How One Rock Becomes Another Rock

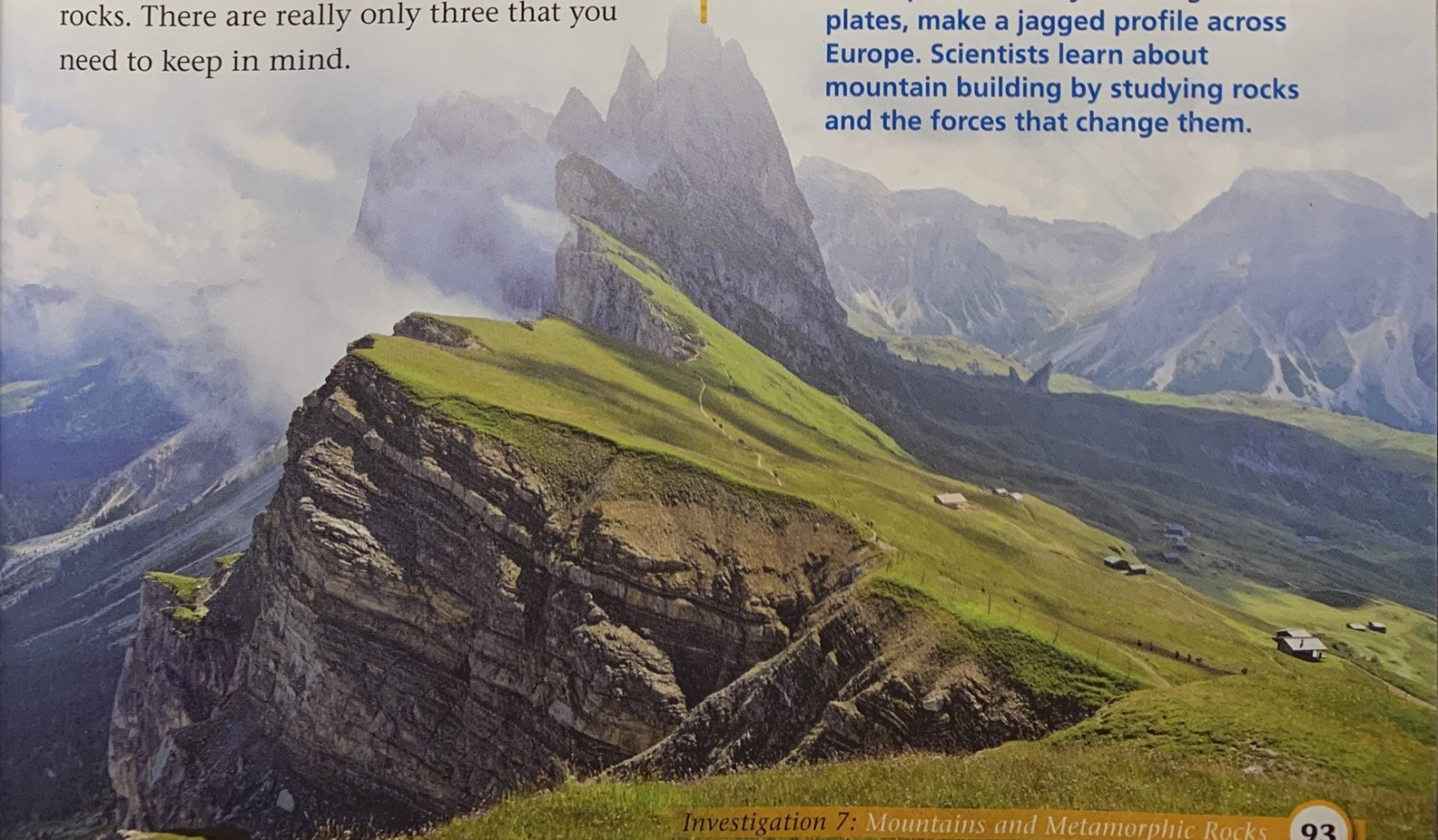
It seems that rocks are constantly changing. Sometimes these changes happen rapidly, as in a volcanic eruption.

But most often the changes take thousands or millions of years. You would get pretty bored sitting and watching a rock, waiting for it to change.

As far as geologists know, every rock on Earth and in the crust has been something different in the past.

Let's review the processes that can change rocks. There are really only three that you need to keep in mind.

Melting and cooling. If any rock gets pushed deeply enough into the crust, extreme heat can melt the rock. It will become magma. The magma can cool in the crust or erupt onto the surface as lava. When magma or lava cool, they become igneous rock.



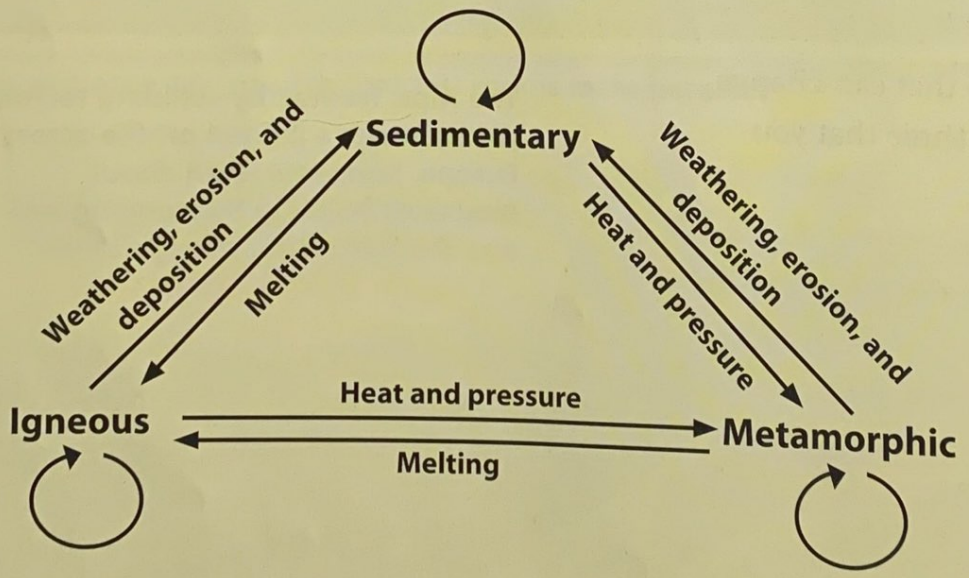
The Alps, formed by colliding tectonic plates, make a jagged profile across Europe. Scientists learn about mountain building by studying rocks and the forces that change them.

Weathering, erosion, and deposition. Physical and chemical weathering break down rocks. The sediments and chemicals from these rocks can be eroded and deposited in a basin. Over time they can become sedimentary rock.

Heat and pressure. Any rock that undergoes enough heat and pressure can be **transformed** into a metamorphic rock. It could happen when the rock is buried under kilometers of other rock. It might be caused by the incredible force of two continental plates converging. It could happen where magma rises to the surface. The magma's heat can change the surrounding rocks into metamorphic rocks.

Sedimentary rocks can become igneous rocks, or metamorphic rocks, or new sedimentary rocks. Igneous rocks can change into sedimentary rocks or metamorphic rocks, or. . . . You get the picture. These processes are the **rock cycle**. The materials in the rocks are constantly being recycled and rearranged to form new rock.

The Rock Cycle



Together, all the ways rocks can be changed from one type to another are known as the rock cycle.

Take Note

Review your rock observations. What characteristics help determine the kind of rock (sedimentary, igneous, metamorphic)?

The Story of the Wrightwood Marble

Let's look at a rock that has taken several trips around the rock cycle. Wrightwood marble is a rock found in the San Andreas Fault Valley near Los Angeles, California. Its story started about 300 million years ago (mya).

Chapter 1: Melting and cooling. About 245 mya, a large pool of magma formed thousands of meters below Earth's surface. The magma contained calcium, magnesium, sodium, aluminum, iron, silicon, oxygen, and other elements.

Because magma is less dense than solid rock, the magma began rising toward the surface. The atoms in the magma began to organize into mineral crystals, like the crystals you saw in salol. After cooling for tens of thousands of years, the whole mass of magma crystallized into solid igneous rock. Let's follow some of the calcium in that igneous rock as we continue the story.

The weathering, erosion, and deposition that break down cliffs into pebbly beaches are part of the rock cycle.

Chapter 2: Weathering, erosion, and deposition. The movement of tectonic plates pushed up the igneous rock. After it reached the surface, the rock on top eroded away. Eventually all the igneous rock was exposed to sunlight and rain. For several million years, weathering broke the rock into sediments. The sedimentary particles containing the calcium ended up in rivers, on beaches, and in bays. Waves, currents, and tides eroded the small grains even more. Some of the calcium and other chemicals dissolved and flowed into the ocean. The calcium joined with oxygen and carbon to become calcium carbonate ($CaCO_3$). Clams and other sea creatures absorbed the calcium carbonate in their shells. When they died, their shells settled to the bottom. Some calcium carbonate settled to the bottom as ooze. The layer of calcium carbonate got thicker and thicker. The water was squeezed out, and over time a layer of limestone formed.

Chapter 3: Heat and pressure. Millions of years passed. Other rock layers were deposited on the limestone. The limestone got warmer and warmer as it was buried deeper. There was tremendous pressure from rocks above and from the Pacific Plate running into the North American Plate. This heat and pressure caused the calcium carbonate in the limestone to change. The rock became marble.

The Wrightwood marble cliff in southern California looks like this today.

If you want to make your own marble, start out with a piece of limestone and apply enough heat, pressure, and time. Put the same pressure on the rock as there would be under 25 kilometers (km) of rock or so. You would need to pile 200–240 cars on it to get enough pressure! You would need to heat it up to a few hundred degrees Celsius. Then wait for several million years while the atoms rearrange themselves. And *that* is how you make marble.

Chapter 4: Uplift. The calcium in the Wrightwood marble today was once part of an igneous rock on top of a mountain, and then part of a limestone buried deep below the ocean floor. When the limestone metamorphosed, this same calcium became part of the marble. When the marble was uplifted, it became part of a mountain again.

This open pit of marble was once an underground bed of limestone. Tremendous heat and pressure gradually changed it to the metamorphic rock so prized for building and sculpture.

What part of the rock cycle is represented by these lava flows? What type of rock is being formed?

The future. As millions of years go by, the marble will weather and erode. Water and wind will transport the sediments and minerals in the marble to a different place. These sediments and minerals will form different rock, and the whole process will continue.

The formation of every rock on Earth involves these or similar processes. And every rock is currently going through these processes and will become some other type of rock in the future. This process will continue as long as Earth exists.

Think Questions

1. Develop a story of a rock cycle that includes sandstone, basalt, quartzite, and granite. The rocks do not need to be in the above order. Describe each step of the story. Include the type of rock, the location of the rock, and the processes that affect it.
2. Choose four or five rocks and make up a rock-cycle story. Explain how the material in the rocks changes and becomes part of a new rock.
3. What is a common type of rock in your community? Start with igneous rock and develop a rock-cycle story that ends with your local rock. Describe what you think might be in store for that rock during the next few million years.