Rock Transformations Overview

What's in This Unit?

Understanding the geologic history of specific regions on Earth helps us understand how rock forms and transforms and how matter cycling on Earth is driven by different sources of energy. The Rocky Mountains and Great Plains are two iconic locations in the United States that have a shared geologic history, which serves as the anchor phenomenon that students investigate in this unit. Students are motivated by the discovery of the surprisingly similar mineral composition of rocks from the two locations. Geologists examine rock formations to learn about the history of the rock. In this unit, students play the role of student geologists as they investigate different ways rocks form and change. Using physical models, a digital simulation, and hands-on activities as well as information gathered from data and science texts, students investigate the cycling of matter (rock material) on Earth and how energy from the sun and from Earth's interior drive different rock transformation processes. Students use their new understanding to explain how these processes caused rock material from the Rocky Mountains to eventually become part of the Great Plains.

Why?

We use the context of the Rocky Mountains and the Great Plains to give students a way to explore sedimentary and igneous rock formations. Rocks from the two areas appear very different yet have surprisingly similar mineral compositions. This provides the context and motivation for students to investigate how rocks form and transform. Students will eventually discover that the rock from the Great Plains is sedimentary rock, and the rock in question from the Rocky Mountains is igneous. (The Rocky Mountains include many rock types, but students focus on one particular formation in the Rockies—rock that is igneous.) They discover the sediment that compacted to create the rock of the Great Plains was transported from the neighboring Rocky Mountains. This sediment formed when igneous rock in the Rocky Mountains was weathered. Students learn that this particular igneous rock formed deep underground before being uplifted. Uncovering and tracing this geologic history allows students to explore the characteristics, transformation mechanisms, and related energy sources of sedimentary and igneous rocks. The particular history of the Great Plains and Rocky Mountains highlights many key processes that transform rock material and the connection of plate motion to those processes. It also highlights iconic features of the American landscape.

How?

The *Rock Transformations* unit begins with the scenario of two fictional geology students who discover that their rock samples, which look very different and come from two different locations, have surprisingly similar mineral compositions. The students are tasked with explaining the geologic history of the two regions in order to account for their similarities.

In Chapter 1, students work to answer the Chapter 1 Question: *How did the rock of the Great Plains and Rocky Mountains form?* Students investigate rock forms and learn that sediment can be transformed into sedimentary rock through compaction and cementation while magma can be transformed into igneous rock through cooling. They explore properties of rocks, determining which properties make it clear if a rock is sedimentary or igneous. The *Rock Transformations* Simulation (Sim) gives students the ability to manipulate landscapes on a large spatial scale by modeling processes that can take anywhere from days to millions of years. Students use a hard candy model to better understand the formation of sedimentary rock.

In Chapter 2, students work to answer the Chapter 2 Question: *Where did the magma and sediment that formed the rock of the Great Plains and the Rocky Mountains come from?* Students discover that different energy sources drive the processes that form sedimentary and igneous rocks. Students explore the formation of igneous rocks further by considering how rock is melted. They determine that energy from Earth's interior is what changes solid rock into magma. The idea that any type of rock can be melted is introduced, so students begin to further explore the connection between energy sources and the formation of different rock types. Similarly, students investigate how the process of weathering any type of rock is ultimately driven by energy from the sun. Students use the Sim and read about the geologic history of Devils Tower (a geologic feature that includes both sedimentary and igneous rock) to investigate these concepts. Using the hard candy model, students model weathering and melting to understand that any rock type can be transformed in either of these two ways.

In Chapter 3, students work to answer the Chapter 3 Question: *How could rock from one of the regions have transformed into a different type of rock in the other region?* Students take a deeper look at how one rock type can be transformed into another type, exploring how rock can be taken from the surface of the Earth down to depths where melting can occur. They also look at how rock from Earth's interior can be moved up to the surface where it can be broken down into sediment. Students explore the effects of plate motion in the Sim and discover how the mechanisms of subduction and uplift allow these transformations, as well as the formation of metamorphic rock, to happen. Students read about the Nuvvuagittuq Greenstone Belt, which contains some of the oldest rock formations on Earth, and learn how being near (or not being near) plate boundaries where subduction and uplift occur affects the geologic history of rock formations.

In Chapter 4, students work to answer the Chapter 4 Question: *What rock transformation processes are happening on Venus?* Students evaluate, sort, and discuss evidence from Venus landers and orbiters, as well as data related to energy sources on Venus, in order to understand what kinds of rock transformations can occur on Venus. This is an unsolved problem because the harsh surface environment on Venus has made lander exploration impossible to date, and its thick clouds make it impossible to take the same visible wavelength, high-resolution images we have of other planetary surfaces. Students use what they have learned throughout the unit to consider competing claims about which rock transformation processes can happen, and, therefore, which types of rocks might be found by a future lander on Venus.