8.4 Conduction and Geological Processes

Figure 1 Exposed rock of the Canadian Shield can be seen along many highways in Ontario.

Have you ever seen rock formations like those in Figure 1? The wavy dark and light lines in the rock indicate that the rock may not always have been completely solid. Were these solid rocks once softer and flexible a long time ago? If so, where did the energy that softened the rock come from? Have you ever wondered why the rocks in this area look the way they do?

The Sun is a major source of thermal energy on Earth's surface. Another large hidden source of thermal energy is **geothermal energy** within Earth. We can see the effects of this energy directly during volcanic eruptions (Figure 2). We also see geothermal energy where hot springs bring boiling liquid to the surface of Earth (Figure 3).

geothermal energy: energy contained below Earth's surface

Earth's interior is composed of four layers. The first is a thin layer of solid rock called the crust. The second is a hot, flexible layer of rock called the mantle. Then there is a molten outer core and a solid inner core of iron and nickel (Figure 4). The temperature of Earth's core is estimated to be close to 7000 °C. Although it is not obvious, even Earth's cooler outer crust contains a significant amount of geothermal energy.

Figure 2 Volcanic eruptions provide evidence of geothermal energy.

Thermal energy from deep within Earth is conducted through the matter in the upper layers. This energy helps form rocks and minerals.

Figure 3 Geothermal energy heats the liquid in hot springs.

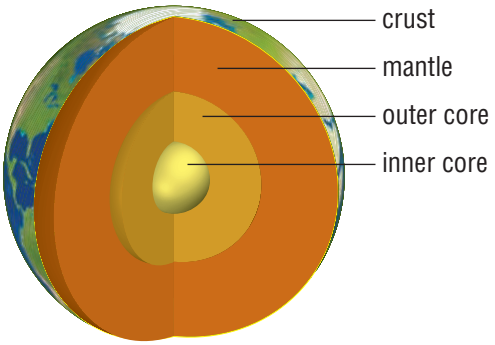

Figure 4 This cross-section shows the four layers that make up Earth's interior.

Heat and Rock Formation

Rocks inside Earth are constantly melting and solidifying. When rock is heated to high temperatures (between 625 °C and 1200 °C), it melts into magma. When hot magma is pushed to the surface in a volcanic eruption, it cools and solidifies into new rock. This new rock is called **igneous rock** (Figure 5). Common igneous rocks include pumice, obsidian, and granite.

igneous rock: rock formed from magma that has cooled and solidified

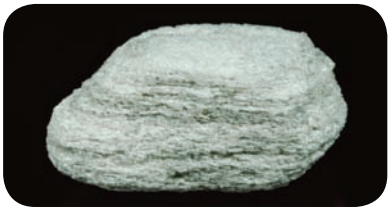

Figure 5 Pumice is an igneous rock.

Earth's crust, which consists of the continents and ocean floors, is constantly moving very slowly. Movements of Earth's crust have significantly changed our planet. Sometimes two pieces of Earth's crust push against each other. This collision pushes existing rocks deep into Earth, toward the hot core. When the rock is exposed to high pressure and temperatures above 200 °C, the particles of the rock absorb the geothermal energy. The particles are rearranged, resulting in the formation of a new type of rock, called **metamorphic rock** (Figure 6).

metamorphic rock: rock that is formed when heat and pressure change existing rock

Figure 6 Gneiss is an example of metamorphic rock.

The Canadian Shield is made mostly of metamorphic rock, and contains some of the oldest rock on Earth (about 4 billion years old). You can see examples of the Canadian Shield through much of Northern Ontario, especially in the Sudbury area. The Canadian Shield covers about two-thirds of Ontario.

Diamond

Diamond is a mineral composed of pure carbon and is the hardest natural material found on Earth (Figure 7(a)). Diamonds form deep in Earth's crust (about 150 km below the surface). At these depths, heat and pressure may change graphite (another form of carbon) into diamond. Therefore, diamonds are a type of metamorphic rock.

Diamonds are often found near the sites of old volcanoes, where magma from ancient eruptions carried rocks containing diamonds closer to Earth's surface. Diamonds are crystals that can be cut, polished, and used in jewellery (Figure 7(b)). Since they are very hard, diamonds are also used on the tips of saw blades and drill bits to cut through rock and steel (Figure 7(c)).

To learn more about diamonds,
Go to Nelson Science

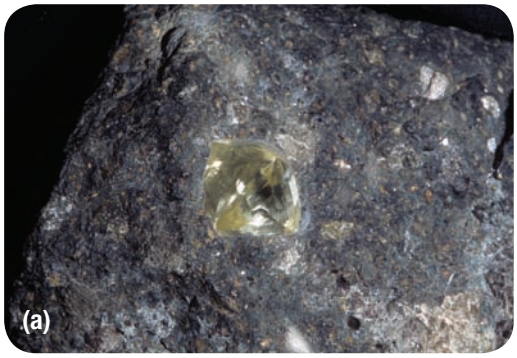

Figure 7 (a) A rough diamond found in a mine, (b) a cut and polished diamond set in a ring, and (c) an industrial diamond in a saw blade

CHECK YOUR LEARNING

1. Describe the formation of rocks due to conduction of geothermal energy within Earth.
2. Name two types of rocks and one mineral formed by conduction of energy.
3. What are some relationships between moving continents, geothermal energy from within Earth, and metamorphic rock?
4. Why can diamond be considered a type of metamorphic rock?