Dynamic Earth – Test One – September 25th

Minerals

- Eight most abundant elements in the Earth's Crust:

	Abundance % by weight –	Most common Ionic Form	Most Common Coordination Numbers	Relative Ionic Size
Oxygen (O)	46.6 %	O^{-2}	- - -	1.40
Silicon (Si)	27.7 %	Si^{+4}	Si (4)	0.26
Aluminum (Al)	8.1 %	Al^{+3}	Al (4, or 6)	0.39
Iron (Fe)	5.0 %	Fe^{+2}	Fe (6)	0.63
Calcium (Ca)	3.6 %	Ca^{+2}	Ca (8)	1.00
Sodium (Na)	2.8 %	Na^{+1}	Na (8)	0.99
Potassium (K)	2.6 %	K^{+1}	K (8, 12)	1.37
Magnesium (Mg)	2.1 %	Mg^{+2}	- - -	0.72

- Distinction between crystalline and non-crystalline solids
  - Crystalline – term refers to the ordered, symmetrical, arrangement or the atoms that make up the structure
    - Minerals are naturally occurring solid chemical compounds with crystalline structure
    - Exhibits cleavage
  - Non-Crystalline – (Ex. Glass) Soften as the temperature increases and have no sharply defined melting point

- The Most common silicate minerals: Structure and Composition
  - Olivine - $(Mg, Fe)_2SiO_4$; Independent Tetrahedral
  - Pyroxenes – $(Mg, Fe)_2Si_2O_6)$; Single Chain
  - Amphiboles – $(W,X, Al)_{7-8}(Z_4O_{11})_2(OH)_2$; double chains
  - Biotite mica – $K(MgFe)_3(AlSi_3O_{10})(OH)_2$; Sheet silicates
  - Muscovite mica – $KAl_2(AlSi_3O_{10})(OH)_2$; Sheet Silicates

- Plagioclase feldspar – $NaAlSi_3O_8$ --- $CaAl_2Si_2O_8$ (solid solution series) ; framework silicates
- Alkali Feldspars – $KalSi_3O_8$ –$CaAl_2Si_2O_8$ (solid solution series); Framework silicates
- Quartz – SiO_2 ; Framework Silicates
  - W represents the large cations Ca, Na and K (That can substitute for one another)
  - X Represents the smaller Mg and Fe
  - Z Represents the cations in the tetrahedral sites, Si and Al

- Pairs of elements that commonly substitute for one another in Silicates:
  - Si and Al
  - Mg and Fe (and also Al)
  - Na and K
  - Na and Ca
    - Factors that control substitution:
      - The size of the ions and the size of the crystallographic sites into which they substitute
      - The charges on the ions that are substitution for one another – if charges are the same, then the crystal structure can remain electrically neutral; if charges not the same then other substitutions must take place to maintain charge balance
      - Temperature and pressure at which the substitution takes place. Greater amount of substitution that takes place at higher temperature. Pressure can change the size of both the site and the ion resulting in different substitutions
    - Degree of substitution:

- Relationship of Cleavage to Structure in Silicates:
  - Cleavage is the breaking along a planar surface of a silicate, and it forms along the planes of ionic bonds

- Definitions:
  - Mafic: silicate minerals, magmas and rocks which are relatively high in the heavier elements, and rich in magnesium and iron
  - Felsic: silicate minerals, magmas and rocks which have a lower percentage of the heavier elements and are correspondingly enriched in the lighter elements, such as silicon and oxygen, aluminum and potassium

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Earth's Heat

- How is heat transferred (Radiation, conduction, convection)
  - Radiation: heat moves as electromagnetic radiation, such as heat transferred from the Sun to the Earth
  - Conduction: enhanced vibrational motion of atoms in materials is induced in neighboring atoms and this motion diffuses through the material
  - Convection: Heat is carried by matter, which is flowing. Warmer and less dense matter rises, while cooler and more dense matter sinks

- Original Source of Heat
  - During the early history of the solar system, the Earth and other planets grew in size and mass as comets asteroids and other smaller masses fell into them, heating up the earth.
  - **Today** meteorites that reach Earth have velocities of approximately 30-70 km/sec, the large ones containing a large amount of kinetic energy that is converted to thermal energy and the planet heats up a bit

- Definitions:
  - Geothermal gradient: the rate at which the temperature increases with depth in the Earth – varies from place to place
  - Geo-Barometric gradient: The change in atmospheric pressure per unit of horizontal distance in the direction in which the pressure changes most rapidly

Magmas

- Melting of Silicate Rocks:
  - Magmas from by the melting of pre-existing silicate; Major mechanisms that can cause a rock to melt are heating, pressure decrease, addition of water

- How composition of magmas are influenced by the degree of partial melting of source rock
  - Partial melting is when only a portion of the parent rock melts ; always produces a magma that is **less mafic** than the parent rock; way of differentiating material, making new rocks that differ in composition from the parent rock

- Role of pressure and volatiles (water and gases) on melting