Igneous Processes and Rock Identification

Introduction

As you learned in the mineralogy lab, a rock is any natural aggregate of minerals, mineraloids, glass, or organic particles. For example, granite is a rock composed of several minerals, rock salt is a rock composed of halite crystals, rock opal is a rock composed of the mineraloid opal, obsidian is a rock composed of volcanic glass, and coal is a rock composed of organic particles. You get the picture:

Elements Minerals Rocks

Magma is molten rock beneath the Earth's surface that has been liquefied by the intense heat and pressure within the planet. When magma flows onto the land surface or the sea floor, it is termed ***lava***. ***Igneous rocks*** form by the cooling of magma or lava. Those that form from the cooling of magma inside or below the surface are called ***intrusive*** igneous rocks. Rocks that solidify and cool above on the Earth's surface are known as ***extrusive*** or volcanic rocks.

Identification and Classification of Igneous Rocks

Igneous rocks are identified and classified based on the rocks ***texture*** and ***compositional*** properties. The various textures of igneous rocks are a direct function of the "rate of cooling" of magma. For example, magma that cools very slowly will allow crystal to form and produce textures that are coarse or grains that can be seen with a naked eye. On the other hand, magma that cools very quickly will produce fine-grained textures that can not be seen with a naked eye. In this section, we will use both textural features and composition (mineral assemblages) to classify and identify igneous rocks

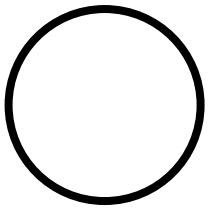
Igneous rock textures

As magma cools and forms igneous rocks, it is important to observe and know the different types of textures that are produced. The size of mineral crystals in an igneous rock generally indicates the rate at which the lava or magma cooled to form a rock. Large crystals require a long time to grow, so their presence demonstrates that molten rock has cooled very slowly. Tiny crystals or none at all, tell geologists that the rock cooled very rapid ally. If lava or magma is cooled

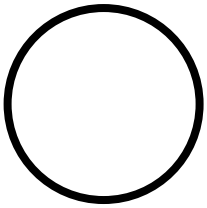
abruptly (quenched), there is no time for mineral crystals to form. Instead, an amorphous volcanic glass called ***obsidian*** is produced. Thus, if you observe a glassy rock with no visible crystals, it may have cooled very quickly from lava.

Several terms are used to describe the texture of igneous rocks. Each term is based on crystal size. Below is a list of textural terms used to describe igneous rocks

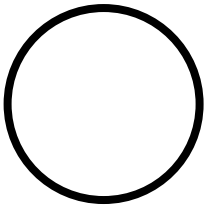
hyaline texture – used to describe volcanic glass. Mineral grains are not visible to the naked eye (Greek word for glass)



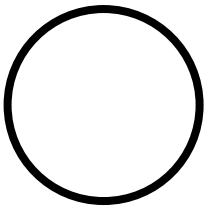
aphanitic texture – crystals that are too small to see without a hand lens (generally < 1mm) (Greek word for invisible)



phaneritic texture – crystals that are visible and form a "mosaic" of interlocking crystal aggregates (1-10 mm)

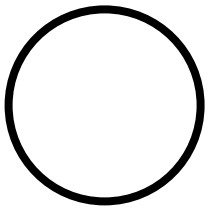


pegmatitic texture – crystals that are very large (>1cm)



The following textural terms are used to modify the above textural terms

porphyriyic texture – crystals can be separated into two distinct visible sizes. There can be small grains or large grains, but crystals occur in 2-distinct sizes



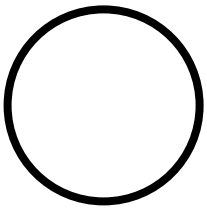
phenocrysts – larger crystals of the two sizes

matrix – smaller crystals surrounding the phenocrysts

One could have a rock with a porphyritic-phaneritic texture: Describe the rock

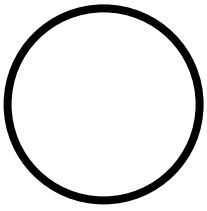
One could have a rock with a porphyritic – aphanitic texture: Describe the rock

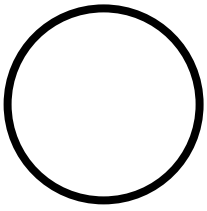
Vesicular texture – "sponge like appearance" textures contain numerous cavities or holes



vesicles – gas bubble cavities (holds produced by escaping gas bubbles)

pyroclastic texture - textures created by volcanic material that cools rapidly and hurled through the air picking up various rock fragments.





Volcanic tuff volcanic breccia

Igneous rock composition (mineral assemblages)

Composition of igneous rocks is related to the various mineral assemblages contained within the rock specimen. Depending on the chemical make-up of the cooling magma, igneous rocks will form groups of minerals (composition). For example, igneous rocks that form at higher temperatures contain minerals that are rich in iron (Fe), magnesium (Mg) and calcium (Ca) creating a dark colored rock or ***mafic*** type composition. Mafic rocks contain no quartz, no potassium-feldspar and posses high concentrations of ***ferromagnesian*** minerals such as olivine, pyroxene and amphibole. In other words, igneous rocks that are dark in color demonstrate compositions of high iron (Fe) and (Mg)

Igneous rocks that form at lower temperatures will contain minerals that are rich in potassium (K), aluminum (Al) and sodium (Na). These elements will produce a light colored rock or ***felsic*** composition. Felsic rocks contain high mineral compositions of quartz, potassium feldspar, and Na-rich plagioclase. However, most felsic rocks will have small percentages of ferromagnesian mineral such as amphiboles (hornblende) and biotite.

Classification of Igneous Rocks

Igneous rocks are classified using both **texture** and **composition**. Using the classification diagram in figure 1, note that textural observations are located along the y-axis and composition of the rock is located along the x-axis. Classifying an igneous rock is a cross reference between the texture and composition. The name and classification of the igneous rock is determined by the intersection point between the texture and composition. To classify hand samples of igneous rocks, follow this procedure using figure 1 or the diagram for classifying igneous rocks.

1. Identify the rocks texture. Inspect the rock using the hand lens and determine if the rock is either phaneritic or aphanitic type texture.
2. If the rock is phaneritic or pegmatitic, estimate the percentage of felsic minerals to ferromagnesian. If there are higher percentages of felsic minerals, than the rock is **felsic** composition. If the rock contains higher percentage of ferromagnesian minerals is predominately dark than the composition is considered **mafic**. In other words, determine if the rock is either felsic (light colored) or mafic (dark colored)
3. Use the textural terms, such as porphyritic or vesicular, as modifiers. For example, you might identify a pinkish (felsic) aphanitic (fine-grained) igneous rock as a rhyolite. If it contains scattered phenocrysts, then you would call it a porphyritic rhyolite. Similarly, you would call basalt with vesicles a vesicular basalt.