from changes in Heat, Pressure, and the presence/abundance of Fluids (the Agents of Change).

The **principles of relative dating** rely on the Doctrine of Uniformitarianism, and include the Laws of Superposition, Cross-cutting Relations, and Fossil Succession. Perhaps you could use them to solve a geological puzzle - or at least to tell how we know that one layer is older than another. What is a Fossil? One good use of the Principle of Fossil Succession is in correlation - comparing ages between rocks on different continents. This was our best method of determining ages before the advent of...

Absolute dating: a technique that is peculiar to Geology and involves natural radioactive decay. What are isotopes? What part of an atom is most significantly affected when decay occurs (the electrons, or the nucleus?) Remember, one element (parent) decays to another type of element (daughter) by a rate known as a "half-life." A half-life is the time it takes for 1/2 of the parent to decay (does not depend on the initial amount); this statistical probability does not vary with temperature or pressure, or any other variables that humans might consider. Therefore, we can date samples if we know the half-life and the amount of parent and daughter product in the sample. For example: suppose the half-life of element X is 300 years and X decays to daughter Y. Suppose you found a sample with 128 "atoms" of X and 1920 "atoms" of Y - how old is the sample? How old is the Earth, for that matter?

Plate Tectonics

What four pieces of evidence (observations) did Alfred Wegener (1880-1930) use in his formulation of the Continental Drift Hypothesis? Why was his theory rejected in the end?

New evidence became available (as a "silver lining" to World War II) that resulted in the hypothesis of Sea Floor Spreading. That evidence was based on Paleomagnetism. What is paleomagnetism, and why is it available for us to study it? How is it used to suggest the sea floor spreading mechanism? (Draw a cross-section of a mid-ocean ridge and explain how spreading leads to creation of the magnetic stripes on the ocean floor.) Some other evidence from the sea floor supports this idea. With increasing distance from a mid-ocean ridge: the age of basalts making up the ocean floor increases; the thickness of sediments increases; and the age of the oldest sediment (at the bottom of the pile) increases.

We can combine the Continental Drift and Sea Floor Spreading hypotheses into one unifying Plate Tectonic Theory. Plate Tectonic Theory explains much of the mountain building, seismicity and volcanism on the Earth. **What are the plates made of**? (See below.) There are three kinds of plate boundaries: *divergent, convergent,* and *transform*. Can you draw a really simple picture that shows what direction the plates move relative to one another in each of these three boundary types? CAN YOU GIVE A REAL-WORLD EXAMPLE OF EACH? Remember that there are two types of CRUST associated with any plate: Continental [granitic, less dense (2.7 g/cm^3), thick (40 km)] and Oceanic [basaltic, more dense (3.0 g/cm^3), thin (6-10 km)]. Plates can contain either or both, and this crust is coupled to the underlying Upper Mantle; together the crust and upper mantle form the Lithosphere (or lithospheric plates).

Hot spots ARE NOT EXPLAINED BY Plate Tectonics! Plate motion is thought to be driven by one of the (three) mechanisms of Mantle Convection and Gravity. On the other hand, hot-spot volcanism is deeply rooted at the core-mantle boundary, and so ignores the long-term overturning of mantle material. Hot spot volcanoes can TRACE THE PATH of the plates, however (ex: Hawaii), and so they give us more evidence of how the plates move.

How are earthquakes and volcanoes associated with these boundary types? Be prepared to **draw a typical subduction zone**, showing which way the subducting plate goes, and where the trench, volcanoes and earthquakes are (Benioff Zone). What is/are the driving force/s of Plate Tectonics?

Can you identify the different layers of the Earth? These layers are bounded by discontinuities - dramatic changes in the velocities of seismic waves - and are distinguished by the rock types involved and their properties (brittle, plastic, liquid...)

Earthquakes and Human Activities

An earthquake occurs when the elastic limit of the rock is exceeded (elastic rebound theory). Be prepared to draw and label the relationship between a **fault, the Earth's surface, the epicenter and the focus of an earthquake**. Can you identify different kinds of faults?

There are two basic kinds of seismic waves: Body Waves and Surface Waves. Body waves travel throughout the body of the Earth, and are subdivided into P- and S-waves. P-waves (or Primary waves), travel fastest through a given medium. They are a kind of *longitudinal* wave because they travel by compression and expansion (push-pull in the direction of propagation). Longitudinal waves can travel through solids and fluids (liquids and gases). S-waves (or Secondary Waves) travel slower than P-waves; they are a kind of *transverse* wave because they propagate by a shearing motion (side to side, perpendicular to direction of propagation). Shear stress is not transmitted through fluids. Surface waves are created when P- and S-waves interact with the surface, and they travel only on the Earth's surface; they are slowest overall, and travel by a rolling motion

(Rayleigh waves) or a side-to-side motion (Love waves). Perhaps because they spend their time and energy moving materials more! Since they involve the most displacement of material (which is why they can only travel along the surface), they (especially Love waves) **cause the most damage** to structures.

How is an epicenter located? (Note: simple questions sometimes require long answers!) Distinguish between Mercalli **intensity** and Richter **magnitude**. (We didn't get into Moment Magnitude in this class - don't worry about it.) *How much more energy is released, and how much more displacement is there, in a magnitude 7.5 earthquake than in a 6.5? 5.5?* What is an "isoseismal map?" Do you suppose it is safer to live in an area where there is "fault creep," or in an area where there is a "seismic gap?"

Some factors that need to be considered when designing buildings and communities for Earthquake Country are ground shaking (remember, acceleration and resonance are important here), landslides, liquefaction, ground rupture, fire (indirectly - wouldn't happen without modifications by humans, e.g., electric wires and gas lines), and tsunamis. What are some sensible measures that we can take to minimize damage from each of these hazards? For example, why do wood-frame structures suffer less damage than unreinforced brick buildings in an earthquake? What should YOU do before, during and after an earthquake in your neighborhood?

With such potential for damage in mind, it would be nice if we could predict them. Can we? What are some of the methods that we try to use? What factors should be included in a useful prediction? Factors that go into the production of a Seismic Risk Map include: likelihood of occurrence, probable magnitude, and properties of the surface materials (geologic response to shaking). What areas of the Contiguous U.S. are susceptible to damage from earthquakes?

Volcanoes

Magma erupted at the surface of the earth is called lava. The **viscosity** of lava is related to its TEMPERATURE, SiO_2 CONTENT, and GAS CONTENT. These factors control the type of eruption (Volcanic Explosivity Index - gentle, explosive or cataclysmic) and the shape of the volcano that is created.

BASALT is a **mafic** magma; it has high temp., low SiO_2 and fairly high gas content, and therefore is generally a fluid lava (not viscous). Basaltic lava flows are typically thin, and they spread out over vast areas. After many flows, the resulting shape is that of a Shield. Hawaii is an example of a shield volcano. Variations can always occur: in a given eruptive cycle, the first magma to erupt may be the most gaseous of the lot, and may form a **cinder cone** (see below). After that gas-rich lava has run its course, lava with a little less gas flows out, with a ropy texture forming on its surface (**pahoehoe**). Lastly comes the basalt that has lost almost all its gases; this version is more viscous, oozing slowly out in a clinkery (rough, jagged) flow known as **aa**. Lavas with higher SiO_2 contents are typically not as hot, and the silica may form complex molecules (polymers) in the magma, and so siliceous (felsic) lavas are more viscous (flow more slowly). When lava does not flow easily enough to allow the gases to escape, violent explosions can occur. These explosions send material (pyroclastic material: ash and blobs of lava) into the air - and these pieces cool very quickly, and then land back on the earth. This spattering can result in a **cinder cone**. Cinder cones can be formed from any lava type, and are easily eroded because they consist of small, angular chunks of material that are not in equilibrium with surface conditions.

Many familiar volcanoes are **composite cones** (or stratovolcanoes). These form from alternating pyroclastic and fluid lava flows, and can build up into high peaks (Mt. St. Helens, Mt. Shasta, Mt. Rainier, most of the Andes, Mt. Fuji, Mt. Etna, etc.). These peaks may have craters associated with them, or they may have collapse structures known as calderas.

What benefits do volcanoes contribute to our lives here on Earth? **What kinds of hazards are associated with volcanism?** Is there anything we can do to stop them?

Can you draw a simple cross-section showing the difference in the slopes developed on shield vs. composite volcanoes? **Why** are the slopes different? What are some of the gases that are emitted from volcanoes? Which is most abundant?

Soils, Weathering and Erosion

Weathering involves mineralogical and textural changes at the surface of the Earth. You might think of these as the "Agents of Change": Heat, Pressure, and Availability of Fluids (water). Q: Why do rocks and minerals undergo weathering? A: The ones that do were NOT formed under the conditions of the Earth's surface, so they are out of equilibrium with those Agents of Change.

Physical weathering simply involves a change in the size of the particles - i.e., NO change in the composition! Making large particles into smaller ones increases the amount of surface area exposed. Here are some ways by which mechanical weathering proceeds.

- Frost Wedging: What **three conditions** must be met for frost wedging to be effective? What is Talus, and how is it associated with Frost Wedging?
- Unloading: What is exfoliation? What are joints, and how do they differ from faults?
- Biological Activity: Can you cite an example of a common sight that shows this happening?
- Abrasion: this one is obvious to most people, but not discussed specifically in your text!

Chemical weathering involves a change in the size as well as the composition of the material. It is best accomplished in the presence of water. Here are some ways by which mechanical weathering proceeds.

- Solution (dissolving of minerals)
- Oxidation ("rusting" of minerals)
- Hydration (combining of water with minerals creates new minerals)
- Hydrolysis (complex chemical reaction involving combining of water with minerals to create clay)

Would you expect a relationship between the *rate of weathering* of certain materials and their *positions* in the "crystallization sequence" referred to on p. 175? What other factors determine the rate of weathering? Some results of weathering are spheroidal weathering, exfoliation, and sheet joints.

Be sure you can label the different horizons in a soil profile (O, A, B, C) and describe what characterizes each. What is soil made of? What factors determine the development of soil? (Hint: see p. 172 for the definition of CLORPT). What is Loess? List some areas around the globe where it can be found in large quantities. The zonal classification of soils involves words like pedalfer ("ped" means soil, "al" and "fer" stand for Aluminum and Ferrous Iron), pedocal ("cal" stands for calcium carbonate), laterite, and tundra soil. Laterite is not only rich in iron, it is also extremely rich in aluminum - much more so than pedalfers - and in some areas of the world it is actually mined as an ore of aluminum!

Once soil is formed, conditions might change such that it starts to be eroded. Explain how some of these processes work and how they affect the soil: sheet erosion, rill erosion, wind, ORVs, overgrazing. How can we minimize soil erosion? Your book is full of ideas - 5 that it describes in detail!

Mass Wasting and Subsidence

Mass movement is characterized on the bases of type of material, type of movement, water content, and rate of movement. Can you describe the different types - for example, rock fall, rock (or block) slide, slump, creep, debris flow, to name A FEW? What is the Angle of Repose, and how does it relate the forces of Gravity and Friction to the mechanics of slides? In light of those forces, what are some ways - both natural and anthropogenic - to *increase* the likelihood of slope failure? How can we help *minimize* the chances - what are some ways to control or stabilize an area? You might want to prepare yourself by learning to draw a scenario similar to one we talked about in class. What is **creep**, and how do we know that it occurs? Which is the fastest method of mass movement? Which is the slowest? Which causes the most damage overall? What are two ways to *increase* the likelihood of slope failure, and how can we help *minimize* the chances? What is subsidence, and how does it differ from settlement?

Freshwater Resources

Can you name the **five important reservoirs** of the hydrologic cycle? What about the **five processes** (or mechanisms) that operate to transfer water between them? What is the ultimate *source of energy* driving this cycle? How do we classify the different ways that we use water? Once and for all, what is the difference between an INFLUENT and an EFFLUENT stream? Which is more common in California?

Water infiltrates the ground by displacing the air within the pore spaces of the soil. A material is said to be POROUS if it contains pore spaces; it is said to be PERMEABLE if those pore spaces are interconnected. Which rock types make good aquifers? Which make good aquicludes? The Water Table marks the interface between the zone of aeration and the zone of saturation. How does topography affect the shape of the static water table? What is drawdown? What is a cone of depression? Mining of groundwater can be harmful to the capacity of an aquifer - why? Can such practices cause subsidence - and if so, can we repair this damage? What constitutes good groundwater management - what data or measurements are necessary? Describe the problems associated with using groundwater in coastal environments (such as barrier islands) and what can be done to stop or prevent salt-water encroachment.

What **three conditions** must be met to form an Artesian System? Many beverage manufacturers claim the water in their product is purer because it comes from artesian wells or springs. Evaluate this claim in light of groundwater-surface water interactions.

Surface Hydrologic Hazards

Draw a *longitudinal profile* of a stream (note that this is surprisingly simple!). On it, label the Head and the Mouth, and where the processes of erosion, transportation, and deposition dominate. How are these related to the amount of energy available (velocity of the stream)? Where is BASE LEVEL? (Is that Ultimate base level or Local base level in your picture?)

A stream has three important jobs: to erode, to transport, and to deposit sediment. A stream's ability to erode and transport material is related to its VELOCITY. Velocity is controlled by: Gradient, Friction of the channel (shape, size and roughness), and Discharge. What is discharge, and how is it measured? A GRADED STREAM (or the graded part of a stream) is one in which erosion equals deposition, resulting in net transportation.

Eventually all that material must be deposited. What is a floodplain, and what are some features commonly found there? Draw *cross-sectional profiles* across a stream at various points in its meandering shape. What are the Point Bar and Cut Bank, and what happens there? **Discuss the formation of natural levees**, including where sediment is deposited and why it is deposited there. How are they different from artificial levees? What other methods are commonly used to prevent or minimize the damage caused by floods - how effective are they, and at what cost? Use examples from the video you saw (Sacramento area). We (and your textbook authors) will have talked quite a bit about dams. What benefits do they impart to humans? What are some of the negative impacts upon humans and the environment? Cite some recent examples of what is being done today to reverse some of those negative impacts.

The Coastal Ocean Environment

A wave is essentially the evidence that energy is passing through the water. What three factors are involved in the formation of waves? Locate these features in a typical wave: Crest, Trough, Wavelength, wave Height, Amplitude. In deep water, the motion of water particles is circular (these are **oscillatory** waves), with circles getting smaller to a depth of 1/2 the wavelength. This depth is known as the **wave base**. Wave base may change with the seasons, and also during a very powerful storm or when sea level changes. When the column of circular motion comes in contact with the ground (or a rock, etc.), the bottom begins losing energy to friction. Eventually (when depth is about 1/20 wavelength), the base of the column can no longer support the overlying column, and collapse occurs - the wave breaks. What do plunging and spilling breakers tell us about the sea floor? After the breaking point, the water carries the energy further by **translation** rather than by oscillation. Moving water is more capable of transporting sand particles, and so can induce abrasion and erosion.

Waves strike the beach obliquely, resulting in littoral drift (a VERY IMPORTANT process!!!). Waves are *refracted* such that energy is concentrated on promontories (headlands); because rocks have different resistances to erosion, there may also be the formation of sea stacks and arches. On the other hand, energy is dissipated (more widely distributed) in beach areas. The beaches are places of deposition (note the differences in grain size!). If erosion occurs along a coast due to removal of sediment, then that erosion causes formation of a corresponding wave-cut cliff (sea cliff) and wave-cut platform. Deposition of sediment in areas of lower energy forms tombolos or spits, some of which may grow to completely block the mouth of a river, resulting in a bay-mouth bar. Barrier islands can form where there is a large amount of sediment available.

Rivers are the dominant suppliers of sediment to the coast. Sediment is then carried by longshore currents. During the stormy winter months, sediment is pulled out away from the coast and gets below wave base. It is then no longer available to beaches, and so it is out of the sediment **budget** of the coast. Some features commonly found along coastlines with a healthy budget of sand are spits, bay-mouth bars, and tombolos. One method of "caring for and feeding undernourished beaches" is to erect groins to "trap" sediment. What does the coastline look like shortly after groins are emplaced? What happens to the rate of erosion where there are no groins? Other attempts to curb the enormous power of the oceans include sediment replenishment and construction of jetties, breakwaters and sea walls. What are the differences among these - what is the purpose and the result of each?

How are the coastlines affected by hurricanes, ENSO, and climatic changes? (We will not be treating these in great detail in class.) What are emergent and submergent coastlines, and what features might we look for to identify them as such? What are estuaries, and why are they important?

Glaciation and Long-Term Climate Change

Discuss the factors surrounding Glacial Budgets. Describe the differences among the types of moraines, and discuss how watching these over time can tell us about climate changes (stationary, advancing, receding glaciers). We will go over the basics of the Factors That Control Climate, and will get into some detail regarding Greenhouse Gases and the Greenhouse Effect. What is the evidence today for Global Warming? Is there good reason to blame humans for some of this? What are other (natural) causes? What are the anticipated effects - short-term and/or long-term - of this "enhanced" global warming? What can we - YOU - do to change the outcome?

Mineral Resources and Society

Have you touched any minerals today? This gives you an idea about who needs mines. There are many different kinds of materials that must be mined, and crushed stone, sand and gravel together constitute 85% of per capita consumption in the U.S. Mining can be done underground - what are some consequences? Will underground mining affect the surface? Surface mining involves removing materials directly from the surface. Some examples of surface mining are dredging, hydraulic mining, strip mining, and open pit mining. Which of these is how gravel is mined? Besides reclamation, what is the most expensive part of gravel mining? What are some of the ways that gravel mines can be reclaimed? Be prepared to list common concerns that a community might have regarding the opening of a gravel mine. How, briefly, does gravel mining compare with mining for other materials - coal, for example? Think in terms of dealing with waste, processing ore, and reclamation; remember that you are supposed to sound intelligent when you make comparisons! ;-) Hint: you might look at Table 13.3 Do you think the environmental concerns of mining are properly addressed, for the most part? Cite specific examples of successes and failures. In light of the concerns, do you think it likely that mining will continue? WHAT CAN OR SHOULD WE DO?!

Energy Resources

Methane Hydrates are chunks or layers of ice that house trapped methane. They occur deep in the oceans, where the water is cold and the pressure is high; bacteria probably produce the methane, which is trapped in the ice that forms. In terms of environmental awareness, what do you think is important about what we know of them? As a start, consider that methane (CH_4) is a strong greenhouse gas, and if it is released then the global warming trend could be significantly enhanced.

"Energy is essential to all life." Can you give an explanation of what the equation, L = (R+E+I)/(population) means, in terms of an industrialized society? Consider this: The U.S. has approximately 5% of the world's population and uses about 20% of the energy. Here's another point to ponder: there is a well-known law of physics ("Conservation of Energy") that says that "energy is not created nor destroyed; it is only transformed." If this is true, then what's the big deal - where's the energy shortage? Okay, okay... We divide our energy resources into two categories: Renewable and Nonrenewable. If all are natural or products of natural processes, what's the difference?

The most commonly acknowledged energy source is crude oil - petroleum. Petroleum companies employ about half the geologists of the world; whimsical oil price fluctuations are perhaps the single most important uncertainty in the world economy. How does oil form - what conditions must be satisfied? It is trapped into economical deposits by salt domes, structures and anticlines, and stratigraphic traps. Oil occurs as a liquid between the grains, much as groundwater occurs. Oil has a propensity for sticking to the grains, however, so it is likely that up to 75% of the oil in a reservoir can only be recovered using secondary (or even tertiary) methods. Ah, but this is a course concerned with Geology and the Environment - not so much Economics (or is it?) - so let's talk about what the effects of oil "consumption" are to the environment! Can you think of any consequences that need to be considered (cite examples from the real world) regarding each phase of our use; and what efforts do we have to combat these gloomy side effects? Let's see, we've got extraction (subsidence?), transport (spills?) storage (leaks?), and use (air pollution, greenhouse gas emission, waste?) - and we haven't even gotten into the politics of getting it from other nations! Which nations have the "most" oil - where are they, and what's the problem, can't we just buy it or them?

What are the 5 rankings of coal? We have to know this to understand better what conditions are necessary for coal to form (coalification - what are those conditions?) and thus where it occurs. What is Methanol, and why is it of interest in this world where petroleum reigns king?

A bit of a recap - what are the major issues associated with burning of fossil fuels? Would conversion to biomass sources alleviate any of these problems?

What options do we have for the Future? Try to get comfortable with the ways in which solar energy can be used, and the pros and cons of solar, hydro, geothermal, ocean wave and tide, and H-fuel cell energy. Nuclear power plants are perhaps the most controversial of all - why, what's the problem? WHAT CAN OR SHOULD WE DO?!

Waste Management

Will we get to this? We'll see! We will at least get to the basics of Landfills and issues that need consideration. For instance: how much trash do ***you*** produce, and what kind of trash is it - Group 1, 2, or 3? Where does ***your*** trash go - to a landfill, incinerator, or to the ocean? What are leachate and effluent, and how can we deal with them? How fast can composting work - as fast as dumping? Decomposition produces methane - how can we deal with it (or do we have to)? WHAT CAN OR SHOULD WE DO?!