Chapter 6. The Rock Cycle

Introduction

Learning Objectives

After carefully reading this chapter, completing the exercises within it, and answering the questions at the end, you should be able to:

• Explain what a rock is.
• Describe the rock cycle and the types of processes that lead to the formation of igneous, sedimentary, and metamorphic rocks.
• Explain why there is an active rock cycle on Earth

6.1 What Is A Rock?

A rock is a consolidated mixture of the same or different minerals. By consolidated, we mean hard and strong; real rocks don’t fall apart in your hands. A mixture of minerals implies the presence of more than one mineral grain, but not necessarily more than one type of mineral. A rock can be composed of only one type of mineral (e.g., limestone is commonly made up of only calcite), but most rocks are composed of several different minerals (e.g., the pegmatite in Figure 6.1). A rock can also include natural materials not classified as minerals, such as organic matter within a coal bed, or volcanic glass.

Figure 6.1 This close-up view of the igneous rock pegmatite shows black biotite crystals, colourless quartz crystals, and pink potassium feldspar crystals. Crystals are mm to cm in scale. [Karla Panchuk; photo by R. Weller/ Cochise College (permission for non-commercial educational use)]
Rocks are grouped into three main categories based on how they form. **Igneous** rocks form from the cooling and crystallization of melted rock. **Sedimentary** rocks form when weathered fragments of other rocks are buried, compressed, and cemented together, or when minerals precipitate from solution, either directly or with the help of an organism. **Metamorphic** rocks form by alteration of a pre-existing rock under high heat and pressure. Although temperatures can be very high, metamorphism does not involve melting of the rock.

### 6.2 The Rock Cycle

The rock components of the crust are slowly but constantly being changed from one form to another and the processes involved are summarized in the **rock cycle** (Figure 6.2). The rock cycle is driven by two forces:

1. Earth’s internal heat engine, which moves material around in the core and the mantle and leads to slow but significant changes within the crust.
2. The hydrological cycle, which is the movement of water, ice, and air at the surface. The hydrological cycle is powered by the sun.

![Figure 6.2 The rock cycle consists of processes that change rocks from one form to another [Steven Earle CC-BY 4.0]](https://physicalgeology.pressbooks.com)

The rock cycle is still active on Earth because our core is hot enough to keep the mantle moving, our atmosphere is relatively thick, and we have liquid water. On some other planets or their satellites (e.g., Mercury), the rock cycle is virtually dead because the core is no longer hot enough to drive mantle convection and there is no atmosphere or liquid water.
In describing the rock cycle, we can start anywhere we like, but it’s convenient to start with magma. Magma is melted rock located within the Earth. Rock can melt at between about 800 °C and 1300 °C, depending on the minerals in the rock, and the pressure the rock is under. If it cools slowly within the Earth (over centuries to millions of years), magma forms intrusive igneous rocks. If magma erupts onto the surface, we refer to it as lava. Lava cools rapidly on Earth’s surface (within seconds to years) and forms extrusive igneous rocks (Figure 6.3).1

Through the various plate-tectonics-related processes of mountain building, all types of rocks are uplifted and exposed at the surface. Once exposed, they are weathered, both physically (by mechanical breaking of the rock, Figure 6.4) and chemically (by reacting with minerals and changing them to something else).

The weathering products — mostly small rock and mineral fragments — are eroded, transported, and then deposited as sediments. Transportation and deposition occur through the action of glaciers, streams, waves, wind, and other agents (Figure 6.5), and sediments are deposited in rivers, lakes, deserts, and the ocean (Figure 6.6).

Figure 6.3 Lava forming pahoehoe (ropy) basalt at Kilauea Volcano, Hawaii [Steven Earle CC-BY 4.0]

Figure 6.4 Mechanical weathering near La Madaleta glacier in Spain. Cycles of freezing and thawing cause ice to wedge open rocks along pre-existing cracks. [Luis Paquito, CC-BY-SA]

1 Remember the difference between intrusive and extrusive igneous rocks by recalling that INtrusive rocks form withIN the Earth, and EXtrusive rocks form when lava EXits the Earth’s crust.
Unless they are re-eroded and moved along, sediments will eventually be buried by more sediments. At depths of hundreds of metres or more, they become compressed and cemented into sedimentary rock (Figure 6.7).

Again through various means, largely resulting from plate-tectonic forces, different kinds of rocks are either uplifted, to be re-eroded, or buried deeper within the crust where they are heated up, squeezed, and changed into metamorphic rock (Figure 6.8).
Chapter Summary

The topics covered in this chapter can be summarized as follows:

6.1 What Is a Rock?

A rock is a cohesive aggregate of minerals. It may consist of many grains of the same mineral, or grains of different minerals.

6.2 The Rock Cycle

The three types of rocks are igneous, formed from magma; sedimentary, formed from fragments of other rocks or precipitations from solution; and metamorphic, formed when existing rocks are altered by heat,
pressure, and/or chemical action. The rock cycle summarizes the processes that contribute to cycling of rock material among these three types. The rock cycle is driven by Earth’s internal heat, and by processes happening at the surface, which are driven by solar energy.

Questions for Review

1. What processes must take place to transform rocks into sediment?

2. What processes normally take place in the transformation of sediments to sedimentary rock?

3. What are the processes that lead to the formation of a metamorphic rock?

See Appendix 2 for solutions to review questions.