Introduction to Geology

Why the heck would you want to take a geology class?

1) Geology is responsible for supplying many of the things we need.

2) Geology is closely related to the environment, which we need to protect.

3) Coping with geologic hazards.

4) Understanding our surroundings

Earth Systems:

1) Hydrosphere

2) Atmosphere

3) Biosphere

4) Geosphere

Overview of Important Geologic Principles

A. The Earth's Heat Engines

1) Internal

2) External

B. What makes up the solid Earth? Over 90% is made from just four elements:

Elements combine in a variety of ways to form Earth materials:

1) Organic Chemicals
2) Minerals
3) Glasses
4) Rocks
5) Sediments
6) Metals
7) Volatiles
8) Melts

C. Parts of the Earth and Plate Tectonics

Compositional View		Geophysical View
Crust (compositional)	**Oceanic**	**Continental**
Average thickness	7 km	30-50 km (thickest under mountains)
Seismic P Waves	7 km/s	6 km/s (higher in lower crust)
Density	3.0 g/cm^3	2.7 g/cm^3
Probable Composition	Basalt underlain by Gabbro	Granite and other Plutonic igneous rocks, met or sediment. cover

Moho - separates crust from the mantle

We also have samples of both types of crust.

Evidence of other layers:

For geophysical view, seismic waves

For compositional view, ophiolite sequences of rocks

Plate Tectonics: states that the earth is composed of lithospheric crustal plates that interact with one another in a dynamic fashion (colliding, spreading apart or sliding by one another).
Plate Boundary Types:
1) Convergent 2) Divergent 3) Transform

Geologic Time Scale

Eons>>>Eras>>>Periods>>>Epochs>>>Ages

The Four Eons:

Hadean Eon (4.5 BYA to 4.0 BYA)

Archaen Eon (4.0 BYA to 2.5 BYA)

Proterozoic Eon (2.5 BYA to 543 MYA)

Phanerozoic Eon (543 to Present)

The Three Eras of the Phanerozoic Eon:

Paleozoic Era (543 MYA to 248 MYA)

Mesozoic Era (248 MYA to 65 MYA)

>Divided into the Triassic, Jurassic and Cretaceous Periods

Cenozoic Era (65 MYA to Present)

>Divided into the Tertiary and Quaternary Periods

Introduction to Minerals

It's all about scale:

Atoms>>>Elements>>>Minerals>>>Rocks>>>Continents>>>Planet

Basic Chem:

Atomic Structure

- Atom: smallest unit of an element that possesses the properties of that element

- Main building blocks-protons, neutrons and electrons although many other subatomic particles have been discovered in recent years.
  Positive Charge:
  Negative Charge:
  No charge:

- A typical atom consist of a nucleus of protons and neutrons and a cloud of electrons surrounding the nucleus.

- The distinguishing feature of an atom of a given element is the number of protons in the nucleus. The number of electrons and neutrons in an atom in a given element can vary, but the **number of protons is constant**.

- Normally atoms are electronically neutral.

Isotopes

■Isotopes, which are varieties of a given atom (element), are produced by variations in the number of neutrons in the nucleus.

Examples: Carbon Uranium

Why are these important to this class?

Ions

- Electronically charged atoms, called ions, are produced by the gain or loss of electrons.

Why do atoms become ions?

- Atoms combine, mostly through ionic or covalent bonding, to form minerals.

Ionic Bonding: involves the transfer of electrons from one atom to another.
Why does this occur? Examples.

Covalent Bonding: involves the sharing of electrons.
Why do atoms share instead of transferring? Examples.

Properties of Minerals

- Occur naturally as an inorganic solid.

Solid- atoms are arranged in a rigid framework
>crystal structure- 3d pattern
>amorphous solids- random – like glass

- Has a specific internal structure; that is its constituent atoms are precisely arranged into a crystalline solid.
- Has a chemical composition that varies within definite limits and can be expressed by a chemical formula.
- Has definite physical properties (hardness, cleavage, etc.) that result from its crystalline structure and composition.
- It is stable over relatively restricted range of T&P.

- Most minerals are a combination of 2 or more elements

Examples:

- NaCl (Halite), PbS (Galena), CaCO3 (Calcite)
- Native minerals will only be one element: Au, Cu, Ag, C, S

Polymorphism
Two distinct forms of the same compound.

- Diamond
- Graphite
- Both are composed of Carbon atoms

<u>Mineral Groups</u>

Non-silicates: Ore Family
1) Sulfides

Examples: Galena (_____), Sphalerite (_____), Pyrite (_____)

2) Oxides

Examples: Hematite (_____), Corundum (_____)

3) Hydroxides

Examples: Bauxite (Al ore), Limonite (Fe Ore)

Nonsilicates-Evaporites
4) Sulfates

Examples: Gypsum (_____), Barite (_____)

5) Halides

Examples: Halite (_____), Sylvite (_____), Fluorite (_____)

6) Borates

Examples: Ulexite, Colemanite

Other Non-silicates
7) Carbonates

Examples: Calcite (_____), Dolomite (_____), Azurite (_____)

8) Phosphates

Examples: Apatite

9) Native Elements

Examples:

Silicates: composed of cations with various combinations of the silicon-oxygen tetrahedron.

1) Isolated Single Silicate (Nesosilicate): bound to each other only by ionic bonds from interstitial cations (stuff from the left and middle of the periodic table).

Example: Olivine, Garnet, Topaz

2) Double Silicate (Sorosilicate): formed by two SiO_4 tetrahedra sharing a single oxygen.

Example: Epidote

3) Ring Silicate (Cyclosilicate): contain rings of linked SiO_4 tetrahedra having a ratio of Si: O of 1:3.

Example: Beryl or Tourmaline

4) Chain Silicate (Inosilicate)

a) Single Chain: two of the four oxygen are shared, forming a ratio of 1:3 (Si:O)

   Example: Pyroxenes (like Augite)

b) Double Chain: half of the tetrahedra share three, the other half two, giving the ratio of 4:11 (Si:O)

   Example: Amphiboles (like Hornblende)

5) Sheet Silicate (Phyllosilicate): form a ratio of 2:5 (Si:O)

Examples: The Micas (Muscovite, Biotite), Clay Minerals (Kaolinite)

6) Framework Silicate (Tectosilicate): form a ratio of 1:2 (Si:O), meaning that all of the oxygen are shared with the neighboring tetrahedra. There are several types of these, two of which are listed below.

Examples: <u>Quartz Family</u>		<u>Feldspar Family</u>	
Macro Quartz	Micro Quartz	Plagioclase	Orthoclase

Note: Terms like Feldspar, Pyroxene, Amphibole, and Mica are all generic names of mineral groups, they are not mineral names.

Physical Properties of Minerals

Minerals are classified according to their physical properties.

1) Luster: the way a mineral reflects light.

2) Color: What color is it? Can be very deceptive. Fool's Gold.

3) Streak: the color of a mineral in powdered form. Most useful with metallic lustered minerals.

4) Hardness: a mineral's resistance to being scratched.
Scaled from 1-10, according to MOHS hardness scale.

1-Talc	2-Gypsum	3-Calcite	4-Fluorite	5-Apatite
6-Orthoclase	7-Quartz	8-Topaz	9-Corundum	10-Diamond

TGCFAOQTCD

5) Cleavage and Fracture: due to how a mineral breaks.
If the mineral has no weaknesses in its internal structure, it will fracture unevenly. If this uneven fracture produces smooth curved surfaces (kind of how glass breaks), it is called Conchoidal Fracture. When a mineral possesses weaknesses in its structure, it will break along planes (of weakness), which are called Cleavage Planes. These cleavage planes can exist in the form of 1, 2, 3, 4, or 6.

a) Basal or Planar Cleavage (One cleavage)

b) Blocky Cleavage (Two cleavages)

c) Cubic or Rhombohedral Cleavage (Three Cleavages)

d) Octohedral Cleavage (Four cleavages)

e) Hexagonal Cleavage (Six cleavages)

6) Other Special Properties

a) Heft: the mineral is heavy or light for its size (because of its composition).

b) Acid Reaction: the mineral reacts to dilute HCl.

c) Tenacity: the mineral peels into thin sheets (typically found with basal cleavage).

d) Crystal Form: the shape of the mineral is crystal form.

e) Striations: straight parallel lines on a cleavage face, commonly found on Plagioclase Feldspar.

f) Magnetism: mineral is attracted to (or is) a magnet.