Lecture Notes - Petrology Introduction

- A recap of important concepts of mineralogy. **Minerals are crystals!**

    - Neumann's Principle. ("The symmetry elements of any physical property of a crystal must include the symmetry elements of the point group of the crystal.") Measurements of the variation of physical properties with direction can be used to determine the symmetry of a crystal. Conversely, if the symmetry is known, the number of measurements needed for each physical property is reduced to a minimum.

    - Crystals have a pattern or structure. The structure and chemistry of a mineral determine its physical properties through the type and distribution of bonds present.

    - Crystals have a pattern or structure. The structure limits the possible chemistry or stoichiometry of the crystals, because only certain atoms "fit" in specific crystallographic sites. The possible variations of mineral composition as a function of mineral assemblage and physical conditions provide important information for unraveling the geologic history of any rock.

    - Minerals have a limited field of stability. Minerals are subject to transformations of their structure and to chemical reactions (including melting!) with other minerals and fluids. Possible changes include displacive transformations, reconstructive transformations, order/disorder transformations, and exsolution.

- **Petrology** has as its root the Greek word (πετροσ) meaning rock and so is literally the study of rocks. (Those of you who are biblical scholars will recognize that the name "Peter" has the same root.) We will be concerned principally with igneous and metamorphic rocks in this course.

- **Igneous rocks** are defined as rocks that have crystallized from a magma. A magma is molten or partially molten rock, which implies high temperatures. Lava is magma that has reached the surface of the earth. Is slush (ice + brine) a magma?

- **Metamorphic rocks** are defined as rocks that are transformed (by the growth of new minerals) sedimentary or igneous (or metamorphic) rocks. Normally the term metamorphism is restricted to changes that occur at depth under conditions of elevated temperature or pressure and does not include surficial processes such as weathering. Shallow processes, such as diagenesis, are generally not called metamorphism, although they may grade into metamorphism. Hydrothermal processes, such as those associated with hot springs, and high grade metamorphism leading to melting and migmatities ("mixed rocks") are examples of processes that produce rocks that may be hard to classify as either igneous or metamorphic.

- Original occurrences of igneous and metamorphic rocks are not random, but are mostly associated with plate margins. The nature of a suite of igneous rocks or a metamorphic terrane depends on the tectonic environment in which it was formed. Therefore, petrologic studies of igneous and metamorphic rocks can provide important clues to processes operating within the earth.