

• Rocks and Minerals



- No other planet in the solar system has the unique combination of fluids of Earth. Earth has a surface that is mostly covered with liquid water, water vapor in the atmosphere, and both frozen and liquid water on the land.

• Solid Earth Materials

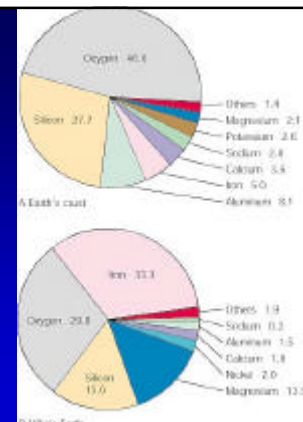
• Earth's Molten Stage

- During the early formation of the Earth it was molten
- During this stage the heavier elements such as iron and nickel, sank to the deeper interior of the Earth.
- This left a thin layer of lighter materials on the surface that is now called the **crust**.
- The majority of the Earth's mass lies below the crust

• Chemical Analysis

- 8 elements make up 98.6% of the crust
- These 8 elements make up the solid materials of the Earth's crust and are known as rocks and minerals.
- A **mineral** is solid inorganic material of the Earth that has both a known chemical composition and a crystalline structure that is unique to that mineral
- A **rock** is a solid aggregate of one or more minerals that have been cohesively brought together by a rock-forming process.

- (A) The percentage by weight of the elements that make up Earth's crust. (B) The percentage by weight of the elements that make up the whole Earth.



- **Minerals**

- Introduction

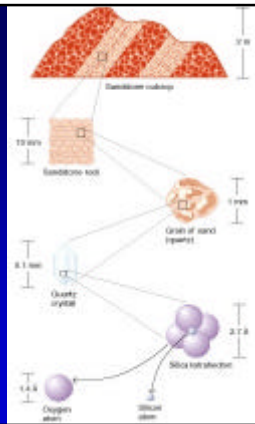
- **Minerals**

- A mineral is solid inorganic material of the Earth that has both a known chemical composition and a crystalline structure that is unique to that mineral

- **Rocks**

- A rock is a solid aggregate of one or more minerals that have been cohesively brought together by a rock-forming process.

**Elements,
Rocks and
Minerals**



What is a mineral?

- naturally forming
- inorganic
- crystalline solid
- known chemical composition
- known physical properties

Ice is a mineral

Glass is not a mineral

What is a rock?

Assemblage of minerals

Elemental Abundances in Earth's crust (Table 4.1 in text)

Element	Abundance (%)
Oxygen (O)	46
Silicon (Si)	28
Aluminum (Al)	8
Iron (Fe)	6
Magnesium (Mg)	4
Calcium (Ca)	2.4
Potassium (K)	2.3
Sodium (Na)	2.1

Crystallization of minerals from melts and solutions

Crystallization: process of mineral formation by the creation of orderly bonds between atoms.

Bond formation leads to a 3D crystal structure

Crystallization by cooling from magma

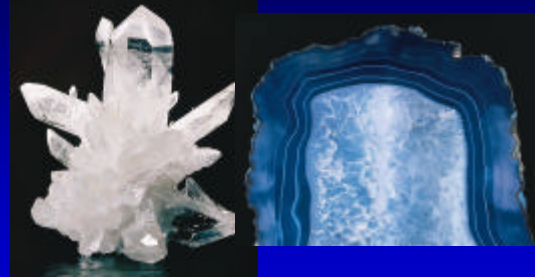
What's magma?

Molten or partially molten rock beneath the earth's surface

Magma is generated when rock deep underground melts due to the high temperatures and pressures inside the earth

Magma is lighter than the surrounding rock, it tends to rise
encounters colder rock and begins to cool

Slow Cooling - bigger minerals with distinct crystal structure



Fast cooling - very fine grained, not crystalline



Not a mineral!!!!!!

Crystallization through precipitation

Atoms or ions left behind in an evaporating solution bond with one another to form solids



Halite: NaCl forms from evaporation of seawater



Major Mineral Groups

Minerals are classified not based on their physical properties but on their chemical composition (anion)

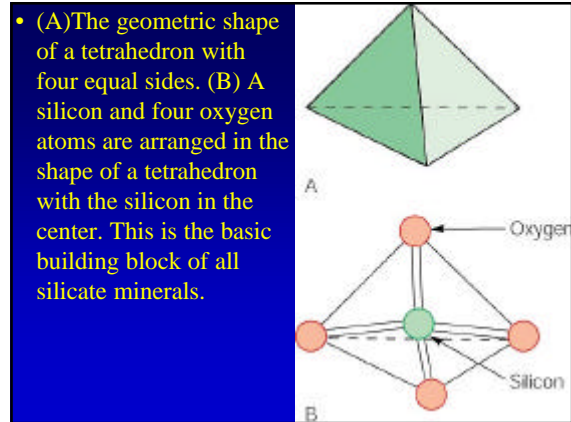
Element	Abundance (%)	
Oxygen (O)	46	Most common elements = most common in minerals
Silicon (Si)	28	
Aluminum (Al)	8	
Iron (Fe)	6	
Magnesium (Mg)	4	
Calcium (Ca)	2.4	"silicates"
Potassium (K)	2.3	
Sodium (Na)	2.1	

Crystal Structures

- Can be made up of atoms of one or more kinds of elements.
- Crystals are classified according to six major groups, with subdivisions of each.

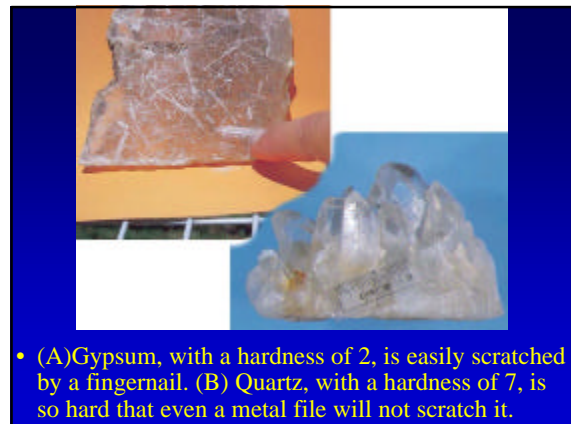


- These quartz crystals are hexagonal prisms.



- (A) The geometric shape of a tetrahedron with four equal sides. (B) A silicon and four oxygen atoms are arranged in the shape of a tetrahedron with the silicon in the center. This is the basic building block of all silicate minerals.

- **Physical Properties of Minerals**
 - **Color**
 - A visual measure.
 - Not very useful for identification as color of minerals varies considerably.
 - **Streak**
 - This is the color of the mineral when it is finely powdered.
 - Rubbed across a piece of tile, leaving a fine powder of the mineral on the tile.
 - **Hardness**
 - Resistance of the material to being scratched.
 - Measured using the Mohs hardness scale, which compares the hardness of the mineral to 10 reference minerals.



- (A) Gypsum, with a hardness of 2, is easily scratched by a fingernail. (B) Quartz, with a hardness of 7, is so hard that even a metal file will not scratch it.

- **Crystal form**
 - Related to the internal geometric arrangement of the atoms that make up the crystal structure.
- **Cleavage**
 - the tendency of mineral to break along smooth planes.
 - Depends upon zones of weakness in the crystal structure.
- **Fracture**
 - The broken surface is irregular and not in a flat plane.

- **Luster**
 - Surface sheen
 - Metallic – like metal
 - Pearly – like pearl
 - Vitreous – like glass
 - Earthy
- **Density** – ratio of the mass of a mineral to its volume.
 - **Specific gravity** – ratio of mineral density to the density of water
 - Depends on:
 - Kind of atoms which make up the mineral
 - How the atoms are arranged in the crystal lattice.

• Rocks

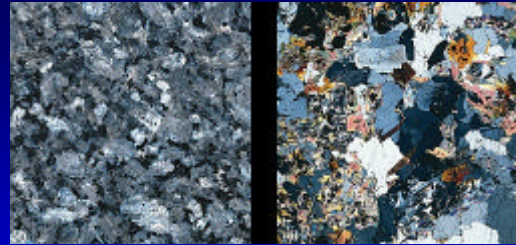
- Introduction
 - Elements are chemically combined to form minerals
 - Minerals are physically combined to form rocks.

Major Rock Groups

Identified by texture and mineralogy

1. Igneous
 - extrusive
 - intrusive
2. Sedimentary
 - clastic
 - biogenic
3. Metamorphic

Igneous Rocks

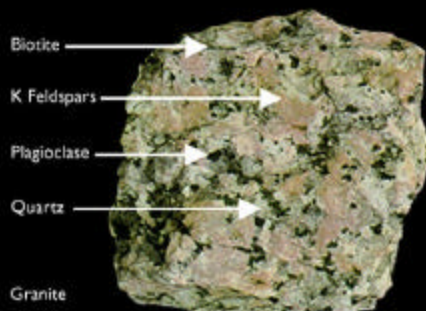


Interlocking minerals

Extrusive: volcanic, fine grained e.g., Basalt

Intrusive: coarse grained e.g., Granite

Granite Mineralogy



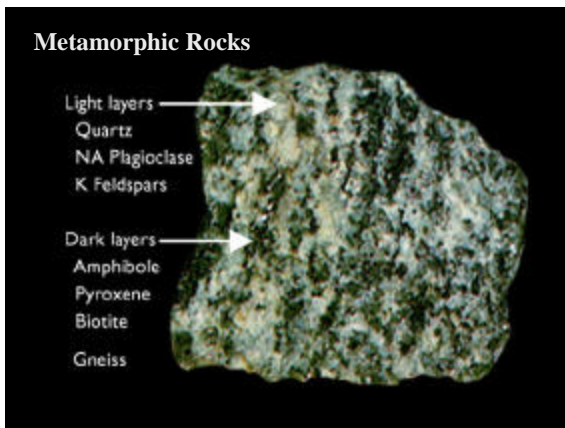
Sedimentary Rocks

Clastic: precipitated from fluid (wind or water)

Chemical: secreted by organisms



Metamorphic Rocks
Produced by temperature and pressure changes to all types of rocks



- Earth is a dynamic planet with the surface and interior in a constant state of flux.
 - Internal changes alter the surface by moving the Earth's plates, building mountains.
 - Seas advance and retreat over the continents bringing in new materials and taking other materials away.
 - Rocks are continually being changed by Earth's forces.

- The **Rock Cycle** describes the continually changing structure of rocks.
 - Igneous, sedimentary, or metamorphic rock are just temporary stages in the continuing changes that all rocks undergo.

Since the lithosphere is constantly being created and destroyed

All rocks are linked in a cycle of creation and destruction

The Rock Cycle

