

Earth Science

Chapter 6 - Rocks

Section 2 – Igneous Rocks

E.Q.: *What are the major types of rocks, how are they formed, and how do we use them?*

STANDARDS:

SES1. Students will investigate the composition and formation of Earth systems, including the Earth's relationship to the solar system.

e. Identify the transformations and major reservoirs that make up the rock cycle, hydrologic cycle, carbon cycle, and other important geochemical cycles.

Objectives

- **Summarize three factors that affect whether rock melts.**
- **Describe how the cooling rate of magma and lava affects the texture of igneous rocks.**
- **Classify igneous rocks according to their composition and texture.**
- **Describe intrusive and extrusive igneous rock structures.**

The Formation of Magma

- **igneous rock that forms when magma cools and solidifies**
- **The three factors that affect whether rock melts include temperature, pressure, and the presence of fluids in the rock.**
- **Rock melts when the temperature of the rock increases to above the melting point of minerals in the rock.**
- **Rock melts when excess pressure is removed from rock that is hotter than its melting point.**

- **Rock may melt when fluids, such as water, are added. The addition of fluids generally decreases the melting point of certain minerals in the rock.**

Partial Melting

- **Different minerals have different melting points, and minerals that have lower melting points are the first minerals to melt.**
- **As the temperature increases and as other minerals melt, the magma's composition changes.**
- **The process in which different minerals in rock melt at different temperatures is called *partial melting*.**

Fractional Crystallization

- **When magma cools, the cooling process is the reverse of the process of partial melting.**
- **Chemicals in magma combine to form minerals, and each mineral has a different freezing point. Minerals that have the highest freezing points crystallize first.**
- **The crystallization and removal of different minerals from the cooling magma is called *fractional crystallization*.**
- **The diagram below shows partial melting.**

Partial Melting



This solid rock contains the minerals quartz (yellow), feldspar (gray), biotite (brown), and hornblende (green).



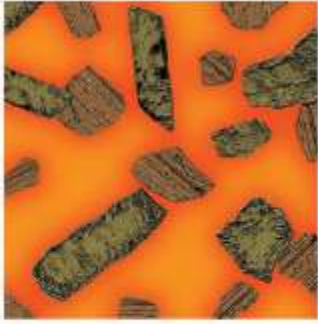
The first minerals that melt are quartz and some types of feldspars. The orange background represents magma.



Minerals such as biotite and hornblende generally melt last, which changes the composition of the magma.

The diagram below shows fractional crystallization.

Fractional Crystallization



As the temperature decreases, the first minerals to crystallize from magma are minerals that have the highest freezing points, such as biotite and hornblende.



As the magma changes composition and cools, minerals that have lower freezing points form.

Textures of Igneous Rocks

- **Igneous rocks are classified according to where magma cools and hardens.**
- **intrusive igneous rock rock formed from the cooling and solidification of magma beneath Earth's surface**
- **extrusive igneous rock rock formed from the cooling and solidification of lava at Earth's surface**
- **The texture of igneous rock is determined by the size of the crystals in the rock. The size of the crystals is determined mainly by the cooling rate of the magma.**

Coarse-Grained Igneous Rock

- **Because intrusive igneous rocks cool slowly, they commonly have large mineral crystals.**
- **Igneous rocks that are composed of large, well-developed mineral grains are described as having a *coarse-grained texture*.**

Fine-Grained Igneous Rock

- **Because extrusive igneous rocks cool rapidly, they are commonly composed of small mineral grains.**

- Igneous rocks that are composed of small crystals are described as having a *fine-grained texture*.
- When magma cools slowly at first, but then cools more rapidly as the magma nears or reaches Earth's surface, the igneous rock that forms may have large crystals embedded within a mass of smaller crystals. This texture is called *porphyritic* texture.
- When highly viscous magma cools very rapidly, few crystals will grow. When the magma contains a small amount of dissolved gases, a *glassy texture* will result. When the magma contains a large percentage of dissolved gases, the gases are trapped as bubbles in the rock, and a *vesicular texture* will result.

Reading Check

- What is the difference between fine-grained and coarse-grained igneous rock?

Fine-grained igneous rock forms mainly from magma that cools rapidly; coarse-grained igneous rock forms mainly from magma that cools more slowly.

Composition of Igneous Rock

- The mineral composition of an igneous rock is determined by the chemical composition of the magma from which the rock formed.

Felsic Rock

- felsic describes magma or igneous rock that is rich in feldspars and silica and that is generally light in color
- Common minerals in felsic rocks include potassium feldspar and quartz.
- The felsic family includes many common rocks, such as granite, rhyolite, obsidian, and pumice.

Mafic Rock

- mafic describes magma or igneous rock that is rich in magnesium and iron and that is generally dark in color

- Common minerals in mafic rocks include plagioclase feldspar and pyroxenes.
- The mafic family includes the common rocks basalt and gabbro.

Intermediate Rocks

- Rocks in the intermediate family contain lower proportions of silica than rocks in the felsic family do but contain higher proportions of silica than rocks in the mafic family do.
- Rocks in the intermediate family include diorite and andesite.

Intrusive Igneous Rock Structures

Batholiths and Stocks

- Batholiths are intrusive formations that spread over at least 100 km^2 when they are exposed on Earth's surface.
- Stocks are similar to batholiths but cover less than 100 km^2 at the surface.

Laccoliths

- A laccolith is an intrusive formation that forms when magma flows between rock layers and pushes the overlying rock layers into a dome.

Reading Check

- What is the difference between stocks and batholiths?
A batholith is an intrusive structure that covers an area of at least 100 km^2 . A stock covers an area of less than 100 km^2 .

Sills and Dikes

- When magma flows between layers of rock and hardens to form a body of rock that is parallel to the layers of rock that surround it, a *sill* forms.
- When magma forces its way through rock layers by following existing fractures or by creating new

fractures, a *dike* forms. Dikes cut across layers rather than lying parallel to the rock layers.

- Sills and dikes vary in thickness from a few centimeters to hundreds of meters.

Extrusive Igneous Rock Structures

- Igneous rock masses that form on Earth's surface are called *extrusions*.
- A *volcano* is a vent through which magma, gases, or volcanic ash is expelled. Volcanic cones and volcanic necks are common examples of extrusive igneous structures.
- Lava flows, lava plateaus, and tuff layers are other common extrusions.