Name Teacher Period Date

CHAPTER 5—LAB 3: METAMORPHIC ROCKS

Introduction

The word metamorphic means changed in form. ~~Intense~~ heat and/or pressure without melting change an older rock to a new metamorphic rock. Most metamorphic rocks begin as igneous or sedimentary rocks. Metamorphism causes new minerals to form, crystals to grow, structures such as sedimentary layers to become distorted, and density to increase.

Figure 5-7 shows that as sediments such as clay are buried deeper within Earth, heat and pressure increase, causing the sediments to change into shale, a sedimentary rock. The shale is changed by deeper burial through slate, phyllite (FILL-ite), schist, and gneiss (NICE). Still higher temperatures and deeper burial could cause the rock to melt. Then, cooling and crystallization would produce an igneous rock.

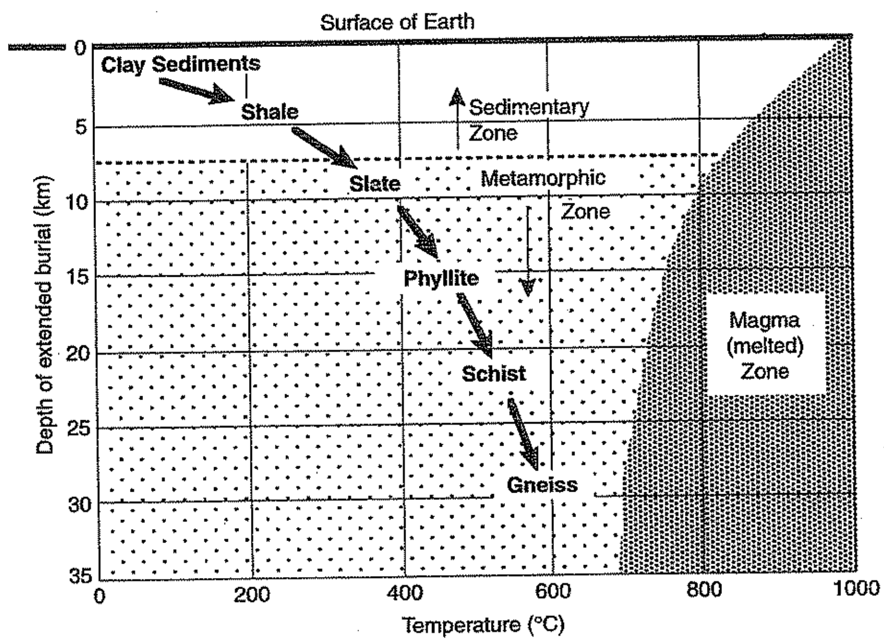

FIGURE 5-7. Changes in rock caused by heat and pressure at increasing depth.

Metamorphic rocks follow a continuum from relatively slightly changed to higher grade rocks that have undergone more extensive alteration. The greater the changes caused by metamorphism, such as foliation and the formation of new minerals, the higher the grade of metamorphism.

Many metamorphic rocks display both mineral crystals and layering. This layering may be the result of crystal growth, and not the remains of original sedimentary bedding. The alignment of mineral crystals is known as foliation. Foliation is a common property of metamorphic rocks, as shown in Figure 5-8.

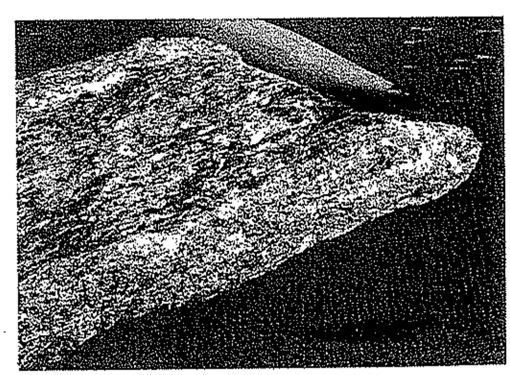

FIGURE 5-8. Foliation is layering caused by alignment of mineral crystals, especially mica.

Name Teacher Period Date

FIGURE 5-9. Banding is a result of minerals separating into layers during metamorphism.

Banding is a coarser kind of layering, resulting in the separation of minerals into bands, often forming light and dark layers as shown in Figure 5-9

Figure 5-10 illustrates the two kinds of metamorphism. **Contact metamorphism** occurs in a narrow zone next to an igneous intrusion. Rocks in contact with the intrusion are baked by the heat they absorb, causing chemical changes that can create new minerals. Usually the metamorphic grade (degree of change) decreases with distance from the heat source. Most contact metamorphic rocks, such as hornfels, do not show foliation or banding. However, when a large mass of rock is buried many kilometers within Earth, heat and pressure can cause widespread **regional metamorphism.**

Most of the rocks of the Adirondack Mountain region and in southeastern New York State probably began as a mixture of sedimentary and igneous rocks, including sandstone, shale, limestone, granite, and basalt. Burial at a depth of as much as 20 to 30 km, where the temperature and pressure are high, gradually changed these rocks into metamorphic rocks.

Metamorphic rocks are usually separated into two groups according to their texture (foliated or nonfoliated) and composition. The foliated rocks have a streaked or layered appearance caused by the parallel growth of mineral crystals. The nonfoliated rocks contain very small crystals, or the crystals show no preferred alignment direction.

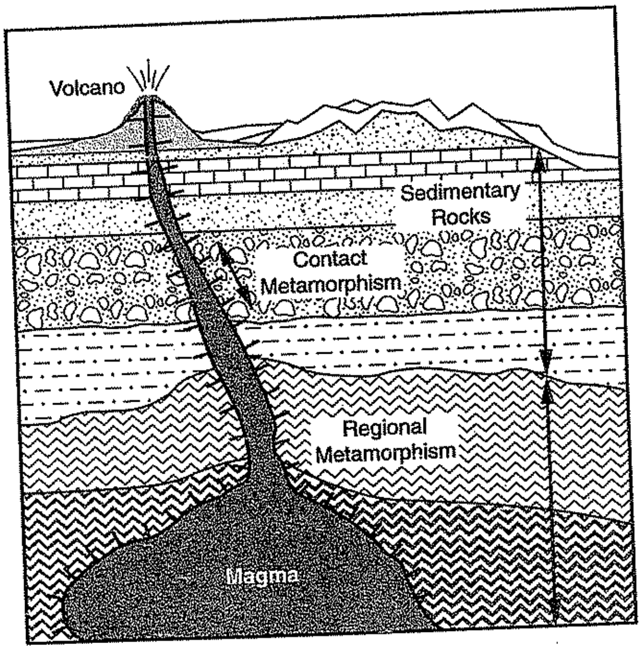

FIGURE 5-10. Contact metamorphism and regional metamorphism.

Foliated Metamorphic Rocks

The following five metamorphic rocks may be similar in composition, but they differ in the amount of metamorphic alteration.

- **Slate** looks like shale, but it is harder and more dense. Unlike shale, slate often breaks along the mineral foliation direction rather than along the original sedimentary bedding. It is usually gray, black, or brown.
- **Phyllite** (FILL-ite) looks similar to slate; however, phyllite is shiny due to the growth of tiny mica crystals. The layering in phyllite is sometimes wavy.
- **Schist** contains mica crystals large enough to be easily visible. Nonfoliated minerals, such as quartz and feldspar may also be present in a few veins or bands, although the mica foliated texture still dominates.

- **Gneiss** (NICE) has a banded look with alternating layers of light-colored minerals, such as quartz and feldspar, and dark minerals such as amphibole and pyroxene. Schist changes to gneiss when most of its flat mica crystals change to other minerals including feldspar. Some gneisses do not show banding and look almost like igneous granite. However, you know it is metamorphic because crystals show a foliation direction.

Increased heat and pressure will cause gneiss to melt and then solidify, changing the metamorphic rock into magma and then an igneous rock.

Nonfoliated Metamorphic Rocks

The nonfoliated metamorphic rocks have variable origin and composition.

- **Marble** is metamorphosed limestone (mostly calcite). It is usually white, gray, or other light color. Some examples are foliated. Powdered calcite mineral, made by hitting marble with a rock hammer, will bubble with a strong acid.
- **Quartzite** is metamorphosed sandstone. It is usually light in color and it commonly has a glassy luster on freshly broken surfaces. Because it is so hard, quartzite weathers slowly to make smooth, rounded surfaces and pebbles.
- **Metaconglomerate**, unlike the sedimentary conglomerate from which it forms, often splits through the pebbles. The pebbles may be squashed or elongated by the combination of heat and pressure deep within Earth.

Objective

To identify metamorphic rocks based on their properties.

Materials

Set of metamorphic rocks, Metamorphic Rock Identification chart

Procedure

Place your set of rocks in numerical order on the desk in front of you. Identify each of your metamorphic rocks using the *Earth Science Reference Tables* and the descriptions above.

Complete the grid below based on your identification of the metamorphic rock samples. Rock names may be used more than once.

Name Teacher Period Date

Sample Number	Texture	Composition	Rock Name
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			

Return your samples. Please let your teacher know if your set is incomplete or if you have extra items.

Wrap-Up

1. What are metamorphic rocks made from?

2. What two conditions change a rock into a metamorphic rock?

3. What mineral feature forms and grows larger with increasing metamorphism?

4. What are foliation and banding?

5. What are the two types of metamorphism?

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Name Teacher Period Date

6. Which kind of metamorphism occurs next to an intrusion of molten magma?

7. If clay is buried very deep within Earth, it can progress through a series of rocks of increasing metamorphic grade. Name the rocks in this series.

8. What process is involved in the formation of all igneous rocks, but not in the formation of metamorphic rocks?

9. What are some of the changes that occur when a sedimentary rock transforms into a metamorphic rock?

10. In what parts of New York State is metamorphic bedrock most common?

Base your answers to questions 11–20 on the Scheme for Metamorphic Rock Identification in the *Earth Science Reference Tables.*

11. Which foliated metamorphic rock has the smallest crystals?

12. What mineral family is often found in most foliated metamorphic rocks?

13. What sedimentary rocks can change into marble?

14. Of the metamorphic minerals shown in the chart under Composition, which one seems to require the most heat and pressure, so it is generally seen only in gneiss or high-grade schist?

15. What mineral family can the mica minerals change to when gneiss is formed?

16. In what two ways does metaconglomerate often differ from a sedimentary conglomerate?

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17. Which type of metamorphic rock is usually foliated and banded? ____________

18. Only one metamorphic rock is always formed by contact metamorphism. What is it?

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19. What group of minerals usually gives schist a strong foliation? ____________

20. Which kind of metamorphic rock is found in the central Adirondacks?

(This question probably requires you to use a different page in the *Reference Tables*.)

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