I. The Crust

A. First:

1. Composition of the whole Earth:

c. Earth is comprised of Solid, liquid and gasses, each made of 92 naturally occurring elements

b. Earth is: 35% Iron (Fe), 30% Oxygen (O), 15% Silicon (Si), 10% Magnesium (Mg), and the remaining 10% is composed of the other 88 elements.

2. Two Types: Continental and Oceanic

B. Oceanic Crust

1. Thickness: 0 to 10 km, ~7 km on average
2. Composition is 'mafic': Si >50% > Mg+Fe > Ca+Al
3. Recall from Plate Tectonic Theory (Sea Floor Spreading):

a. Ocean crust created at divergent oceanic plate boundaries

b. Volcanoes on these plate boundaries produce the rocks that make the oceanic crust

C. Continental Crust – more complicated than oceanic crust

1. Thickness:

a. ~20 to 70 km, average ~ 35 km

b. Thickness depends on the continental 'setting' - mountains vs. interior vs. coastal plain

2. Composition is 'felsic': Si > 50% > Ca+Al > Mg+Fe > K & Na\
3. Origin of Continental Crust is complex – many different processes. In this class we will investigate these processes and the origin/history of the North American Continent.

D. Rocks and Minerals

1. Note that the crust (and Earth) is not made of Native elements.

- Not simply metallic iron, silicon etc.

2. Rather, the crust (and Earth) is made of rocks
   a. Rocks are made of minerals
   b. Minerals are made of elements

II. Mineralogy

A. Definition of a Mineral: Naturally occurring, inorganic, crystalline solid with definite chemical composition.

1. Naturally occurring = not man made
2. Inorganic = not composed of organic molecules (C-H-O chains): Amino acids, Lipids, Plastics etc.
3. Crystalline = Ordered internal arrangement of atoms
   a. Evenly spaced and alternating in a repeated pattern (lattice structure)
   b. This structure is responsible for nearly all a minerals diagnostic properties!
4. There are >3000 different known minerals. Fortunately, only 25 compose most of the crust.

B. Origins of Minerals

1. Crystallization from a liquid magma
   - Cooling of molten magma inside a volcanic system results in the crystallization of minerals (freezing).
2. Crystallization from other mineral = chemical reactions
   - Minerals are the reactants – add energy and they will react to form products (new minerals)
3. Precipitation from water – water can become saturated with dissolved ions resulting in crystallization of minerals from the water.
4. Note: Volcanic Glass is not a mineral. Rather, it forms from liquid magma by instantly freezing the atoms before they can form crystals of minerals.

III. Rocks

A. Definition and Classification:

1. Definition: Rocks are natural aggregates of minerals (and or volcanic glass)
2. Rocks are classified into three types based on the processes by which they form.
   a. Igneous
   b. Metamorphic
   c. Sedimentary

B. Igneous Rocks (*igneous* is greek for 'from fire')

1. Origin:

a. Crystallize from molten/liquid magma

b. This results in a crystalline texture (interlocking crystals form the rock).

2. Two types:

a. Intrusive: Formed when magma cools deep in the Earth

i. Slow cooling (interior of Earth is hot)

ii. Crystals that form these rocks grow large – due to slow cooling.

b. Extrusive: Formed when magma cools on the surface

i. Magma erupted onto surface is called lava

ii. Lava Freezes rapidly

- Surface of Earth is VERY cold relative to lava

- Results in very small crystals and glass (not enough time to grow large).

3. Classify igneous rocks based on

a. Intrusive vs. extrusive origin, and

b. Composition

c. Examples: gabbro, granite, basalt, and rhyolite

C. Sedimentary Rocks

1. Composed of fragments of other pre-existing rocks or fossils.

- e.g. Sandstone, conglomerate, limestone

2. Or, composed of mineral grains that precipitate from water

-e.g. Chert, rock salt

3. Note that these rocks form on (or very near) Earth's surface

- Covering 65% of the surface of continents

D. Metamorphic – VERY complicated rocks (*metamorphic*= 'change shape')

1. Form by changes in composition, texture, and mineralogy of pre-existing rock in the solid state in response to changing pressure and temperature (greater than 200ºC)

2. So, pre-existing rock is buried deep in the Earth where it is subjected to heat and pressure causing chemical reactions to change the rock into a new rock.