

## GY 111 Lecture Note Series

### Rocks and the Rock Cycle

#### Lecture Goals:

- A) Types of Rocks
- B) Igneous Rocks
- C) Sedimentary Rocks
- D) Metamorphic Rocks
- E) The Rock Cycle

*Reference: Press et al. (2004), Chapter 4; Grotzinger et al. (2007) Chapter 3*

#### A) Types of Rocks

If we haven't already done so, we will eventually be talking about the chemistry of **minerals**. By then, you will learn that minerals are *naturally occurring, inorganic, crystalline solids with unique chemical compositions*. We also need to define **rocks**. Rocks are *naturally occurring solids containing more than one mineral*. As it turns out, some times rocks will contain only one mineral. An example of this is a quartz sandstone. The only mineral it contains is quartz, but as many separate grains rather than a single crystal. So perhaps the definition of a rock needs to be refined just a bit:

Rocks are *naturally occurring solids containing one or more minerals*.

Geologists recognize three broad **groups** of rocks:

1) **Igneous Rocks** (*literal translation: born from fire*): These are rocks that were formed from originally molten states (see lava fountain, right)

2) **Sedimentary Rocks**: These are rocks that were formed initially through the accumulation of **sediment** (e.g., particles of old rock and minerals; see image of Mississippi Delta to right), or new minerals formed through the result of **chemical precipitation** or **organic activity**).



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3) **Metamorphic Rocks**: Pre-existing rocks that are affected by **pressure**, substantial changes in **temperature** or by **chemically active fluids** (e.g., hot water), can be altered. These are the processes of **metamorphism** which can result in minerals or **fabric changes** to rocks.

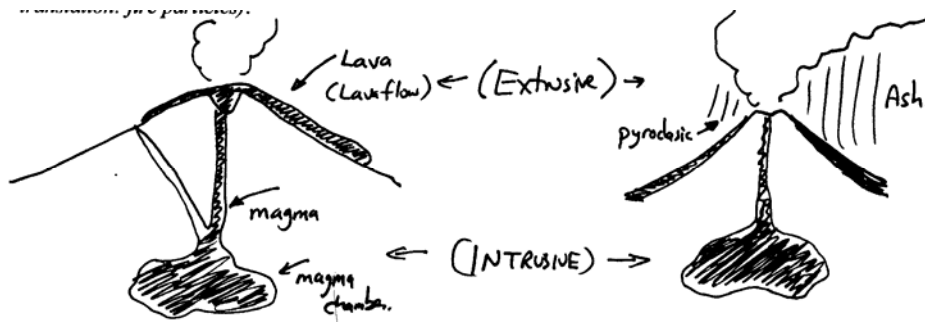
Over the course of GY 111, we will spend a lot of time discussing the details of each of these rock groups, but some basic understanding of each of these rocks is necessary now before we get into the rock cycle.

## B) Igneous Rocks

Igneous rocks come in 3 main types or **classes**. Those formed as molten rock that flows from a **volcano** are said to be **extrusive igneous rocks** or **volcanic igneous rocks**. Like an iceberg, a lot of the “bulk” of a volcano is actually below the Earth’s surface. Molten rock resides within chambers beneath volcanoes. It is from these chambers that molten rock makes it to the surface. Molten rock *on the surface of the Earth* is known as **lava**. Molten rock *below the surface of the Earth* is called **magma**. A significant proportion of igneous rock forms directly within **magma chambers** and these rocks are known as **intrusive igneous rocks** or **plutonic igneous rocks**.



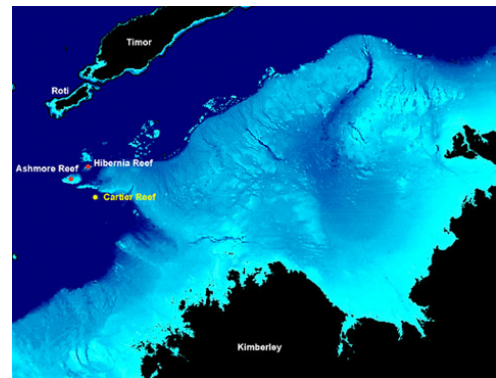
The last type of igneous rock results from explosive volcanic eruptions. Most of you recall the eruption of Mt. St. Helens. While some lava was produced, the majority of the eruption was in the form of **volcanic ash**. The magma that will eventually produce ash remains molten below the surface of the Earth, but once it gets near the **volcanic vent**, it is blasted out of the volcano at high velocity (See image of Mt. Ruapehu, New Zealand to right from <http://203.86.194.7/Images/craigPotton/243.jpg>). Rather than becoming lava, the molten rock is broken up into various sized particles that cools to solid almost instantly (only the finest stuff is called ash). The ash then falls back to earth as small igneous rock fragments. This type of extrusive igneous rock is called **pyroclastic** (*literal translation: fire particles*).



## C) Sedimentary Rocks

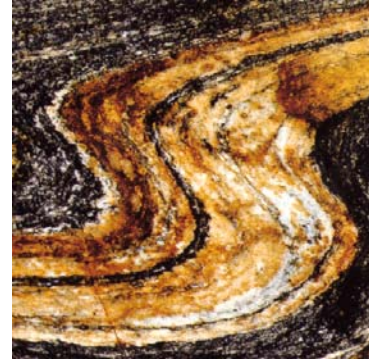
The sedimentary rocks come in 4 main classes depending upon the origin of the particles that comprise them:

- 1) **Siliciclastic sedimentary rocks:** particles came from eroded pre-existing rocks
- 2) **Biochemical sedimentary rocks:** particles came from the remains of organisms that left behind mineralized shells, tests or skeletons (see satellite image of reefs off of NW Australia).
- 3) **Chemical sedimentary rocks:** particles came from minerals precipitated from water.
- 4) **Organic sedimentary rocks:** particles came from the remains of plants.



**D) Metamorphic Rocks**

Metamorphic rocks are classified according to the processes that formed them and/or by the rock fabric that resulted from the metamorphism (see image of Gneiss to left from <http://jersey.uoregon.edu/~mstrick/myimages/Scanned/gneiss.gif>).



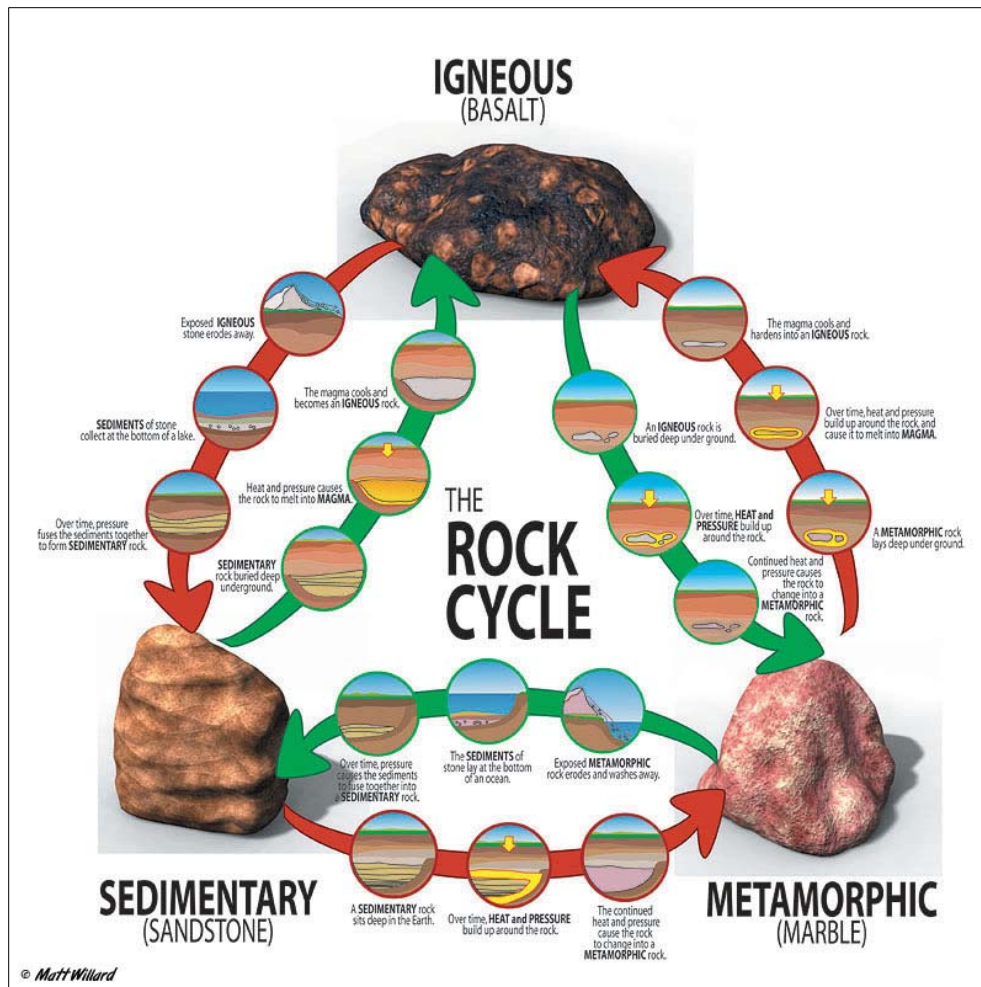
The three major classes are:

- 1) **Foliated metamorphic rocks:** those with a prominent parallel layering
- 2) **Non-foliated metamorphic rocks:** those without layering
- 3) **Cataclastic metamorphic rocks:** those that are composed of broken up rocks and minerals.

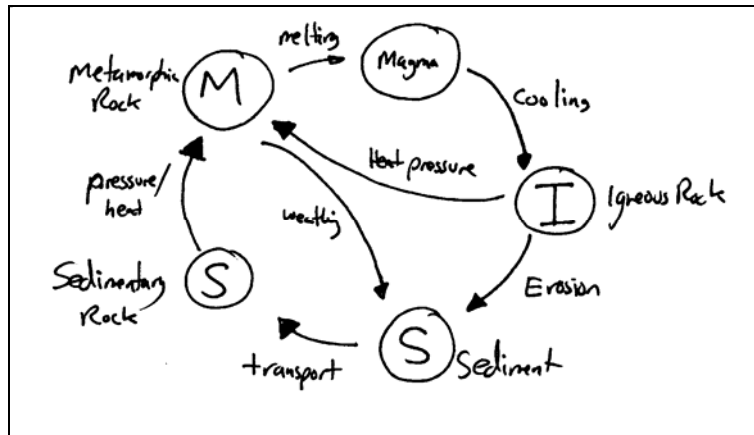
As stated earlier, all of these rocks will be discussed at length in upcoming lectures and labs. The main thing to remember at this point of the course is that all of these rocks can be related together in a simple concept called the **rock cycle**.

**E) Rock Cycle**

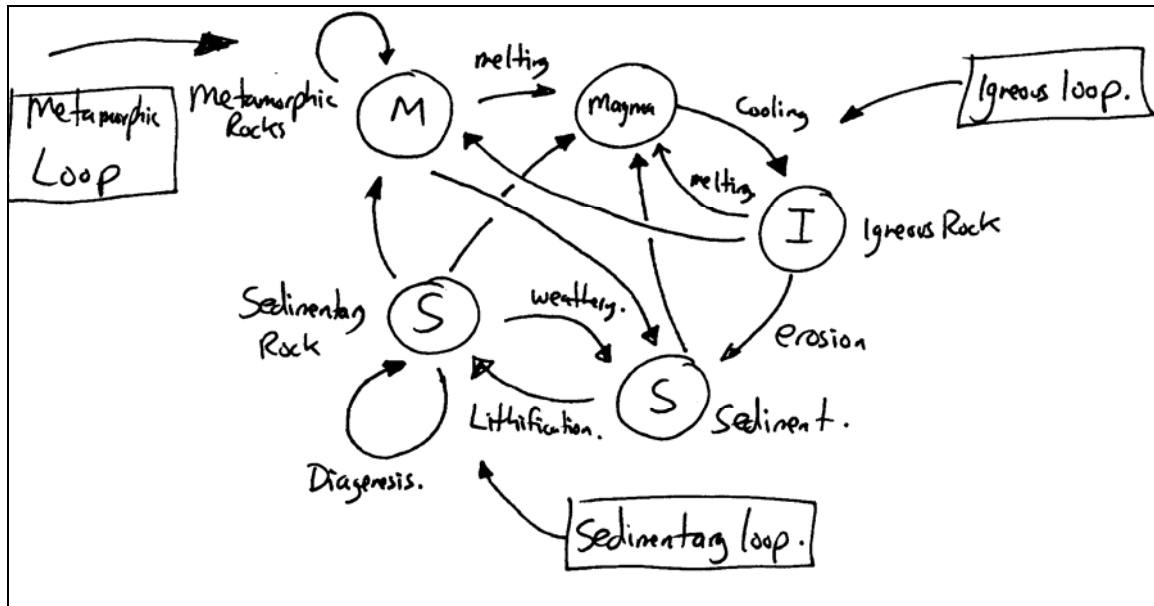
The rock cycle, according to most text books, looks like this:



But the cleaned up version that I'll draw for you in class will be this one (at least initially)



The version above is really quite good for highlighting how each type of rock can be “altered” into other rocks, but it often leads students into believing that the rock cycle is a one way road. This is not the case at all. The real rock cycle contains many loops. For example, the sedimentary loop may see sediment/sedimentary rock recycled hundreds of time before metamorphism occurs. Some sedimentary rocks are melted rather than being metamorphosed. So I prefer the following rock cycle. It looks a lot more complex (downright nasty!) but is a bit better for giving all of the options available in the rock cycle:



**Important terms/concepts from today's lecture**

*(Google any terms that you are not familiar with)*

Rocks

Minerals

Igneous, Sedimentary and Metamorphic Rocks

sediment

chemical precipitation  
agents of metamorphism (temperature, pressure, fluids)  
extrusive (volcanic) igneous rocks  
intrusive (plutonic) igneous rocks  
lava  
magma  
magma chamber  
volcanic vent  
pyroclastic igneous rocks  
siliciclastic, biochemical, chemical and organic sedimentary rocks  
foliated, non-foliated and cataclastic metamorphic rocks  
rock cycle