

Reading Guide for Chapters 1, 3, and 4

Recall from the syllabus, that the purpose of the Reading Guides is to help you sort out the most important ideas in the text. I recommend answering the questions as you read the book.

Chapter 1 (p.3):

This quarter we will study many processes that shape the Earth and influence our safety, but we will also take some time to examine what rocks and minerals tell us about the history of our planet. Read the short section on pages 18 and 19 that describes minerals and the three major types of rocks.

What is a **mineral**?

How are **igneous** rocks formed?

How are **sedimentary** rocks formed?

How are **metamorphic** rocks formed?

The remainder of pages 2-21 will not be on the first exam, but I recommend that you read this part because it will give you an overview of the field of geology, the scientific theories on the formation of Earth and the solar system, and the concept of geological time.

Read pages 21-28 to answer the questions below. This section is on probably most important major concept in this course, plate tectonics. At this point we will use plate tectonics to explain features we see around the world, but we will have to wait until near the end of the quarter to understand the development of the idea and the evidence we have that plate tectonics exists.

Since this section is on *plate* tectonics, what is a “plate”?

There are several very large plates on the Earth’s surface and many smaller plates, see figure 1-21 on page 22. These plates move in various directions. When two plates meet or touch we term this a plate boundary or margin. What are the three types of plate boundaries and draw two arrows for each margin to illustrate the relative motion of the two plates on the sides of the boundary.

For each of the three boundaries give an example from the map on figure 1-21.

Please read up to page 29, (In Support of Plate Tectonics- A Theory Develops). We will come back to the information from p. 29 to the end of the chapter later in the quarter. You may read this section if you are curious, but you will not be tested in unit one over the information from page 29 to the end of the chapter.

(You may wonder, why aren't we reading chapter 2? It is on minerals, the building blocks of rocks. If this course was designed for geology majors, we would read chapter 2, but since this a course for non-science majors, there is more detail in that chapter than you will need in this course. Of course, if you are curious about minerals and their structures, please read chapter 2, but you will not be tested over chapter 2 directly).

Chapter 3:

Please turn to page 70 and read the introduction of chapter 3.

What does the term “igneous” mean? What is the difference between the terms magma and lava?

The most common two elements in the outer portion of the Earth are silicon and oxygen. **Silica** is the name we give this combination of silicon and oxygen. Instead of referring to rocks by silica percentage, we call them a name to convey the level of silica in the rock. Basalt is considered a silica- _____ rock, while rhyolite is a silica - _____ rock.

Melting Rocks and Crystallizing Magma (p. 72)

The Creation of Magma (p.73)

We will return to this section of Chapter 3 near the end of the quarter when we discuss the origin of igneous rocks. The concepts involved in this part of chapter 3 are more complicated than we need at this point of the course. If you would like to read this section, that is fine, but Exam 1 will not cover the processes that create magmas.

The Motion of Magma (p. 75)

Define the term viscosity:

Something like honey is _____ (higher/lower) in viscosity compared to water.

What controls the viscosity of magmas?

In what way does the viscosity of the magma influence whether magma will rise to the surface and erupt?

→Why are there more basaltic eruptions than rhyolitic eruptions?

The Crystallization of Magma: (p. 76)

The main concept in this section is that as minerals (the basic building blocks of the rock) crystallize at different temperatures as the magma cools, the composition of the magma can increase in silica percentage. There are many mineral names in this section, but I will not ask you to know these names. Use this reading guide and the lecture information to get the level of information you need from this section. Do not worry about the differences in the continuous and the discontinuous series in the Bowen's Reaction Series.

The basic principle in this section is that as a magma cools crystals begin to form and those minerals with the highest **melting** temperatures (same as crystallization temperature) will form first from the magma. Since these high temperature minerals that form in the magma have the **lowest** silica content, the magma will become more silica-rich as the magma cools.

In general rocks that are mafic (dark colored) are composed of minerals that have _____ (lower/higher) crystallization temperatures (same as the melting temperatures), while rocks that are more felsic (light colored) are composed of minerals that have _____ melting temperatures.

When a magma body has become more silica-rich as crystals have been removed, we term that process **fractional crystallization**.

Another process that may affect the composition of magma is when blocks of the existing rock (termed the "country rock") are assimilated by the magma. Normally the continental crust is higher in silica than the magmas which originate in the upper mantle, so the blocks of country rock then to increase the silica content of the magma in a manner similar to crystal fractionation.

Igneous Textures (p.79)

What is meant by the texture of an igneous rock? What controls the texture of igneous rocks?

Igneous rocks are classified based on their _____ and their _____.

→Igneous rocks that have at least some fine-grained or aphanitic texture are known as Extrusive or Volcanic rocks. These rocks cool _____ (slowly/quickly) at or near the Earth's surface.

→Igneous rocks that are all crystals (coarse grained or phaneritic) texture are known as _____ or _____ rocks. These rocks cool _____ (slowly/quickly) under the Earth's surface.

→In some igneous rocks there are well-developed crystals surrounded by a background of very fine-grained rock. This type of texture is known as a _____ texture. This texture is formed by:

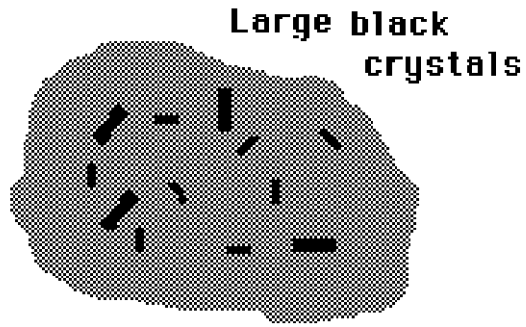
Imagine that you found a rock that looked like the rock illustrated to the right:

Would this texture be aphanitic, phaneritic, or porphyritic?

Explain your logic.

An igneous rock

**fine
grained
grey
matrix**



**Large black
crystals**

Most of the time when people have heard of volcanic glass before, they have heard of obsidian, the black or reddish glass used by Native Americans to make arrowheads and other hunting implements. Your text states that obsidian comes from lavas that cool “instantaneously.” However, it is apparent when you look at obsidian lava flows, such as some of the flows near Bend, Oregon, that they did not cool faster than other types of lava flows. The shiny, glassy texture of obsidian is primarily a function of the high silica content of the magma.

Your text mentions that another type of frothy, glassy texture exists in the form of pumice, a rock so porous that it will commonly float. There are more gas bubble holes in pumice than there is volcanic material. (The gas bubble holes are called vesicles. If a rock is highly vesicular and light in color we refer to it as pumice. If some vesicular material is very dark in color (basaltic in composition) it is called scoria. I will not expect you to know the difference between pumice and scoria on a test!)

Most volcanic (extrusive) rocks contain a mixture of sub-microscopic crystals that did not have time to grow and a glassy matrix, however you can't see that glassy texture easily in most volcanic rocks.

In the discussion of the various types of igneous rock groups, please do not let the mineral names or chemistry stop you. If you have questions about them you can look at Ch. 2 or see me. I will not test you over these mineral names!

From the information on pages 79--85, complete the following chart:

	silica content	color	volcanic rock type	plutonic rock type	relative viscosity of magma
felsic	highest			granite	
intermediate			andesite		
mafic		dark			
ultramafic			you do not need to know this one	peridotite	you do not need to know this one

Intrusive Rock Formations (p. 85)

Tabular Plutons: (p. 85)

An intrusion that is parallel to the preexisting rock is a _____ (sill/dike)

An intrusion that cuts across the existing layers is a _____ (sill/dike)

How could one determine whether an igneous rock (such as a basalt layer) is either a sill or a lava flow? (see pages 86 and 88 and figure 3-26).

Batholiths and Other Large Plutons (p. 87)

A mass of intrusive igneous rock greater than 100 square kilometers (about 6 miles by 6 miles) is termed a _____. Normally, these intrusions are a result of several intrusions, not just one event.

The information from page 92 to the end of the quarter will not be covered in this unit. We will return to this information near the end of the quarter as we develop the idea of how magmas form and their connection to plate tectonics.

An aside (There are six basic rock types noted in the text: granite, diorite, gabbro (intrusive rocks) and rhyolite, andesite, and basalt (extrusive rocks). In lecture, we will add two more to this list: granodiorite and dacite. Granodiorite and dacite are from the same composition of magma, but the granodiorite magma did not reach the Earth's surface and the magma cooled slowly to produce crystals. Dacite, the volcanic rock, was the type of magma erupted by Mt. St. Helens in 1980. Granodiorite (plutonic) and dacite (volcanic) are the rocks types that originate from magmas that have a composition between granite and diorite (or rhyolite and andesite)).

There are more basaltic lava flows than gabbroic intrusions. Why?

We will return to this chapter at the end of the quarter. On exam #1, you will not be tested on the information from page 91 to the end of the chapter.

► *One of the important ideas from Ch. 3 is that intrusive rocks (plutonic rocks) do not erupt! Igneous is not the same as volcanic—magmas that are trapped underground, cool slowly and are found only at the surface when erosion has stripped away the overlying rock layers. So, don't fall into the trap of thinking igneous and volcanic mean the same!*

Chapter 4: (page 100)

Please read the introduction to the chapter.

The Nature and Origin of Volcanoes (p. 103)

Mt. Rainier is classified as a dormant volcano. What does that mean? Mt. Theilsen in the Oregon Cascades is classified as an extinct volcano, what does that mean?

The Causes of Volcanism: (p. 104)

Gases are a natural part of magma. The principle gases in most magmas are _____ and _____. Within the Earth these gases are dissolved in the magmas due to the _____ of overlying rocks.

When the magma finds a weakness in the overlying rock and begins to move toward the surface, the pressure from the overlying rocks is reduced, the pressure created by the gas expansion helps push the magma to the surface.

The primary reason that magma sprays into the air in lava fountains is due to the presence of _____. If a magma comes to the surface and there is very little gas in the magma, the eruption is normally very _____(explosive, quiet).

(Review from Chapter 3): _____ is the resistance of a liquid to flow. If magma has a high viscosity it moves _____(slow/fast), while magma with a low viscosity moves _____.

The higher the temperature of magma, the _____(higher/lower) the viscosity of the magma (lava).

The lower the temperature of magma, the _____(higher/lower) the viscosity of the magma (lava).

In what way does the silica content of the magma influence the viscosity of the magma (lava)?

If magma has a high viscosity, how does this affect the ability of the magma to release gases? How does this affect the explosiveness of the magma?

So, _____(low/high) viscosity magmas are usually more explosive and _____ viscosity magmas are usually less explosive.

→We could summarize that there are three primary variables that influence the character of a volcanic eruption: (all three are in this section—two of them affect the viscosity of the magma!!)

- 1.
- 2.
- 3.

The Products of Volcanism (p.106)

Types of Lava: (p. 106)

When a lava flow pools and stops flowing, a pattern of mostly vertical cracks develops. These cracks are due to:

These mostly vertical fractures are called _____.

Distinctive rounded masses of lava known as pillow structures are formed when the lava is erupted into _____.

Normally, andesitic lava flows flow _____(slower/faster) than basalt. This is because andesite lava usually has a _____ viscosity.

→Rhyolitic magmas tend to crystallize _____ forming granite, so eruptions of rhyolite are rare. The viscosity of most rhyolitic magmas is very _____. When rhyolite does erupt, it usually erupts very _____, producing large amounts of ash.

Pyroclastic Materials: (p. 111)

How would the grain size and the thickness of the tephra layer change if you examine the tephra close to the volcano and compare the same tephra layer farther from the volcano?

One of the most dramatic and dangerous volcanic events is a _____ flow. This is a flow of ash and volcanic gases that can move very rapidly down a volcano.

The term geologists prefer for a volcanic mudflow is _____. This type of mass movement is common following an eruption because:

Secondary Volcanic Effects: (p. 114) interesting information, but you will not be tested on this section.

Eruptive Styles and Associated Landforms (p. 116)

Effusive Eruptions: (p. 116) and *Pyroclastic Eruptions:* (p. 121)

- | | |
|--|---------------------|
| 1. ____ A large depression created by the collapse of a volcano | A. crater |
| 2. ____ The principle rock type erupted from fissures | B. composite cone |
| 3. ____ When _____ mixes with basaltic magmas, the eruption may be very violent | C. caldera |
| 4. ____ Volcano formed primarily of basaltic lava flows. Has relatively flat slopes. | D. cinder cone |
| 5. ____ This type normally erupts dacite or rhyolite. Lava flows not common. | E. basalt |
| 6. ____ A depression created by the explosion of a volcano. | F. volcanic dome |
| 7. ____ A small, steep-sided volcano built mostly of tephra- usually basaltic in composition | G. sea water |
| 8. ____ Mt. Rainier is an example of this type of volcano | H. shield volcano |
| | I. rhyolite |
| | J. fissure eruption |

Is “Crater Lake” in Oregon a crater or a caldera? How did it form?

Explain the difference between a composite cone and a cinder cone. If you observed a cone that you believed to be a cinder cone, how would it differ in appearance from a composite cone?

Plate Tectonics and Volcanism (p. 128) and **Coping with Volcanic Hazards** (p. 132) sections will not be covered on the first exam.

Please read the section on Mt. St. Helens on pages 132 and 133. It will reinforce the lecture on the same topic.

Extraterrestrial Volcanism—(p. 138) will not be covered on the exam.