

Russia's Varied Landscape: Physical Processes at Work

17.1 Introduction

In 1687, an English scientist named Isaac Newton proposed an amazing idea. He suggested that humans could launch a craft into space. This artificial satellite would orbit Earth, just as the moon does. Newton's idea finally came to pass in 1972. That year Russian scientists launched a satellite known as Sputnik into space. Since then, a number of countries have launched more than 5,000 satellites. Cameras and other instruments on satellites have given humans a new view of Earth.

Geographers use **satellite images** to study Earth. These views of Earth from space show how landscapes develop and change. It may seem like mountains and valleys have always been where they are and always will be. Actually, Earth's surface is forever changing. **Physical processes**, or natural forces, are always at work on the landscape. Some physical processes build up land into mountains. Others wear down land into valleys and plains.

In this chapter, you will learn about four physical processes that shape our Earth. You will also learn how those processes have changed Russia's landscape. Russia is the largest country in the world. It covers almost one eighth of the world's land surface. Because of its great size, Russia has a large variety of landscapes to explore.

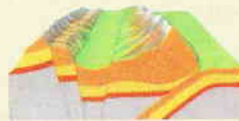
Essential Question

How do physical processes shape Earth's landscape?

The map at the center shows the physical landscape of Russia. The four drawings around the map represent physical processes that have shaped the Russian landscape. Two have built up the landscape. Two have worn it down. Keep this illustration in mind as you try to answer the Essential Question.

Graphic Organizer

Tectonic movement



Erosion



Volcanic activity



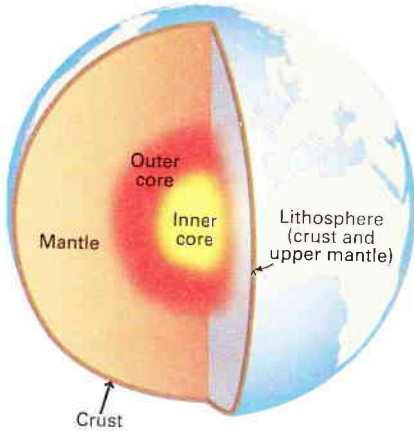
Glaciation



17.2 The Geographic Setting

Russia is a giant country that covers almost 7 million square miles. It includes a large part of Europe and Asia. It is so big that it has 11 **time zones**. In contrast, the continental United States has only 4 time zones.

The western part of Russia is one large plain. At the eastern edge of this plain are the Ural Mountains. East of the Urals lies Siberia, another vast plain. High plateaus, icy mountains, and deep valleys surround Siberia. Physical processes have shaped this varied landscape. These processes begin deep inside our planet.



A Cutaway View of Earth

Earth may seem cool on the surface. But deep inside lies a hot liquid core. Earth's crust "floats" on this molten core. Cracks in the crust may result in volcanic activity or tectonic movement.

Inside Planet Earth Earth was once a liquid fireball. It has been cooling for more than 4 billion years. Inside Earth, though, temperatures are still so high that in some places rock and metals are a fiery liquid.

At the center of Earth lies the **core**. The core has two parts. The inner core is solid iron. The outer core is liquid iron. The core is the hottest part of Earth. Temperatures in the core may reach over 10,000 degrees Fahrenheit.

The next layer out from the core is called the **mantle**. It is made up of molten, or liquid, rock called **magma**. The mantle makes up about two thirds of Earth's mass.

The outermost part of Earth is called the **lithosphere**. The lithosphere includes a layer of solid rock and, above that, the **crust**. The crust is the only cool layer of Earth. It is where we live.

Forces Below the Crust Build Up Land Two physical processes build and shape land from below. They are **tectonic movement** and **volcanic activity**.

Tectonic is a Greek word that means "builder." Tectonic movement is movement inside Earth that results in changes on the surface. Over millions of years, tectonic movement builds mountains. It also triggers earthquakes.

Volcanic activity includes the formation and eruption of **volcanoes**. Volcanic activity also begins below the surface of Earth. When volcanoes erupt, they can change the landscape suddenly and dramatically.

Forces Above the Crust Wear Down Land Two physical processes work above the crust to reshape landscapes. They are **erosion** and **glaciation**. Erosion is the wearing away of Earth's surface. The most common sources of erosion are wind and running water. Glaciation is the formation of large sheets of ice called **glaciers**. Glaciers can erode, or wear down, Earth's surface as they move across the land. Erosion and glaciation create change very slowly.

These four physical processes have been changing Russia's landscape for millions of years. They have built its mountains and worn down its plains, canyons, and valleys. In this chapter, you will find out more about how these four physical processes have shaped not only Russia, but also the rest of our Earth.

► Geoterms

erosion the gradual wearing away of Earth's surface by the action of wind, water, ice, and gravity

glaciation the creation and movement of glaciers

physical processes natural forces that change Earth's physical features, including forces that build up and wear down Earth's surface

tectonic movement the movement of plates below Earth's surface

volcanic activity the formation and eruption of volcanoes

Physical Features of Russia



The World's Largest Country

Russia stretches from Europe across Asia to the Pacific Ocean. Tectonic activity and volcanoes have created its mountains. Erosion and glaciation have shaped its vast plains and plateaus.

17.3 How Tectonic Movement Shapes Earth

Earth's Tectonic Plates



A Crust of Moving Plates

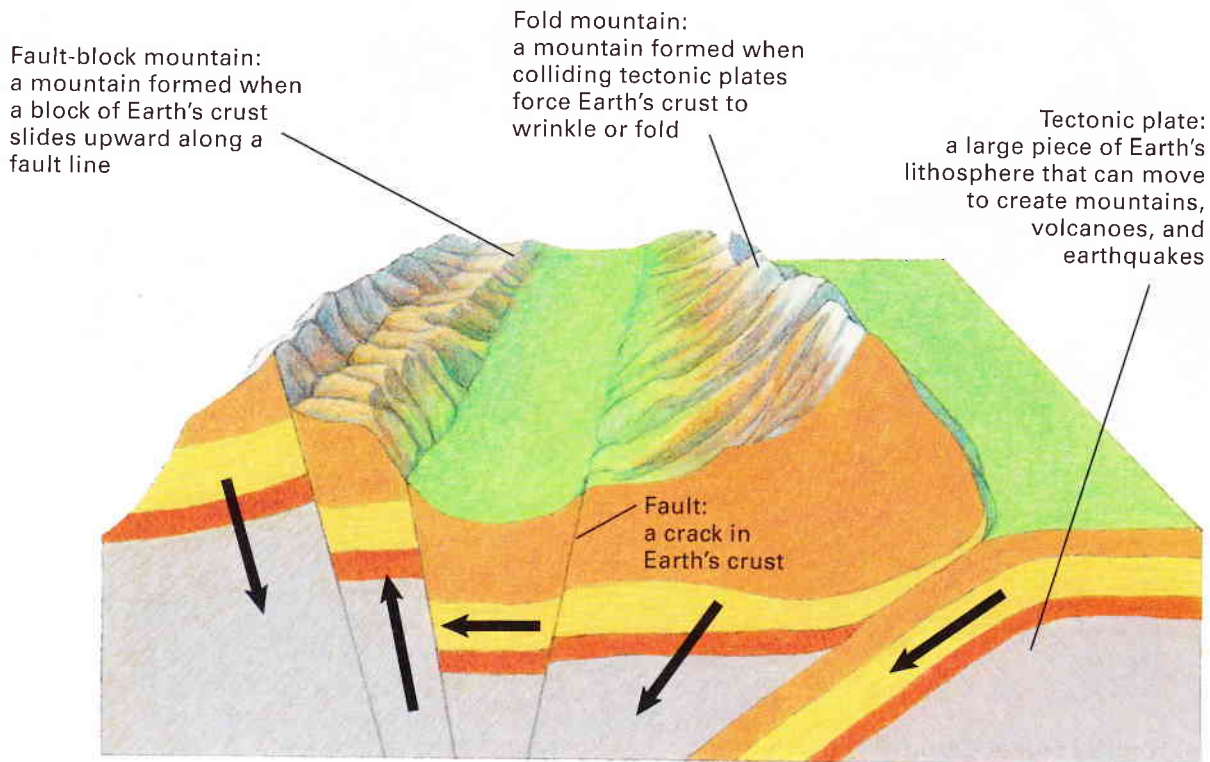
Earth's solid crust is made up of tectonic plates. These plates float on the liquid rock that makes up the middle layer of Earth. There are at least 14 plates, some very large in area, some smaller.

In 1906, a terrifying earthquake shook the city of San Francisco, California. "Trolley lines snapped like threads" and buildings "crumbled like card houses," wrote one eyewitness. "The cobblestones danced like corn in a popper." No one at that time understood how or why earthquakes happened. Today we know that they are caused by tectonic movement.

The Continents and Oceans Rest on Plates Scientists solved the mystery of earthquakes in the 1960s. They discovered that the lithosphere is broken into huge pieces called **tectonic plates**. Earth's lands and seas rest on these plates, which lie below the surface of our planet. The plates float like rafts on Earth's liquid mantle.

Tectonic plates move in three ways. They can move away from each other. They can move toward each other. Or they can scrape sideways past each other. When two plates collide, one usually slides under the other.

Tectonic plates are incredibly heavy. When they meet, friction can lock them into place for long periods. During this time, enormous pressure builds up below Earth's crust. When the pressure gets too great, the plates come unstuck and move with tremendous energy. We feel this sudden movement as an earthquake.



Mountain Building

Over millions of years, the slow movement of tectonic plates has created mountains. When plates collide, they push rock upward to form mountains.

The Movement of the Plates Creates Mountains The movement of tectonic plates forms mountains. When plates collide head-on, they can build mountains in two ways.

Sometimes the pressure of colliding plates forces Earth's crust to fold, or wrinkle, without breaking. The resulting folds form mountains. The Appalachian Mountains and the Urals are examples of **fold mountains**.

At other times, the collision of plates causes the crust to crack into huge blocks. The cracks between the blocks are called **faults**. As pressure builds up, the blocks of crust tilt and tip. Some tilted blocks slide upward along **fault lines** to form mountains. The Sierra Nevada range in California is made up of **fault-block mountains**. So is the West Sayan range in Russia.

17.4 Signs of Tectonic Movement in Russia

Russia covers a large part of both Europe and Asia. Its mountain ranges show how tectonic movement can shape a landscape.

The Ural Mountains in western Russia are considered the dividing line between Europe and Asia. Even though Europe and Asia form one **landmass**, this division makes good geographic sense. The Urals mark the place where two tectonic plates meet beneath Earth's crust. Over millions of years, pressure from these colliding plates pushed the crust upward to create the Urals.

Ural Mountains The Urals slice through Russia from north to south. This long chain of mountains separates the Northern European Plain to the west from the West Siberian Plain to the east.

The Urals are fold mountains. In some places, erosion has worn these mountains down into rolling hills. Other areas still have rugged peaks. Mount Manaraga in the northern Ural Mountains is sometimes called Bear's Paw because of its jagged ridge.

Caucasus Mountains The Caucasus Mountains are in southwestern Russia. They run west to east on a narrow strip of land between the Black Sea and the Caspian Sea.

Like the Urals, the Caucasus Mountains are fold mountains. Snow brushes their high peaks with dabs of white.



West Sayan Mountains The West Sayan Mountains are in southern Siberia, just west of Lake Baikal. Around Lake Baikal, major faults separate high mountains and plateaus from deep valleys and basins.

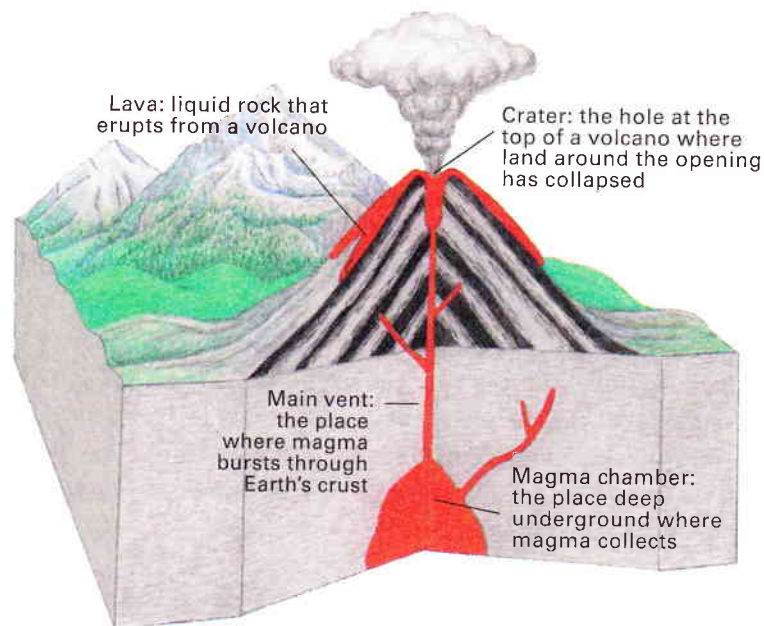
The West Sayan Mountains are fault-block mountains. In this range, erosion has worn away loose soil and rocks from the peaks. This process has left behind steep ridges and exposed layers of rock on the upper slopes of the mountains.

Snowy Caucasus Ridges

The Caucasus Mountains mark the southeastern edge of Europe. This mountain range was formed by moving plates around 25 million years ago.

Volcanic Activity

Inside Earth is a layer of liquid rock called *magma*. When magma reaches the surface, it creates a volcano. Volcanic eruptions can be quite violent. Lava flows and falling ash can change the surrounding landscape. Eruptions can also build up and reshape mountains.



17.5 How Volcanic Activity Shapes Earth

Like earthquakes, volcanoes can reshape the landscape with awesome force. In 1883, an erupting volcano destroyed most of Krakatau, an island in Indonesia. People heard the explosion more than 2,000 miles away. Clouds of ash flew 20 miles or more into the air. Dust from the eruption created colorful sunsets around the world. Two thirds of Krakatau disappeared into a hole under the sea.

Volcanoes Form Below Earth's Surface As you read earlier, hot liquid rock called *magma* lies beneath Earth's crust. This molten rock is always moving. Sometimes magma pushes its way to the surface through cracks in the crust. Scientists call the place where magma reaches the surface a *volcano*. When magma erupts from a volcano, scientists call the liquid rock **lava**.

Volcanoes often occur along the edges of tectonic plates. The hot magma rises through cracks between two plates. Magma can also rise at "hot spots," or weak points, in Earth's crust. Either way, the result might be a single volcano. Or it could be a chain of volcanoes. The Hawaiian Islands are an example of a chain of volcanoes.

Volcanic Explosions Alter the Landscape Some volcanic eruptions are relatively quiet. Lava oozes out or sprays like a fountain. At other times, volcanoes can explode with enormous force. They literally blow their tops off. In 1980, a huge eruption shook Mount St. Helens in the state of Washington. Afterward the mountain was at least 1,300 feet shorter than it was before the eruption.

Violent eruptions hurl tiny bits of rock, or ash, into the air in an enormous cloud. Eventually the hot ash falls to Earth. If thick enough, the ash can bury people and buildings. Sometimes ash mixes with steam to create a fast-moving mudslide. Such a slide can bury everything in its path. After a violent eruption, the land around a volcano may collapse, creating a large **crater**, or hole.

17.6 Signs of Volcanic Activity in Russia

Two huge tectonic plates meet under the easternmost edge of Russia. As a result, this area is one of the world's most active earthquake zones. It is also the location of most of Russia's volcanoes. Most of them are on the Kamchatka Peninsula.

Some of the volcanoes in this region are dormant, or inactive. They have not erupted for a very long time. Others remain active. When they erupt, they can change the landscape through lava flows, mudslides, and deposits of ash. Some eruptions also change the shape of the volcanoes themselves.

The Kliuchevskoi Volcano The Kliuchevskoi Volcano rises out of the northern part of the Kamchatka Peninsula. It is the most active volcano in the country. It is also the highest. Snow covers its upper slopes all year.

In 1994, Kliuchevskoi erupted with great force. Rivers of lava flowed down the sides of the volcano. A cloud of gray ash rose almost 12 miles into the air. Still more ash combined with melting snow to trigger major mudflows.

The Maly Semyachik Volcano The Maly Semyachik Volcano rises out of the center of the Kamchatka Peninsula. It has a large crater at the top called Troitsky Crater. The crater is filled with warm, bright blue water.

The Krenitsyn Volcano The Krenitsyn Volcano is on Onekotan Island, which is part of the Kuril Island chain. During one of its eruptions, part of the volcano collapsed. The collapse left a large hole at the base of the volcano. Once the mountain cooled, the hole filled with water. Today the hole is called Ring Lake.

Russia's Karymsky Volcano

The Karymsky Volcano is one of 160 volcanoes located on Russia's Kamchatka Peninsula. Of these, 29 are still active. Karymsky has erupted 29 times since 1771.



17.7 How Erosion Shapes the Landscape

Landslide! A hill starts to move, sending dirt, rocks, and trees tumbling down its slope. If you lived in the house at the bottom of the hill, you would probably see this event as a terrible disaster. As a geographer, you would also see it as an example of how erosion can reshape the surface of Earth.

Wind, Water, Ice, and Gravity Cause Erosion Erosion takes place everywhere on Earth. Wind, moving water and ice, and gravity all can wear down the land around us.

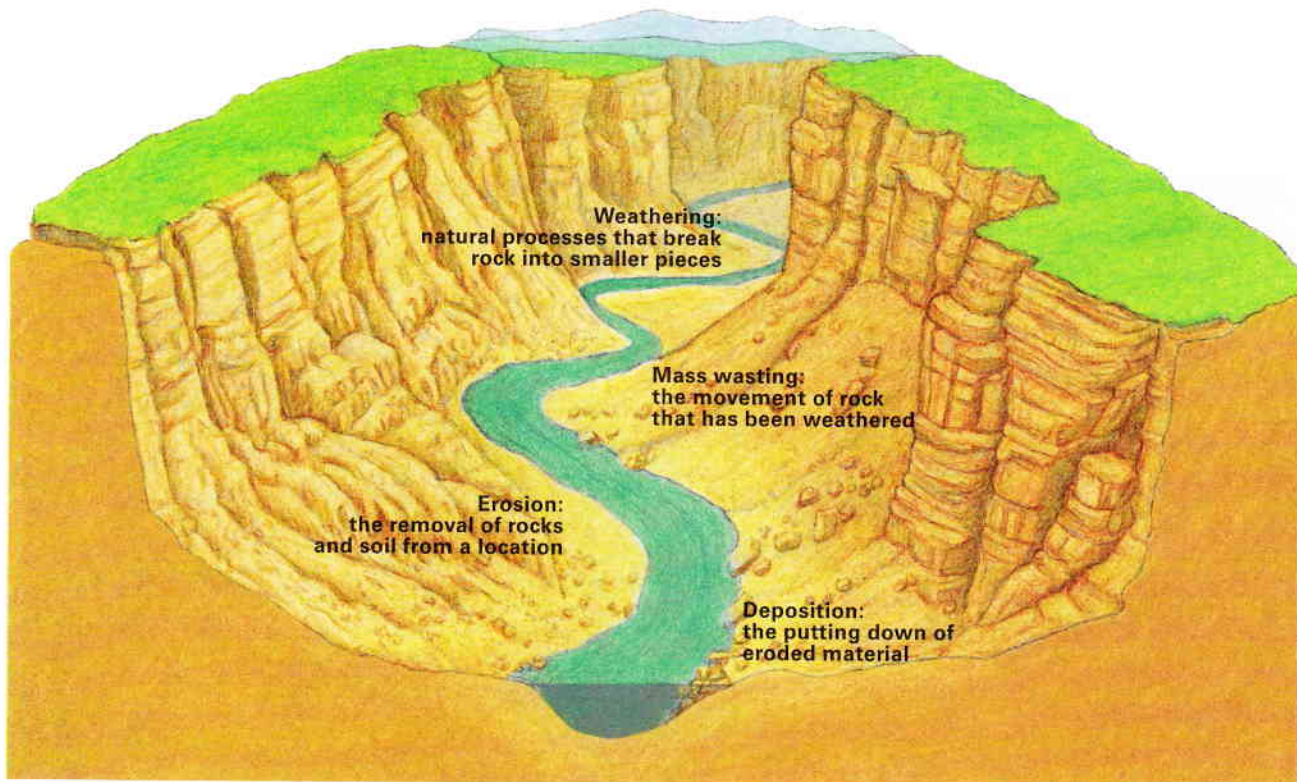
Wind erodes land by picking up tiny grains of dirt and carrying them to distant places. This process wears away the layer of soil that covers Earth's crust. Wind can also grind away rocks and hills by blasting them with gritty sand and dirt.

Moving water also shapes the land. Rivers can erode the land to create deep **V-shaped valleys**. The faster a river flows, the more soil it can wash away and carry downstream. Along coastlines, ocean waves can wear away the shoreline to create steep banks and cliffs. Waves can also erode soil at the base of cliffs, causing the land to collapse. When this happens, homes built on the cliffs may slide down into the sea.

Glaciers can reshape the land as well. These sheets of ice move slowly. They can carve out valleys or create new landforms by depositing rock and soil. Over time, they can push huge quantities of rocks and soil over great distances.

Sources of Erosion

Wind, water, ice, and gravity all cause erosion. Wind moves soil from one place to another. Moving water and ice create cliffs and valleys. Gravity pulls land downhill in landslides and mudslides. Erosion caused by wind and water created the Grand Canyon.



Gravity is a constant force on the landscape. Anything that is not well rooted, or attached, to the ground will eventually move downhill. This movement can occur so slowly we may not be aware of it. Or it can occur quickly, as in a landslide or mudslide.

Floods Build Up Land On flat plains, water can build up as well as wear away land. After heavy rains, rivers overflow their banks and flood the surrounding plain. When the river returns to its banks, soil carried by the floodwater is left behind on the **floodplain**. This fresh layer of soil makes floodplains good places to farm. But the floods that create floodplains also make them dangerous places to live.



17.8 Signs of Erosion in Russia

Much of Russia is covered with plains. On the west side of the Ural Mountains is the Northern European Plain. On the east side are the West and Central Siberian plains. Over millions of years, wind, water, ice, and gravity have worn away any high ground on these plains. The flat or gently rolling land of the plains today is the result of this erosion.

The Volga River Many major rivers crisscross Russia's plains. One of them, the Volga, is Europe's longest river.

The Volga wanders south across the Northern European Plain. It carries along many tons of **sediment**, or soil and sand, as it travels. During floods, the river leaves some of the sediment on the surrounding land. This process is called *sedimentation*. Eventually, the Volga deposits its remaining sediment into the Caspian Sea. The sediment turns the sea a cloudy green.

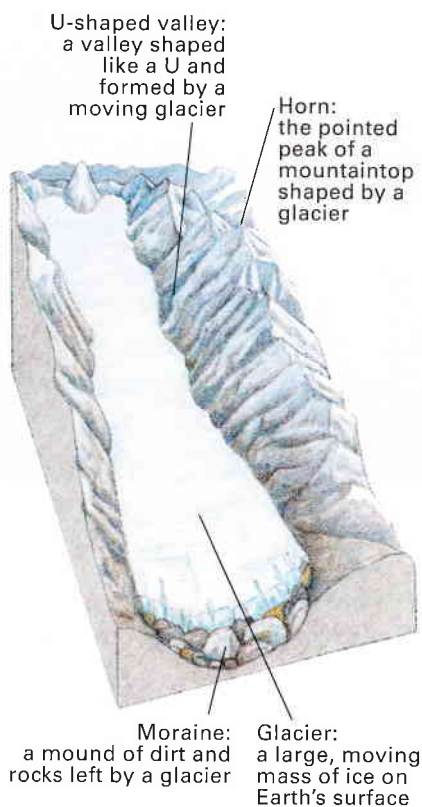
The Volga flows through the agricultural and industrial heartland of Russia. Almost half of the Russian population lives in the Volga River basin. No wonder Russians call the Volga "Matushka," or "Mother."

The Amur River The Amur River flows from the mountains of northeast China and through eastern Siberia to empty into the Sea of Okhotsk. This sea is a large arm of the Pacific Ocean on the eastern boundary of Russia. Frequent springtime floods have created flat and fertile floodplains along the river's banks. For 1,000 miles, it forms a natural boundary between Russia and China. Large boats travel most of the length of the Amur River from April to November.

The Lena River The Lena River flows northward through Siberia into the Arctic Ocean. Seen from above, this river looks like a black snake winding its way across the plains. In late spring, ice blocks the flow of water at the mouth of the Lena. Water backed up behind this ice dam floods the land.

The Lena River Delta

This land along the Lena River shows signs of both flooding and erosion. Flooding built up the land that forms the Lena's banks. Erosion has worn it away.



A Landscape Carved by Glaciers

Continental glaciers are large ice sheets that form over land with extremely cold weather. Their weight forces them to spread outward. Alpine glaciers form at the top of some mountains. Gravity pulls them downhill. Glaciers act like bulldozers, grinding and pushing land as they move. Glaciers can move between two inches and two feet a day.

17.9 How Glaciation Shapes the Landscape

In the coldest places on Earth, large fields of winter snow turn into ice that stays frozen all year. These sheets of ice are called *glaciers*.

About 20,000 years ago, during the last ice age, glaciers covered one third of the world. Most of North America was covered by ice. Gradually, the glaciers retreated, changing the landscape as they moved. Today glaciers cover only one tenth of Earth's surface. But they can still shape the landscape in dramatic ways.

Two Kinds of Glaciers Geographers have identified two kinds of glaciers. **Continental glaciers** form in huge, thick sheets in low areas near the poles with extremely cold climates. Much of Antarctica, for instance, is buried under continental glaciers. The weight of the ice sheet eventually forces the edges of the glacier to push outward. Scientists call this movement *creeping*.

Alpine glaciers form in high mountain valleys where snowfall is plentiful and temperatures are low. Instead of creeping outward, these rivers of ice slide downhill as they are pulled by gravity.

Glaciers Reshape the Land as They Move Glaciers move very slowly, but they have enormous power. They can grind the hardest rock into fine soil. They can also push great loads of rock and dirt over long distances.

Continental glaciers erode land as they spread outward. They pick up rocks and soil as they creep. They can pile up dirt and rock into mounds called **moraines**. Sometimes they leave behind finger-shaped holes in the land. When the glaciers melt, these holes become lakes. The movement of continental glaciers during the last ice age formed the Great Lakes of North America.

Alpine glaciers reshape the land as they travel downhill. Sometimes they scrape away whole hillsides, turning rounded mountaintops into pointed peaks called **horns**. As they move down canyons, they carve narrow V-shaped river valleys into broad **U-shaped valleys**. California's famous Yosemite Valley was reshaped in this way by an alpine glacier.

17.10 Signs of Glaciation in Russia

Earth has seen several long cold periods when glaciers covered vast regions. During the last of these ice ages, continental glaciers covered parts of Russia. As the climate warmed, those glaciers melted. But alpine glaciers can still be found in high mountains. Both types of glaciers have left their mark on Russia's landscape.

The Kolka Glacier The Kolka Glacier is in the Caucasus Mountains. It is located on Mount Kazbek, one of the highest peaks in the Caucasus range. In 2002, an **avalanche** occurred on the mountain. Rocks and chunks of ice from the avalanche are still scattered on top of the Kolka Glacier.



The Amanauzsky Glacier The Amanauzsky Glacier is located in the western Caucasus Mountains. As this glacier slides downward, it creates a large valley between two jagged mountain ridges.

The Glaciated Yamal Peninsula The Yamal Peninsula juts into the Arctic Ocean in northwestern Siberia. Continental glaciers once scraped across this peninsula. Today summers are just warm enough to melt each winter's snowfall. The melted water then fills the holes left behind by glaciers.

Glaciers in the Caucasus

Glaciers have covered the Caucasus Mountains since the last ice age. But over the last century, many have been melting. Curiously, as glaciers shrink, their numbers increase. This happens when big glaciers break up into smaller ones.

17.11 Beginning to Think Globally

In this chapter, you learned how four physical processes shape our Earth. They are tectonic movement, volcanic activity, erosion, and glaciation. You have also seen these processes at work in Russia.

Tectonic movement is the slowest of these processes. Over time, however, it has reshaped Earth's surface. Scientists believe that about 200 million years ago, all of Earth's land formed one enormous continent. In time, this supercontinent broke apart into tectonic plates. The movement of these plates formed the continents that we know today.

Tectonic movement is still a powerful force. We see that every time an earthquake rattles windows or a volcano starts to smoke. Keep this in mind as you look at tectonic plates around the world.

17.12 Global Connections

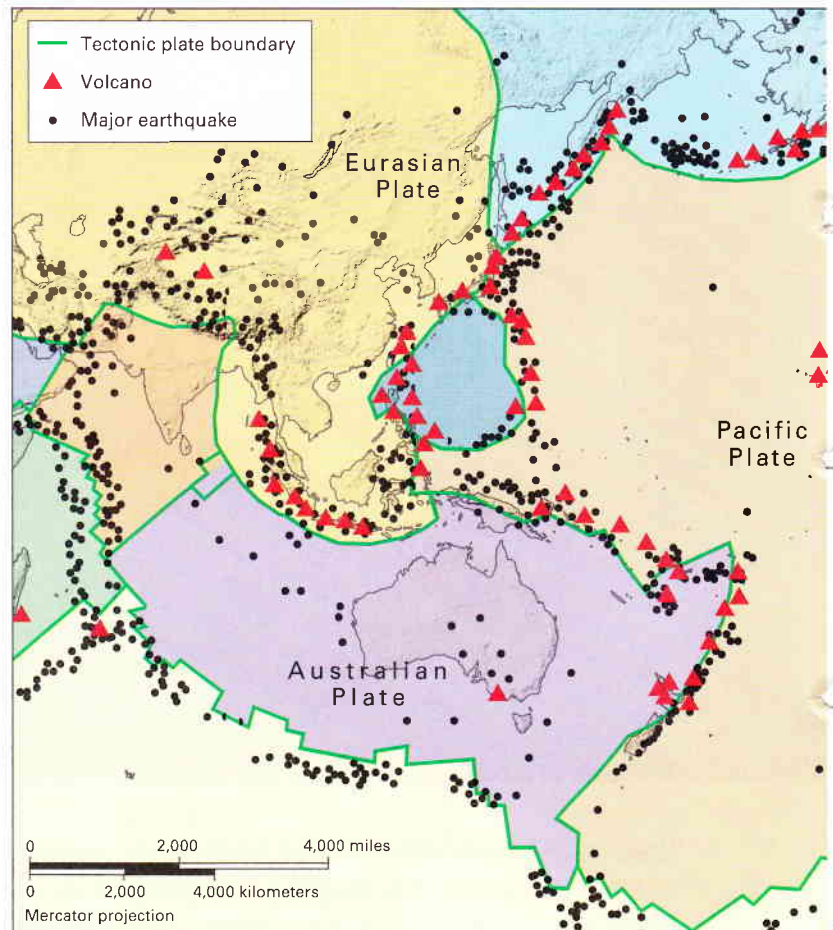
The map shows the boundaries of the world's tectonic plates. It also shows active volcanic and earthquake zones. Notice how many volcanoes are located around the rim, or edge, of the Pacific Ocean. Scientists call this zone of volcanic activity the Ring of Fire.

Why is the Ring of Fire located around the Pacific Rim? A vast tectonic plate lies under the Pacific Ocean. This Pacific Plate stretches from Asia to North America. When it moves against plates around the Pacific Rim, one plate is forced under the other. As the plate sinks, friction and the Earth's heat causes part of it to melt. This melted part rises to the surface to form a volcano.

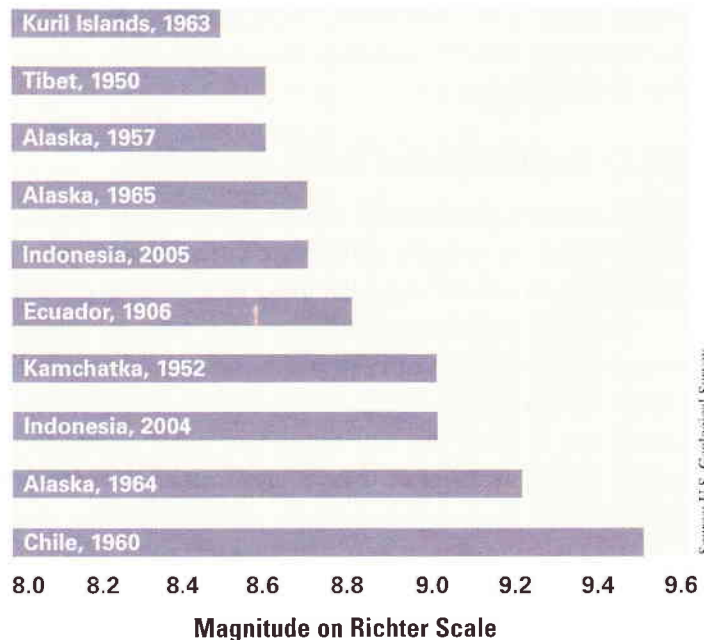
Why isn't there a Ring of Fire around the edge of the Atlantic Ocean? Look closely at edges of the Atlantic Ocean in North America and Europe. Notice that there are no plate boundaries there. The North American Plate and the Eurasian Plate meet in the middle of the Atlantic Ocean. As a result, there are no colliding plates around the edge of the Atlantic—and no Ring of Fire.

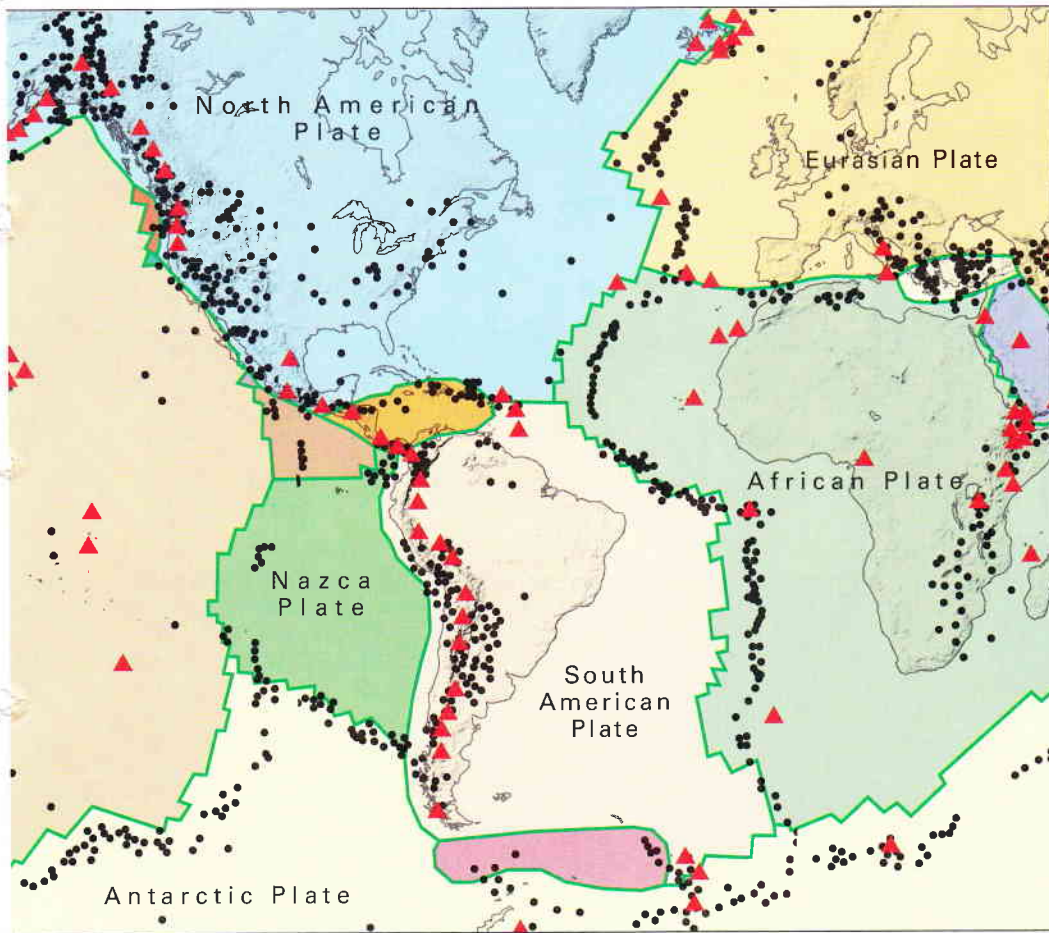
How has tectonic movement shaped human life on Earth? Imagine our world without tectonic movement. All humankind might be living together on one flat supercontinent. Tectonic movement not only broke up the supercontinent. It also built most of Earth's mountains. In the past, mountains kept people isolated from each other. As a result, many human cultures have developed over time in different landscapes.

Volcanoes and Earthquakes Around the World



The Largest Earthquakes of the Twentieth Century





Lava flow in Hawaii Volcanoes National Park