Chapter 6 – Processes Shaping Planet Earth

- In this chapter, you will learn about Earth's
- **lithosphere** (*Earth's crust and landforms*),
- **hydrosphere** (*oceans and other bodies of water*),
- **atmosphere** (*layers of gases surrounding Earth*) and
- **biosphere** (*plants and minerals*).

TEKS Covered in Chapter 6

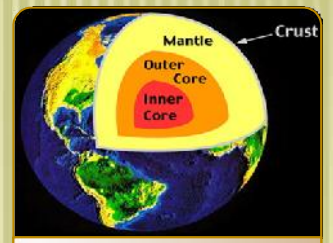
- **Geography 3** The student understands how physical processes shape patterns in the physical environment.
  - **Geography 3(A)** Explain weather conditions and climate in relation to annual changes in Earth-Sun relationships.
  - **Geography 3(B)** Describe the physical processes that affect the environments of regions, including weather, tectonic forces, erosion, and soil-building processes.
  - **Geography 3(C)** Examine the physical processes that affect the lithosphere, atmosphere, hydrosphere, and biosphere.
- **Geography 4** The student understands the patterns and characteristics of major landforms, climates, and ecosystems of Earth and the interrelated processes that produce them.
  - **Geography 4(A)** Explain how elevation, latitude, wind systems, ocean currents, position on a continent, and mountain barriers influence temperature, precipitation, and distribution of climate regions.
  - **Geography 4(B)** Describe different landforms and the physical processes that cause their development.
  - **Geography 4(C)** Explain the influence of climate on the distribution of biomes in different regions.

An Essential Question

- What forces have helped shape Earth's landforms, climate, and plant life?

Chapter 6 Terms

Lithosphere



Earth's mantle

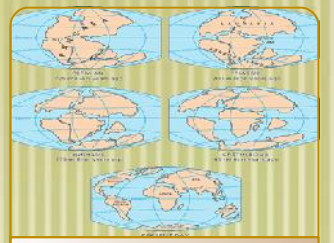
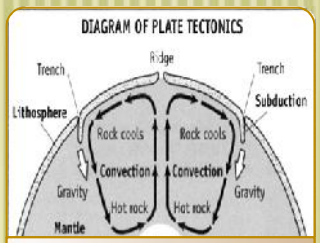
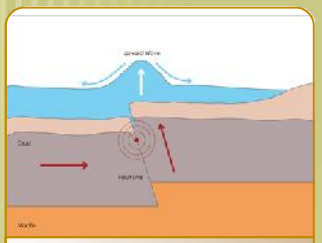


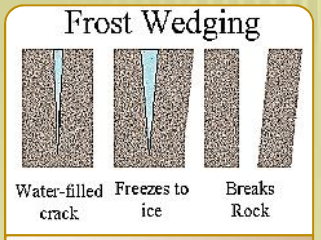
Plate Tectonic Motion



Convection



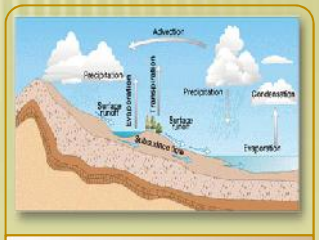
Tsunami



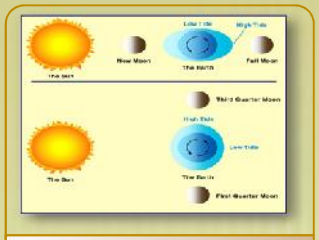
Weathering

Erosion

Deposition



Water Cycle



Tides and Currents

Atmosphere

Biomes

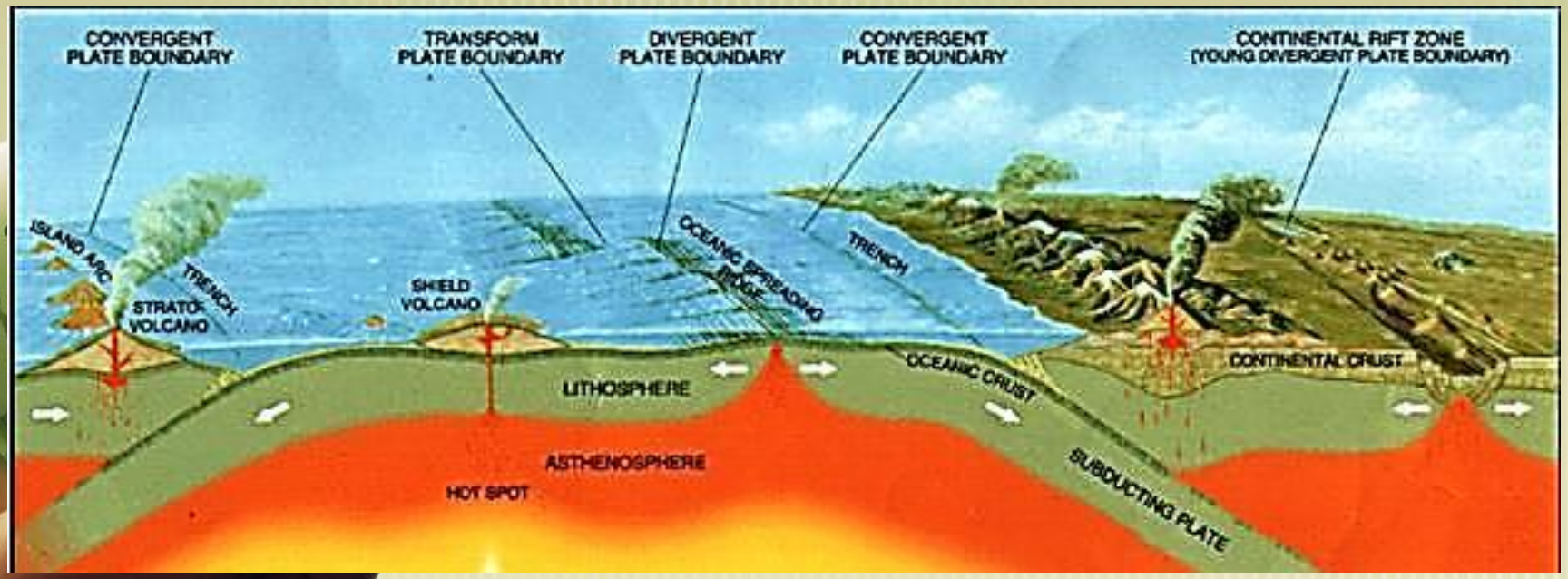
Grasslands

Steppes

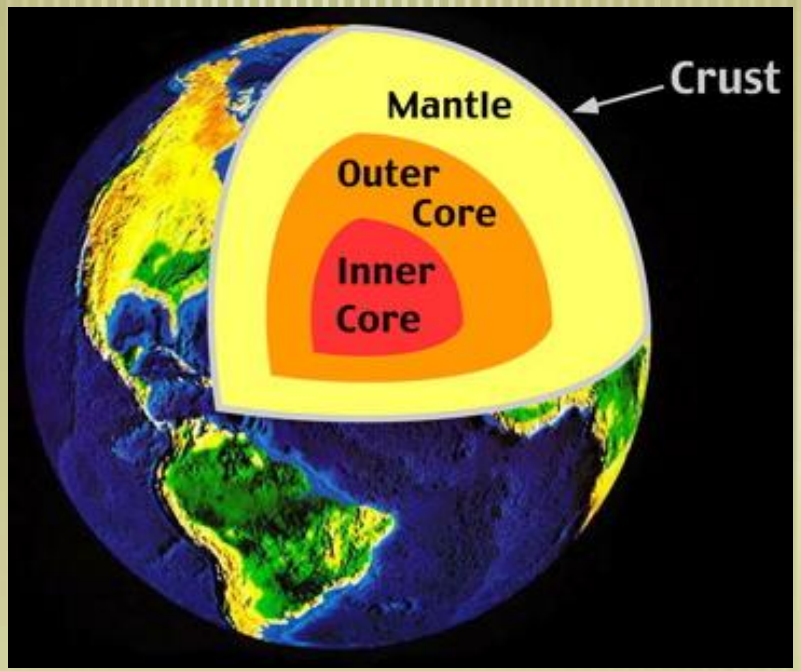
Tundra

Important ideas

- **Lithosphere.** The lithosphere is made up of the Earth's crust and solid upper mantle.
- It is broken up into **tectonic plates** which through their movement shape the Earth's surface. As the plates move apart new crust is made as they collide mountains are formed. Often found along plate boundaries are volcanoes and the occurrence of Earthquakes.
- **Weathering** and **erosion** tear down Earth's surface. From these particles of rock along with decayed plant and animal life the Earth's **soil** is formed.

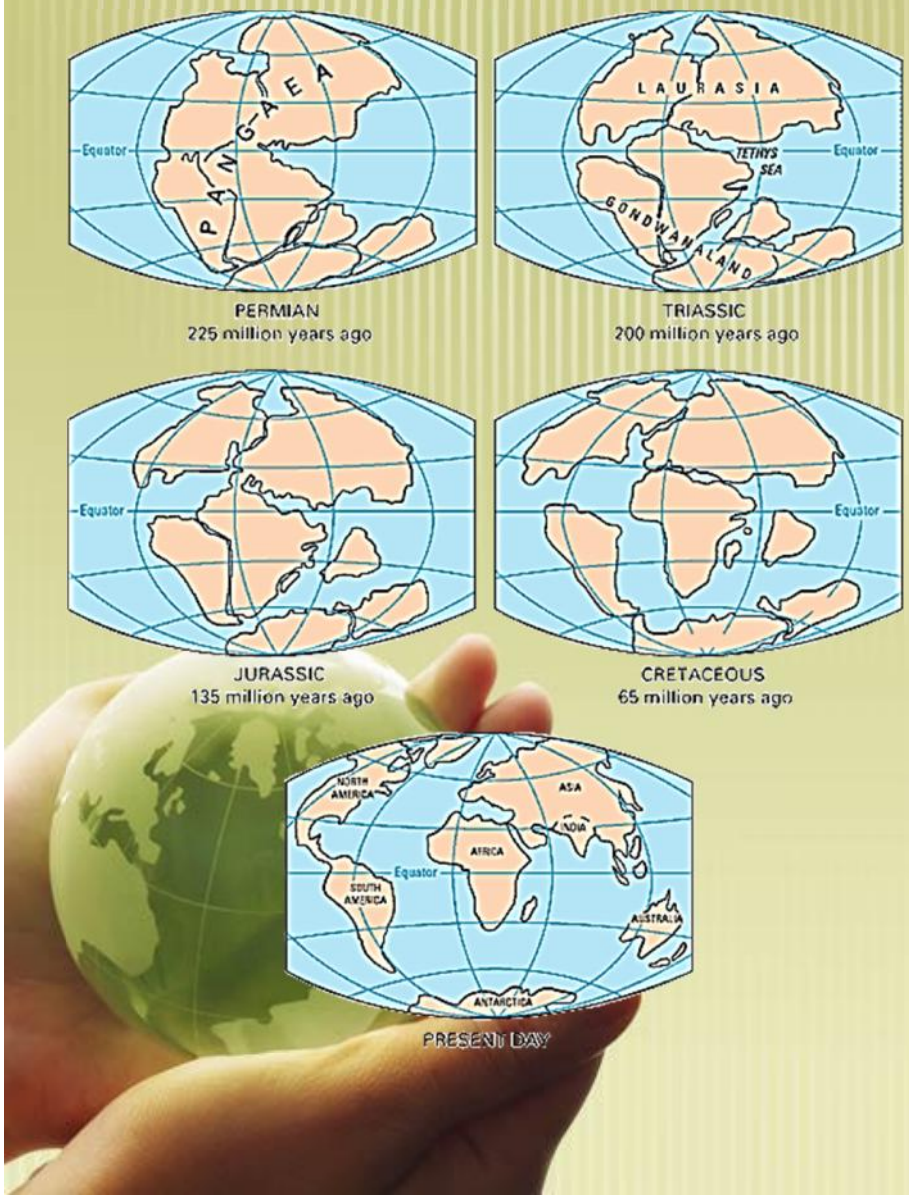


Lithosphere



- Earth's crust forms a thick skin around the Earth, like the crust on a loaf of bread. Below the crust is the **mantle,** a region of hot, dense rock.
- Deeper towards the Earth's center, temperatures and pressure rise. About 100 km below the surface, rock is near its melting point and becomes semi-solid or plastic. Scientists are investigating how to use the Earth's heat as a source of usable, clean, geothermal energy.
- The **lithosphere** consists of Earth's crust and the top section of solid mantle. This brittle uppermost shell of the Earth is broken into a number of tectonic plates.

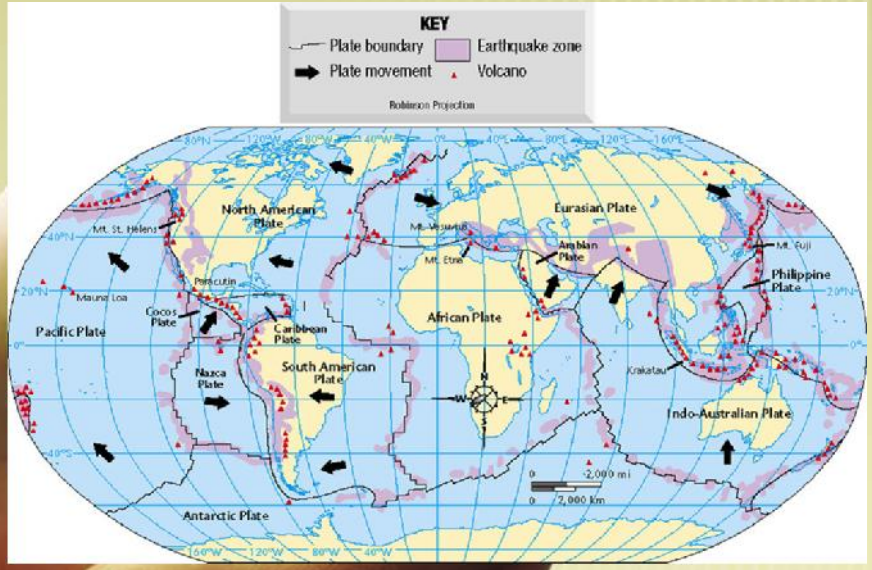
Plate Tectonic Motion

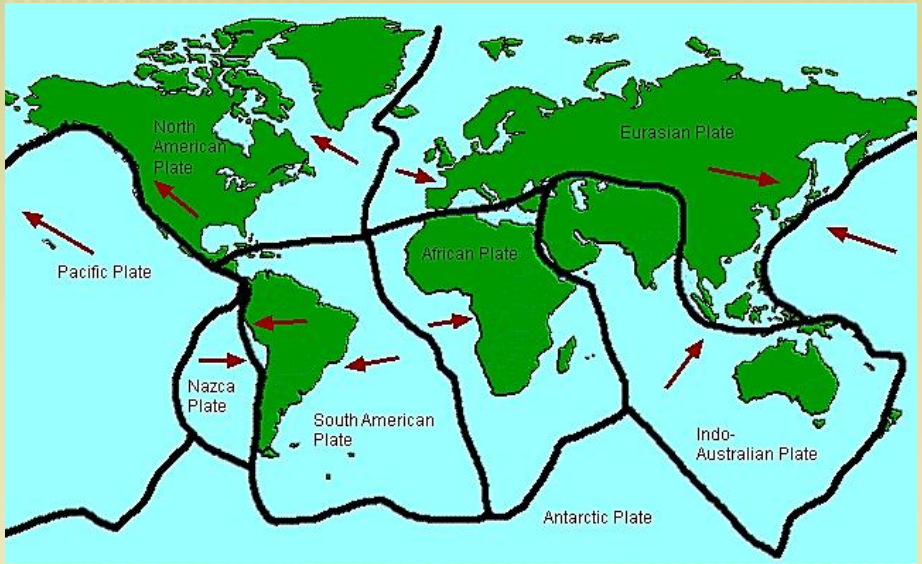


- If you look at a map of the world, you may notice that different continents seem to fit together like a giant puzzle. For example, eastern South America seems to fill the space below West Africa. Mountain ranges that end at one coastline seem to continue again on another coastline.
- Many scientists believe that several or even all of the present continents of the world once fit together into a single, giant continent. Gradually, this large land mass separated and its pieces drifted apart to their present locations. Scientists refer to these ideas as **plate tectonic theory.**

Plate Tectonic Motion

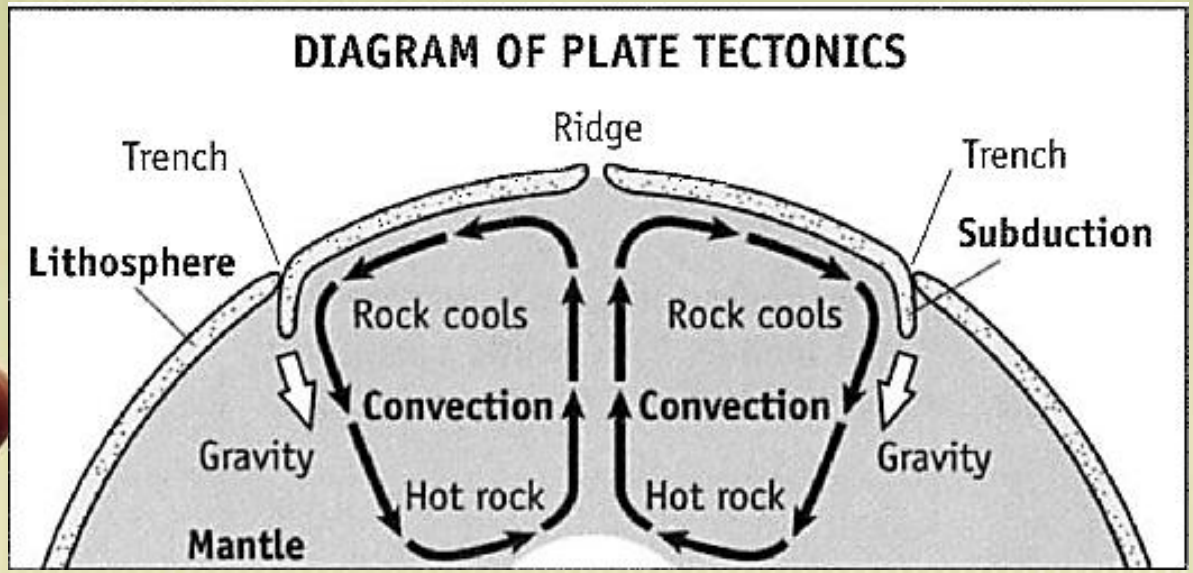
- Earth's lithosphere is divided into large slabs of rock known as **tectonic plates.** Earth's continents are attached to these plates. Scientists believe that these plates move as solid chunks floating on top of the more "plastic" part of the mantle.
- The plates move only a few centimeters each year. Despite such slow movement, over hundreds of millions of years these plates can move thousands of kilometers.





What causes plate movement?

- Scientists believe heat and gravity may be responsible for the movement of tectonic plates.
- **Convection** is the spread of heat through the movement of a fluid substance. Inside the mantle, semi-solid rock is heated. As it is heated, it expands and becomes less dense. The lighter rock rises as gravity pulls down cooler, denser rock in its place. After the hotter rock rises, it begins to cool down. Once cooled, it sinks, creating a circular motion or current. This circular motion pushes the plates above.
- **Gravity** also contributes to plate movement. When oceanic and land plates collide, the dense oceanic plate is pulled by gravity under the lighter land plate. At one end of the oceanic plate sinks, it pulls on the rest of the plate as well.



APPLYING WHAT YOU HAVE LEARNED

★ Take a hard-boiled egg and crack its shell slightly. You will see the shell divide into several pieces. How are these pieces similar to and different from tectonic plates?

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★ Look at a map of the world. Make your own hypothesis about which continents were once joined together. For example, some scientists believe the west coast of Africa fits next to the east coast of South America.

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★ Summarize how convection and gravity lead to the slow movement of tectonic plates.

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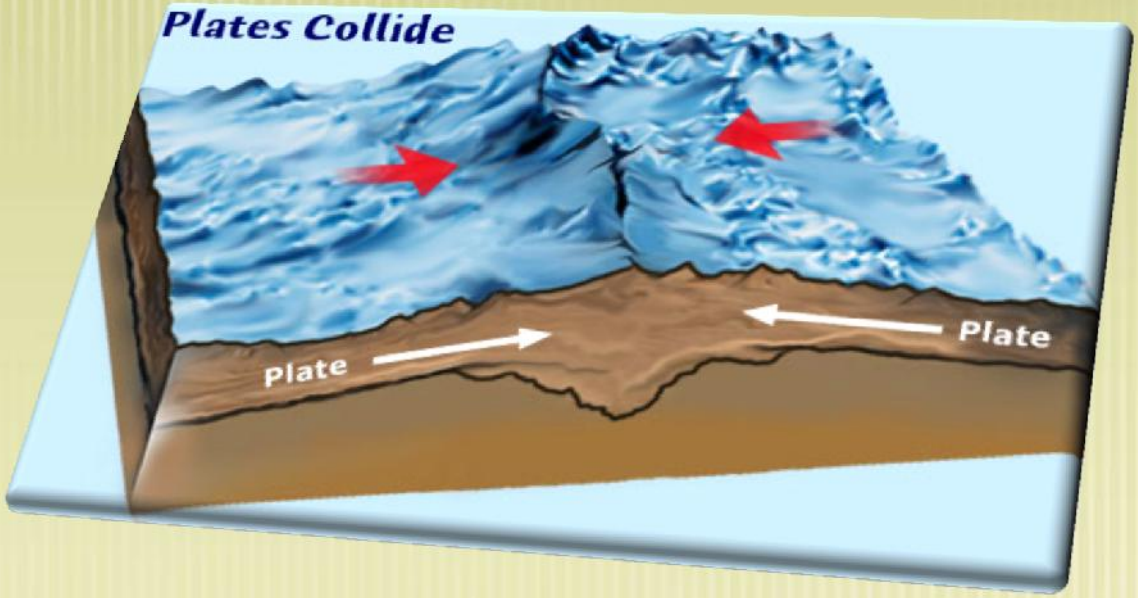
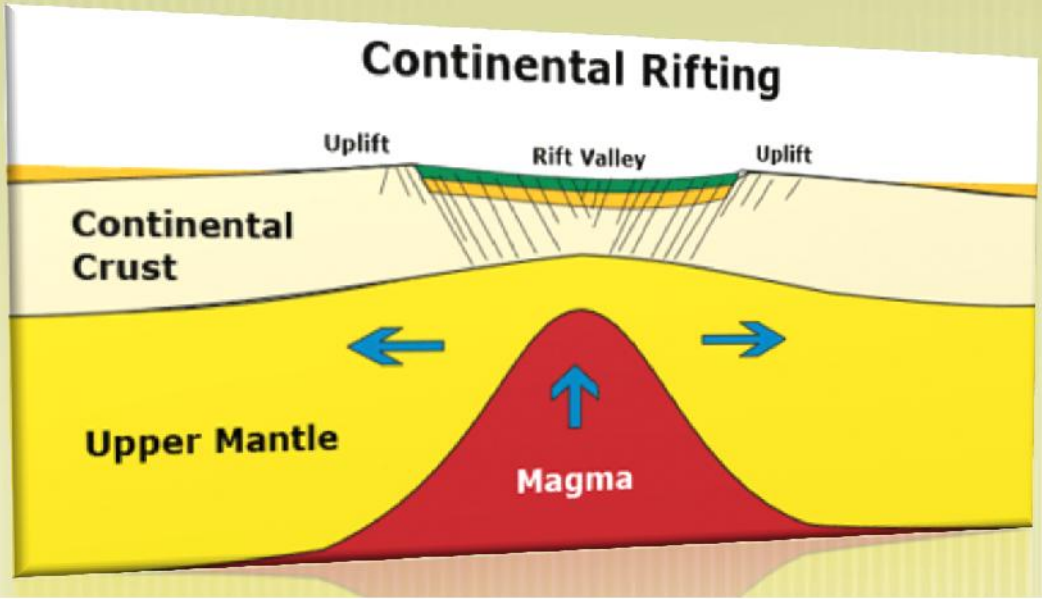
Effects of Plate Tectonic Movement

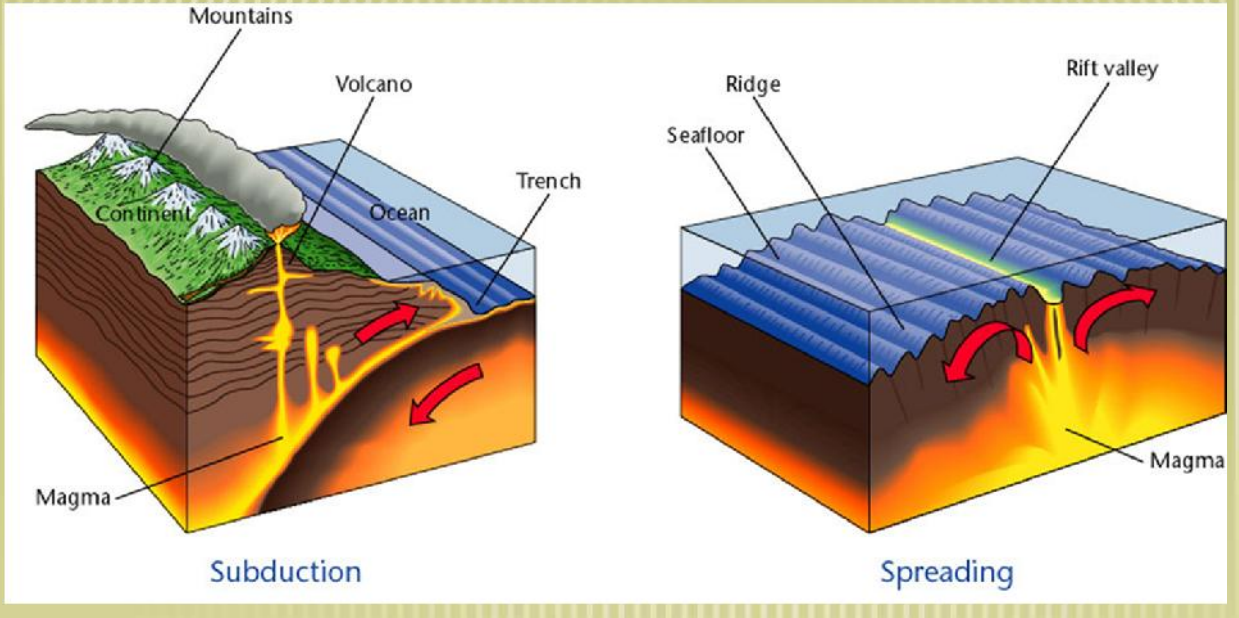
- Mountain Building occurs when two land plates, known as continental plates, slowly push into one another, they often fold upwards, creating mountain chains.

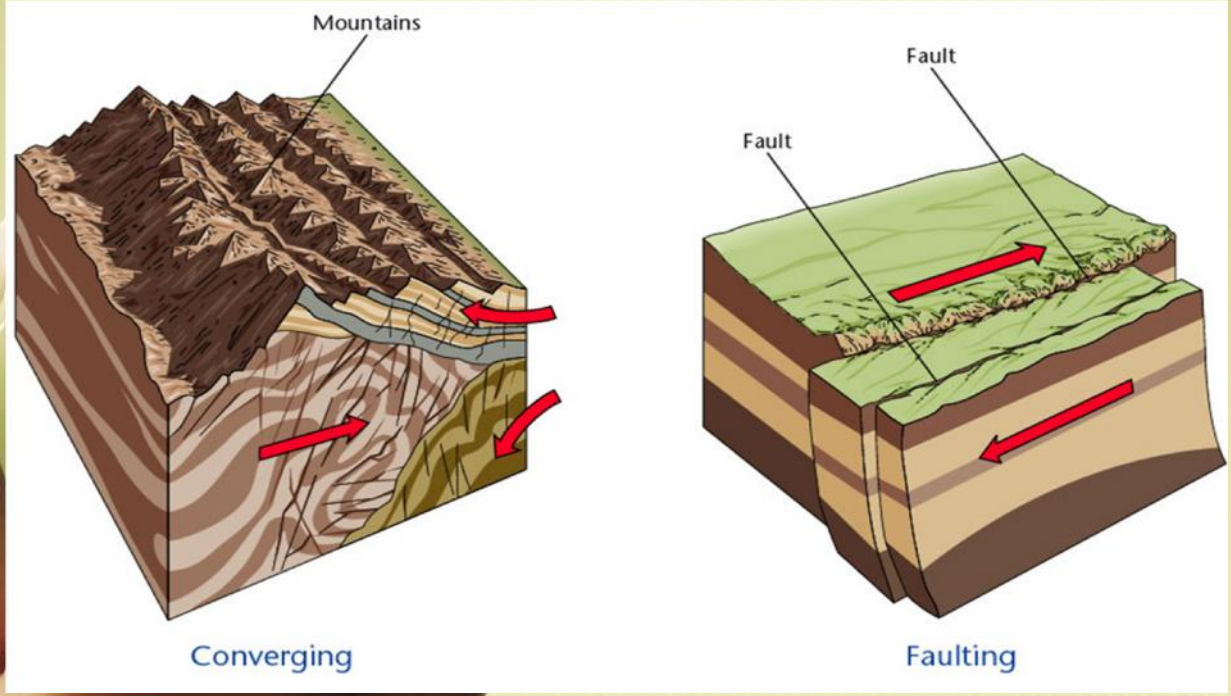


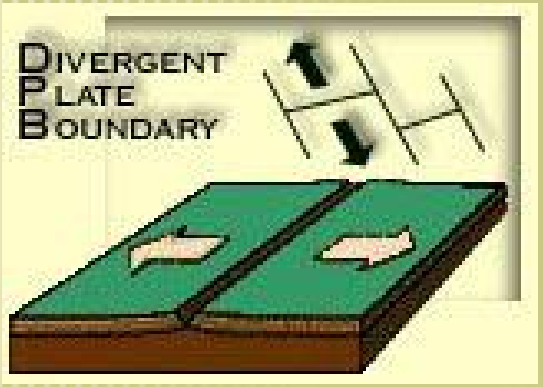
Seafloor spreading and rift valleys

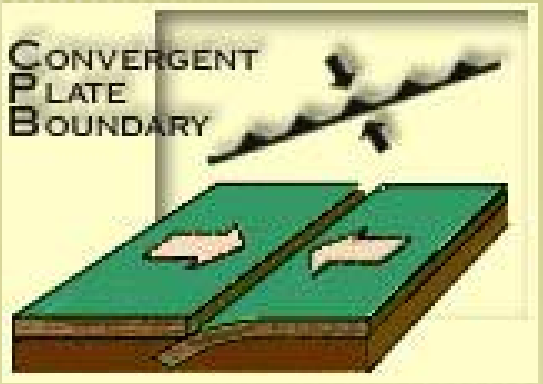
- Some tectonic plates move apart. Scientists have discovered that in the middle of the Atlantic Ocean, the separation of plates is actually causing the seafloor to spread. As the plates move apart, magma rises up through the cracks in the ocean floor, creating a ridge of mountains.
- In other areas, the separation of tectonic plates has created **rift valleys** – long valleys between parallel ridges of mountains. This creation of new crust would increase the Earth's size, except that it is balanced by the folding and colliding of plates elsewhere.

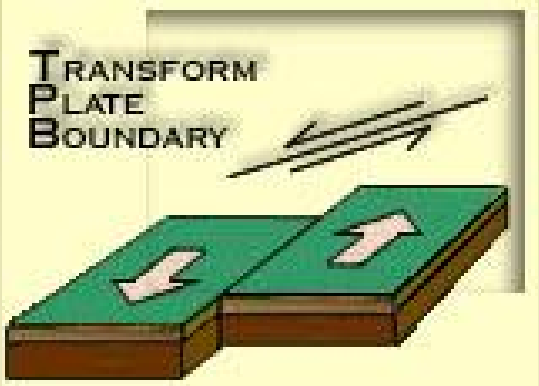



Mountains
Volcano
Trench
Continent
Ocean
Magma
Subduction
Ridge
Rift valley
Seafloor
Magma
Spreading


Mountains
Converging
Fault
Fault
Faulting


DIVERGENT
PLATE
BOUNDARY

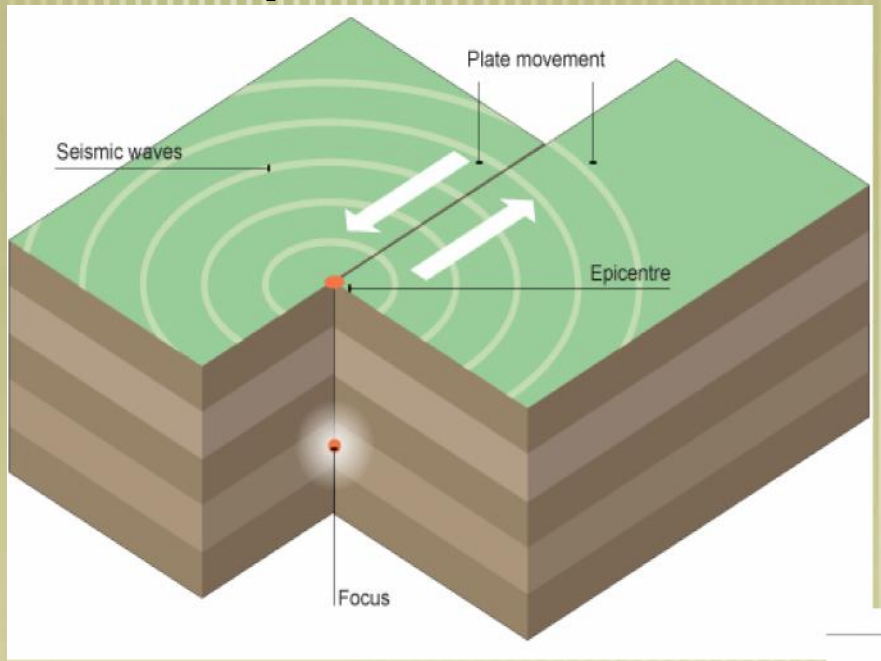

CONVERGENT
PLATE
BOUNDARY

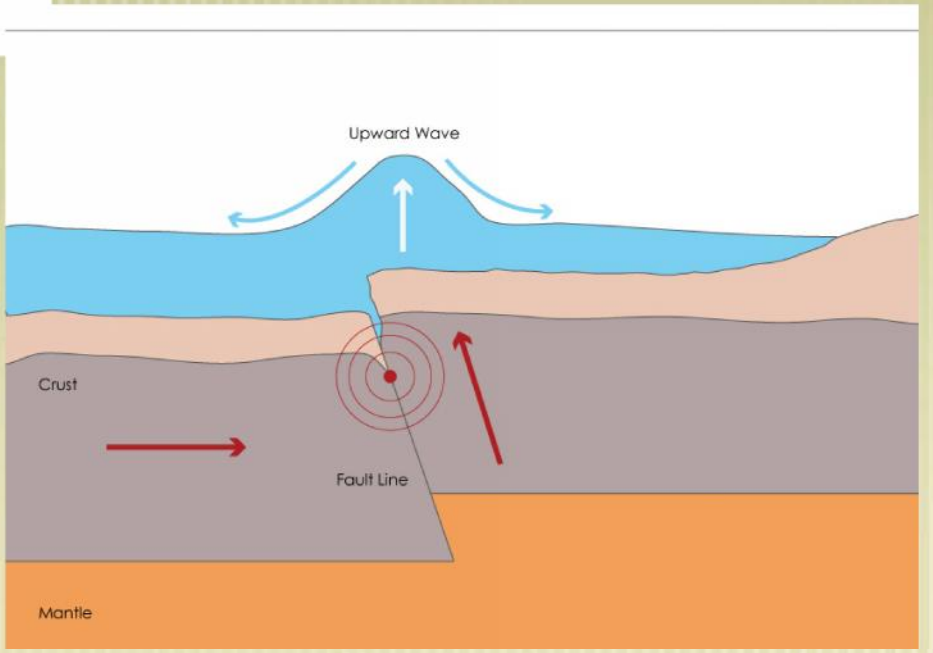

TRANSFORM
PLATE
BOUNDARY

Earthquakes and Tsunamis

- Plate movements can cause a break in Earth's crust, known as a **fault.**
- Plate movements can also cause vibrations known as **earthquakes.** As plates move, they create tremendous stress at plate boundaries.
- Eventually, parts of rocky crust will break, creating a fault and sending vibrations known as **seismic waves.**
- Scientists measure the waves sent by an earthquake with a **seismograph.** They can see that most waves originate at plate boundaries.
- When an earthquake occurs under or near the ocean, it creates immense ocean waves of destructive force known as **tsunamis.**

Earthquakes and Tsunamis

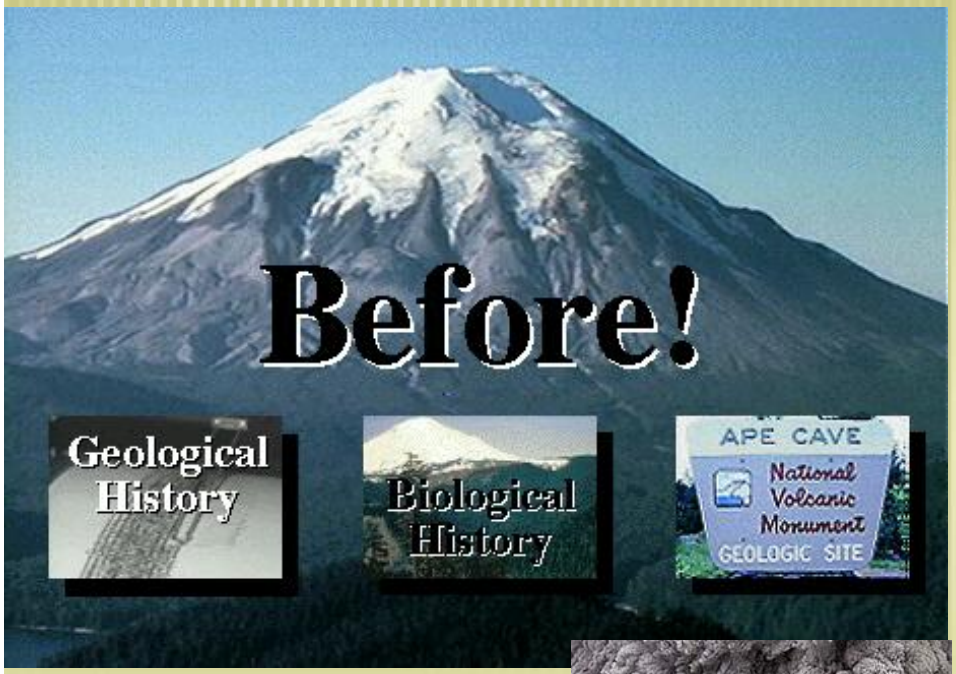




Volcanoes

- In places where tectonic plates diverge or where one plate dives under another, pressure in Earth's mantle is reduced and some of the hot, solid rock turns to liquid. Any part of the tectonic plate that sinks into the mantle may also melt.
- Pockets of molten rock form beneath Earth's surface. This magma may break through weaknesses in Earth's crust.
- Magma, ashes and gases erupt and form a **volcano.** Once the magma reaches Earth's surface, it becomes known as **lava.**
- The location of most volcanoes and earthquakes has been shown to be almost identical with the location of plate boundaries.

VOLCANOES


Before!
Geological History
Biological History
APE CAVE
National Volcanic Monument
GEOLOGIC SITE

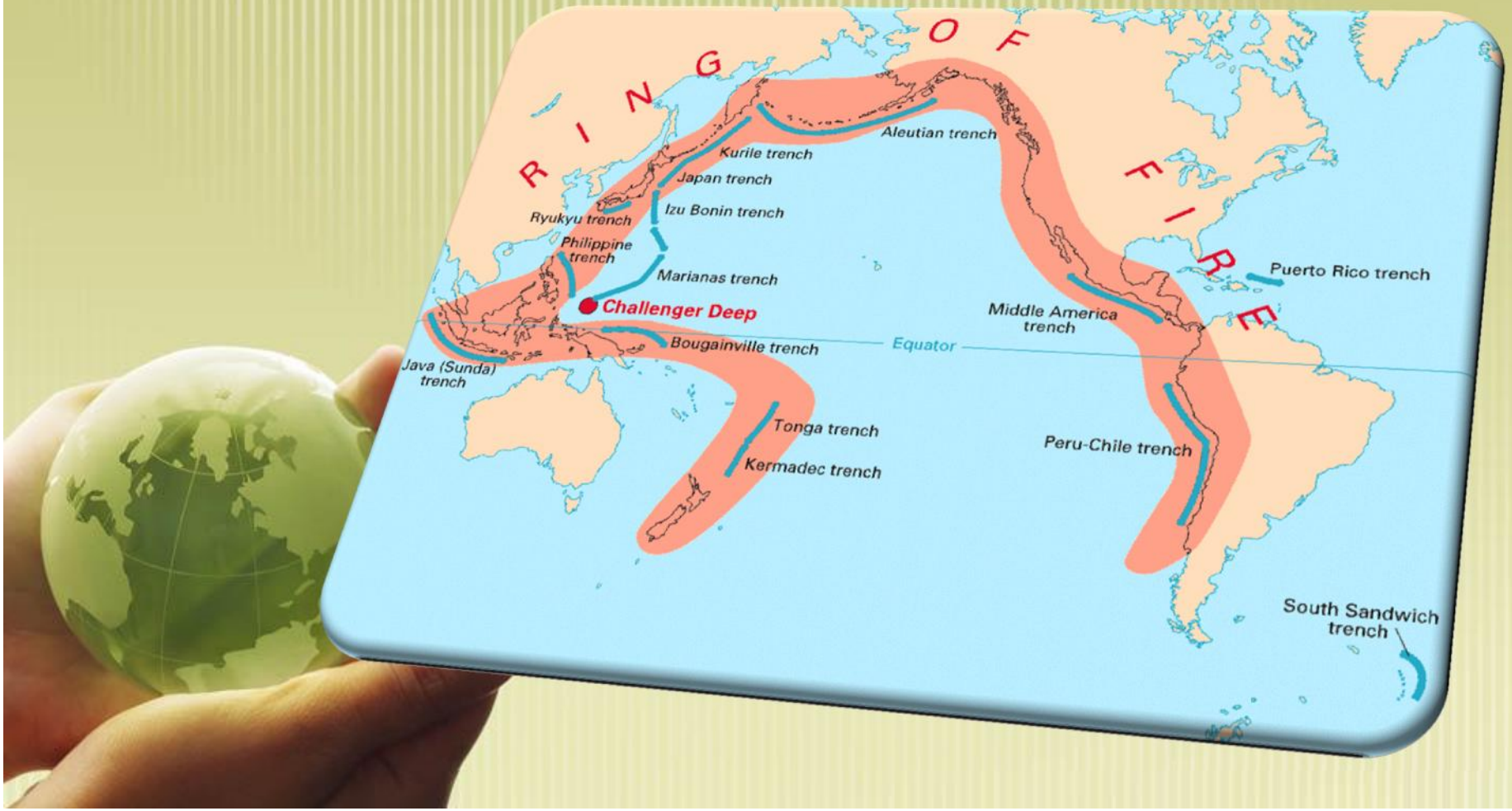

After!
Lava Domes
Monitoring Volcanoes
Ash Eruptions


Copyright John Seach
www.volcanolive.com

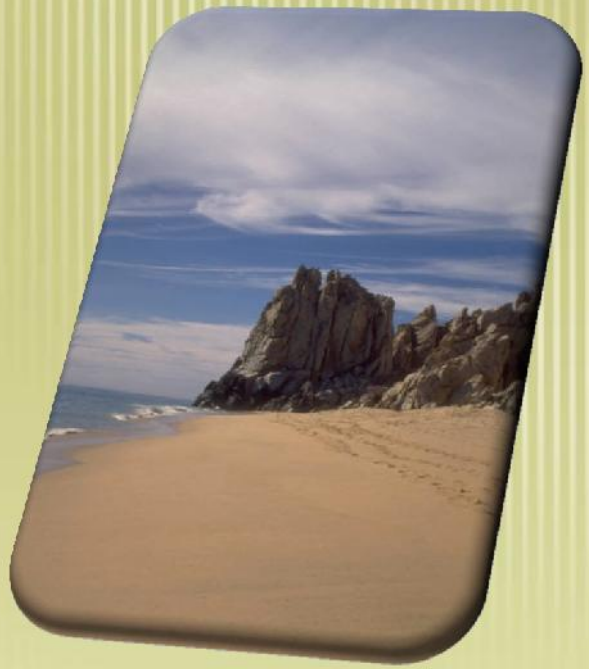

Spirit Lake, 1982
May 17, 1980
1982

Volcanoes

- The **"Ring of Fire"** around the Pacific Ocean – a zone of volcanoes and frequent earthquakes – coincides with the boundaries of the Pacific tectonic plate. Many mountains and even islands have been formed by volcanoes. The Hawaiian islands are actually the tops of volcanoes in the Pacific Ocean.

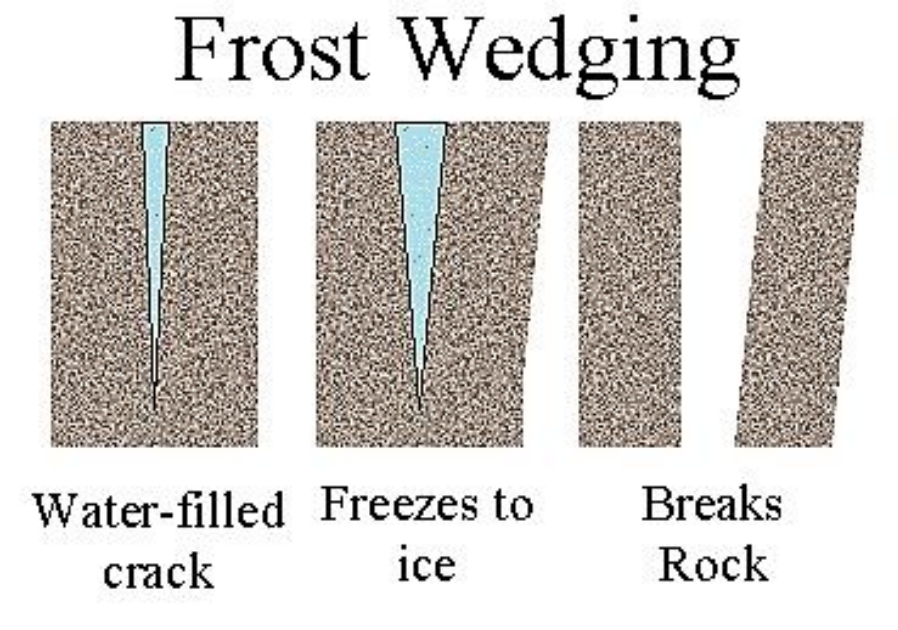


Other forces affecting earth's lithosphere



- Tectonic plate movements build mountains through folding.
- They also create new crust when they separate and new magma comes pouring through.
- The processes of weathering and erosion reduce the mountains and other land features created by volcanoes, earthquakes, and folding.

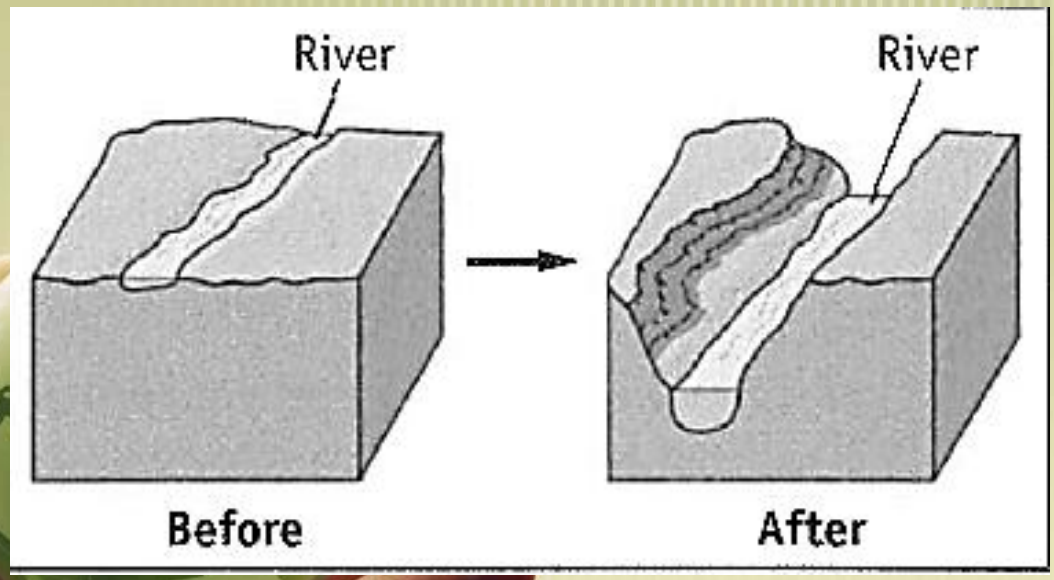
Weathering



- The wearing down of rocks at the Earth's surface by the actions of wind, water, ice and living things is referred to as **weathering.** Water, for example, expands when it freezes.
- Water may seep into cracks or pores in rocks and expand these cracks if the temperature drops and the water freezes. Rain and running water will also break down rock into smaller particles.
- Some chemicals, like acids, will dissolve rocks. Microscopic organisms can also cause rocks to break down and disintegrate.

Erosion

- The processes by which rock, sand, and soil are broken down and carried away are known as **erosion.** By erosion, a river can cut a canyon, like **Grand Canyon**, through solid rock. An icy glacier can carve and wear away a region, leaving behind valleys and lakes, such as the **Great Lakes.**



Deposition

- The same forces that erode one place can deposit particles and sediment in another, building it up. Rivers carry sediment downstream and deposit this sediment where they meet the ocean.

  The action of ocean waves can bring sand to a beach.

APPLYING WHAT YOU HAVE LEARNED

Can you think of any examples of weathering, erosion or deposition that have affected your own community?

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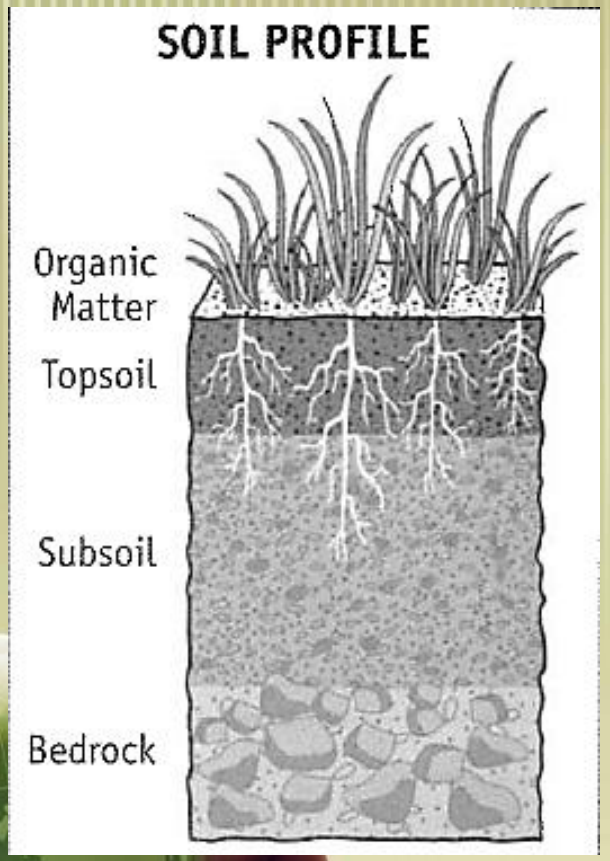
Soil: Building Processes

- Weathering breaks down rocks on Earth's surface. The material left from the rocks mixes with decaying plants and animals to make soil.
- Soil is therefore a mixture of several materials, including sand, clay, rocks, water, fungi, bacteria, and decayed plants and animal material. A layer of soil covers much of Earth's land surface. There are many different types of soil, based on different mixtures of its basic ingredients. Each type of soil has its own texture, ability to hold water, and ability to support plant life.
- For example, clay and dead plant and animal material can hold water. Soils with a large amount of clay and decayed material will therefore hold more water than sand soils.

Soil Quality



- The type of soil found in an area greatly affects the types of plant life that can grow there.
  - The sands of the Sahara or Arabian Desert, for example, will not support many forms of life.
  - The Amazon basin of South America and the rainforests of central Africa have tropical soils with few minerals or nutrients. Rain quickly washes these nutrients and animals that are still decomposing.
  - Soils found in grassland areas – the Great Plains, pampas, and Russian steppes – have the organic matter and are among the best soils for farming.

Earth's many land forms

- All these processes acting on Earth's lithosphere create typical landforms. These landforms include mountains, hills, plateaus, plains, valleys, canyons, deserts, and beaches.

Mountains

Himalayas

Andes Mountains

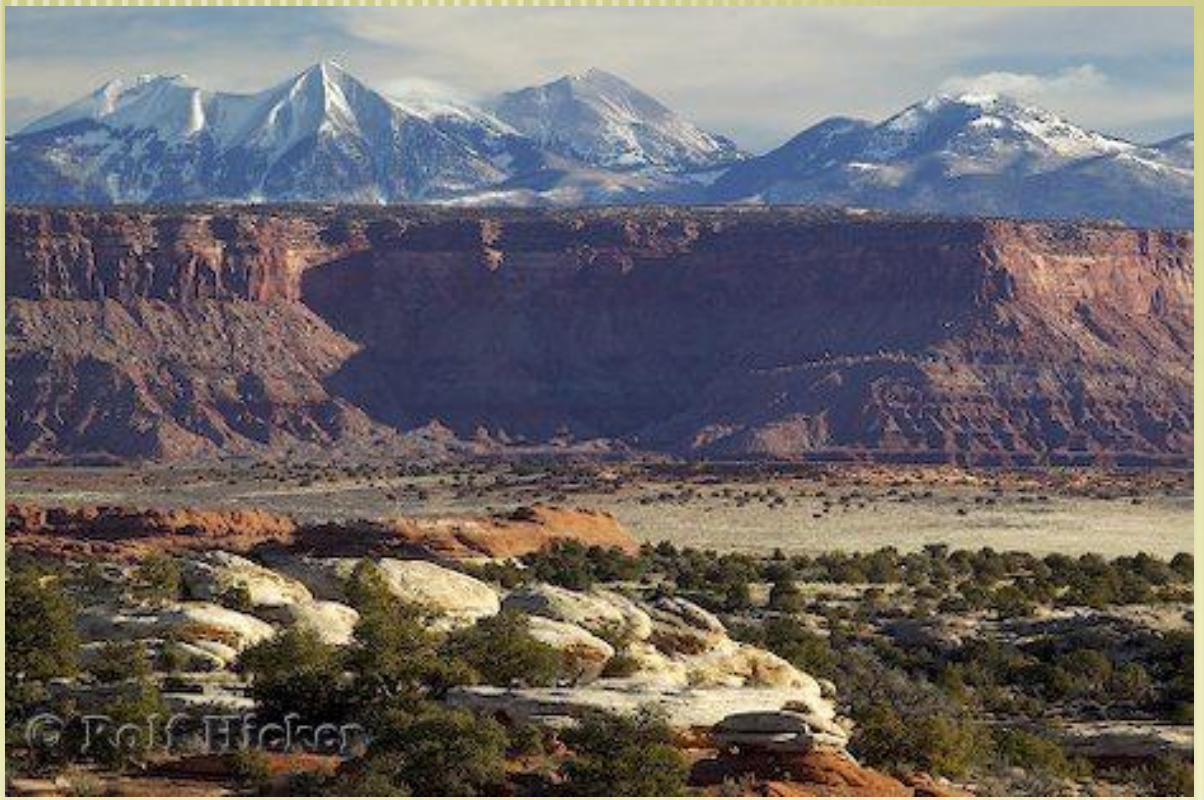
- **Mountains,** often formed by the collision of tectonic plates, can be thousands of feet high in elevation.

Plateau

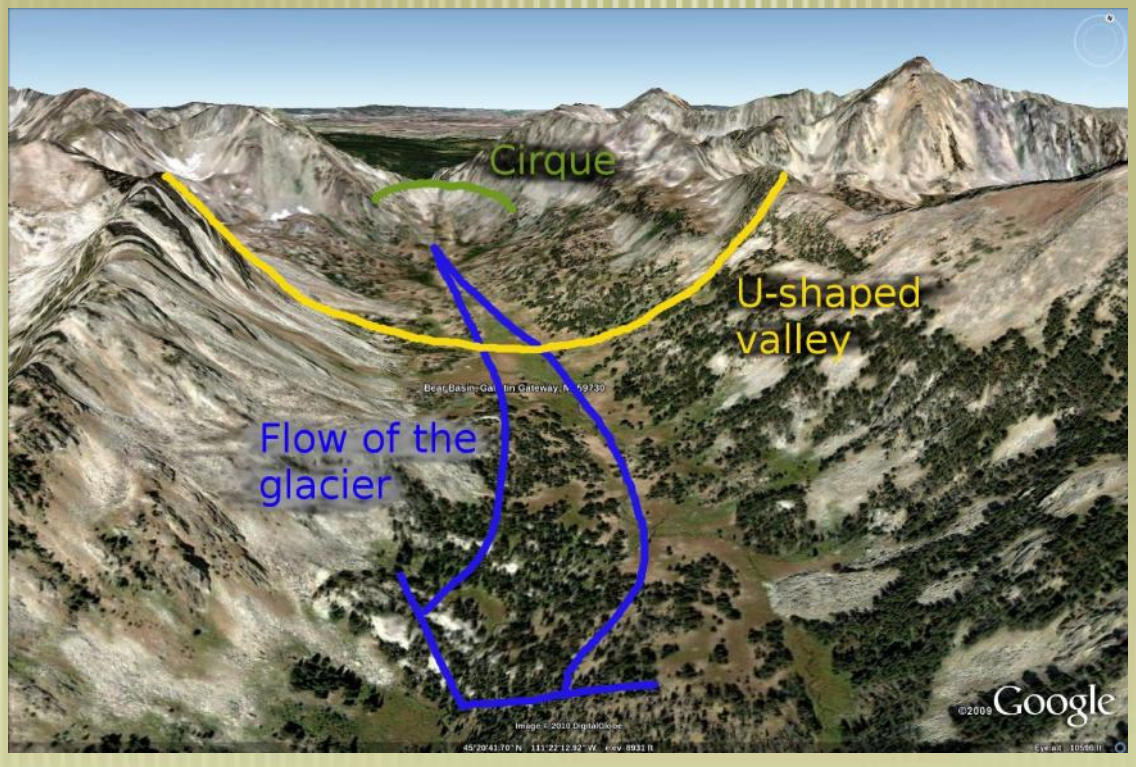
- A **plateau** is a flat highland, whose sides drop suddenly because of erosion.

Edwards Plateau

Colorado Plateau



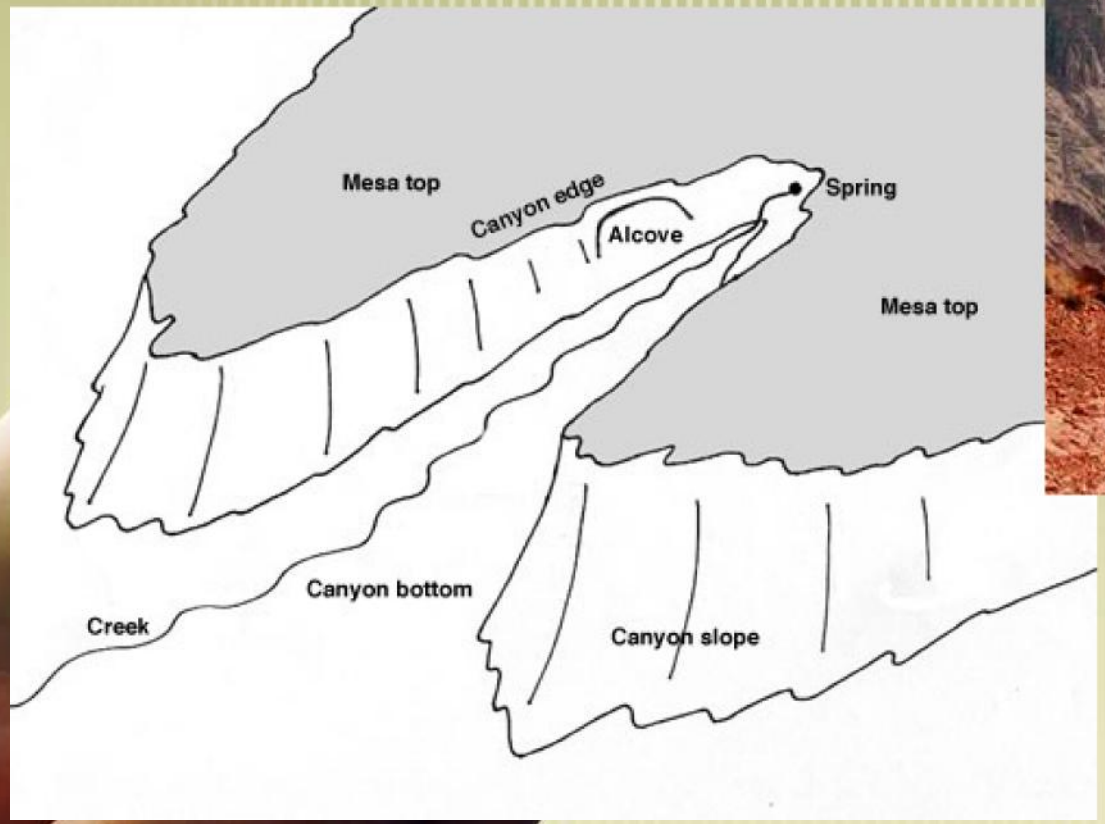
Valleys



- Valleys are long, low areas between ranges of mountains, hills, or uplands. They are often created by erosion, and may have a river or stream running along the bottom.

Canyons

- A **canyon** is a deep gorge or ravine between cliffs, often carved from the landscape by a river.



APPLYING WHAT YOU HAVE LEARNED

★ Select one of the landforms identified on the previous pages that exists in your community. Take a photograph of it, find it on the Internet and print it out, or make a sketch of it. Place your image in the space below:

★ Now describe this landform in your own words. _____

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★ Finally, explain the forces that most likely created this landform. _____

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LEARNING WITH GRAPHIC ORGANIZERS

Complete the graphic organizer below.

FORCES AFFECTING EARTH'S LITHOSPHERE

Mountain Building

Seafloor Spreading and Rift Valleys

Earthquakes and Tsunamis

Volcanoes

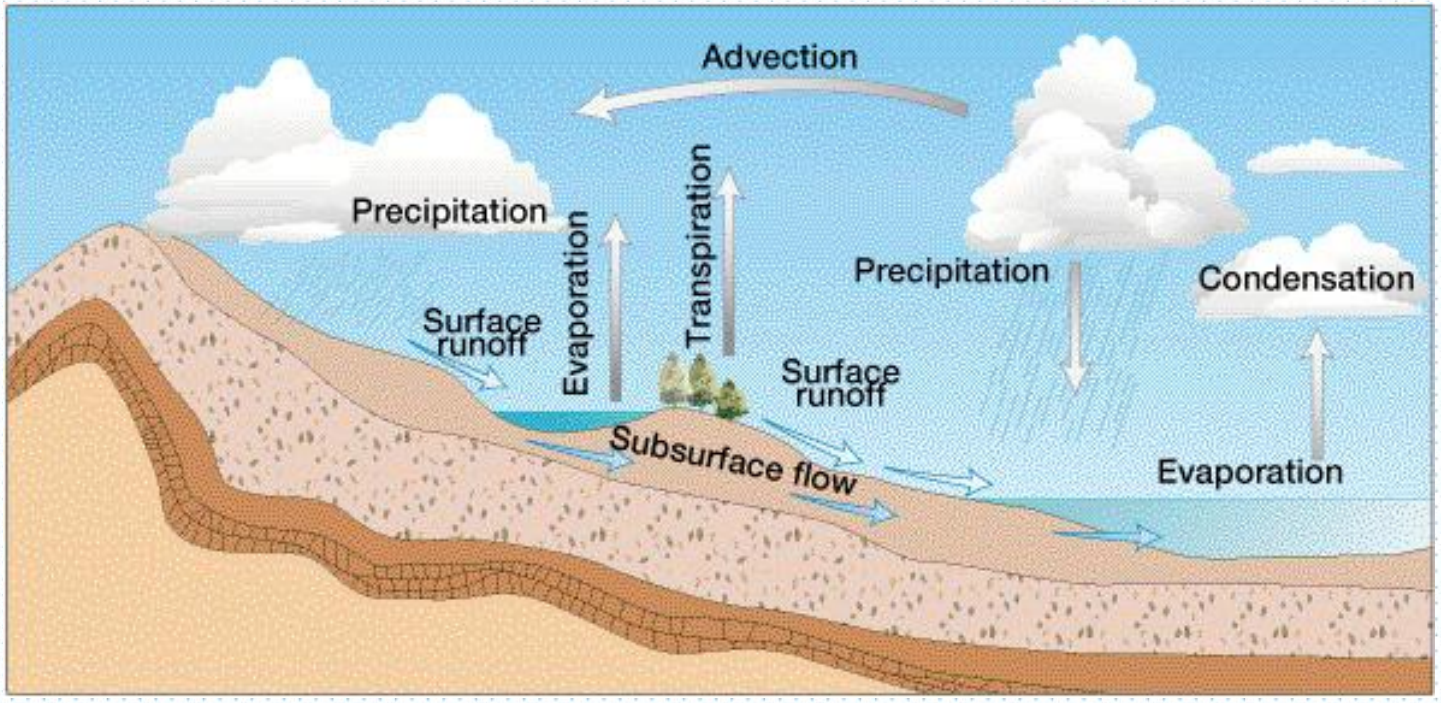
Weathering

Erosion

Soil-Building

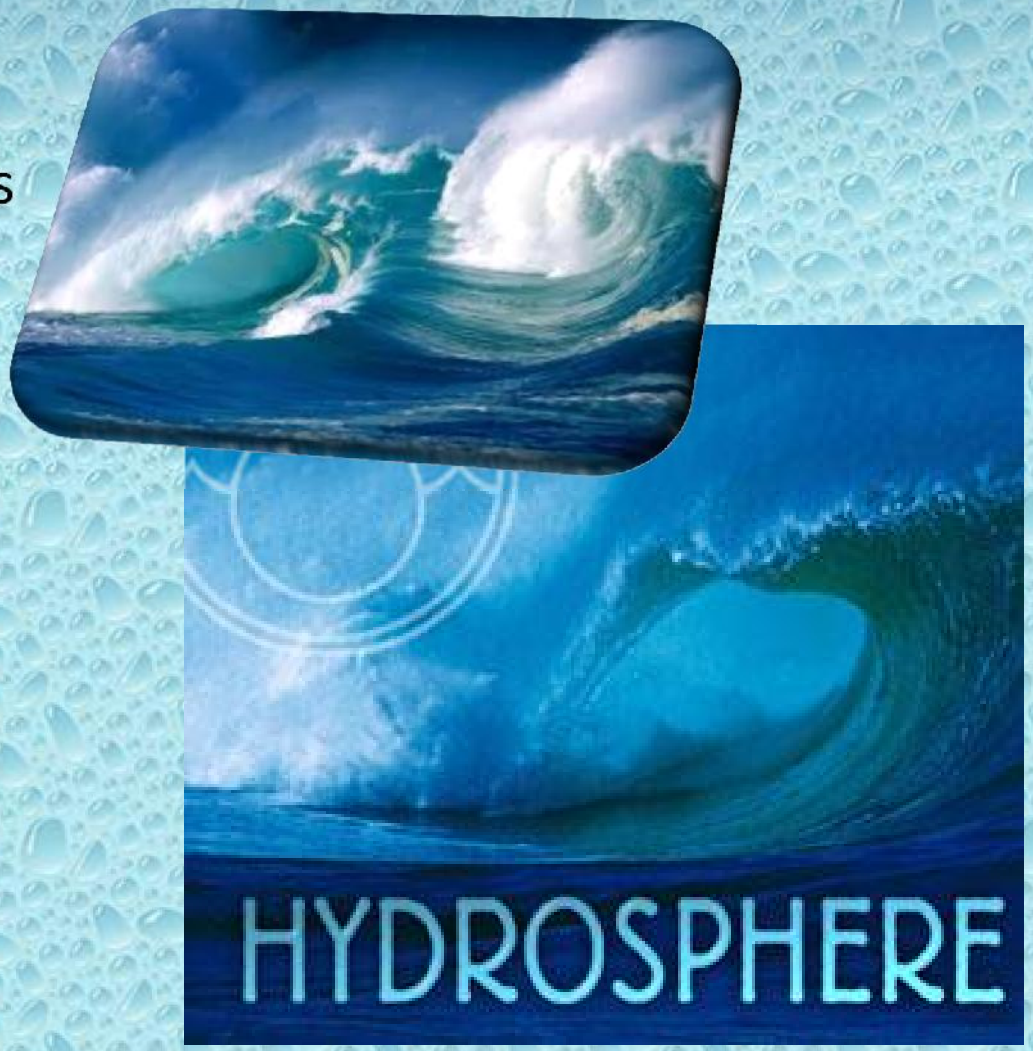
Hydrosphere

- **<u>Hydrosphere</u>.** Oceans cover over 70% of our planet's surface area. Currents, caused by winds and differences in water density, move the ocean's waters around the planet. Water is also moved between the atmosphere, oceans, and land surfaces through the **water cycle.**



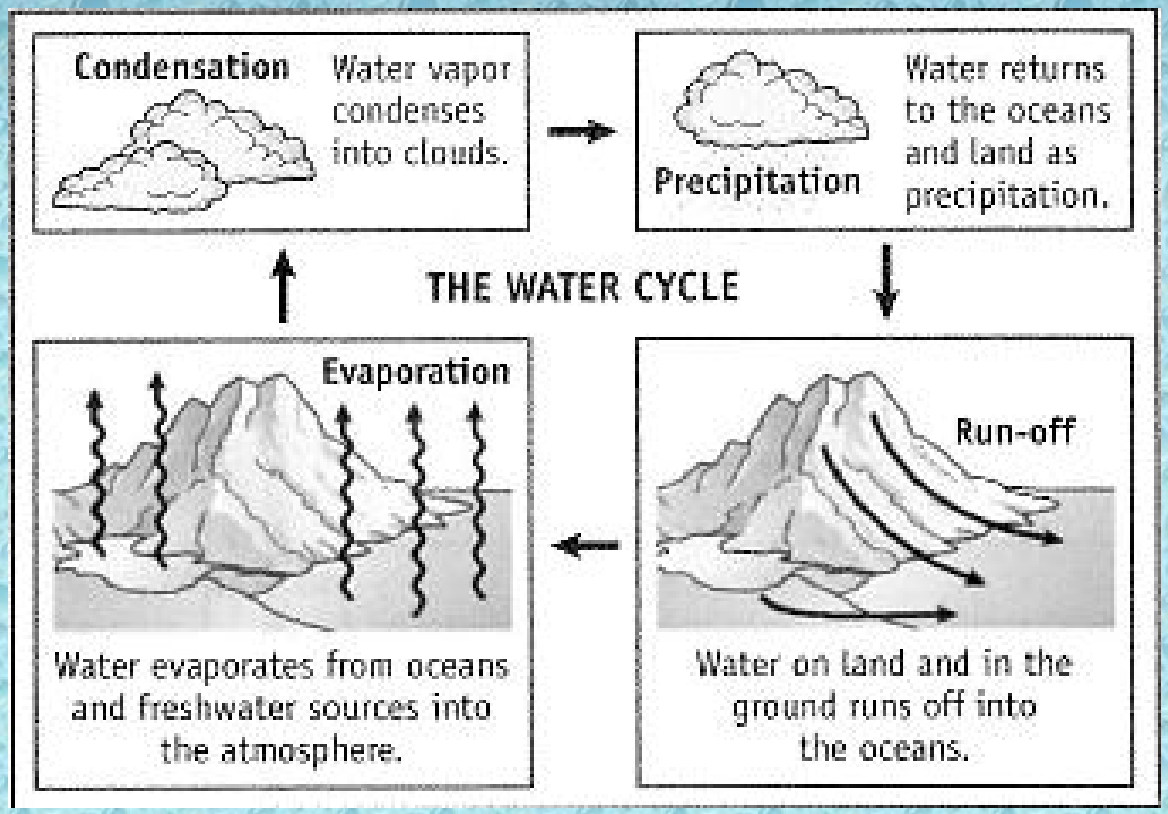
The Hydrosphere: Earth's Oceans

- More than 70 percent of Earth's surface is covered by water. Scientists refer to this as the **hydrosphere.**
- About 97 percent of this water is in the ocean; most of the rest of it is frozen in the polar ice caps; less than one percent is found in the atmosphere, groundwater, or in freshwater lakes and rivers.



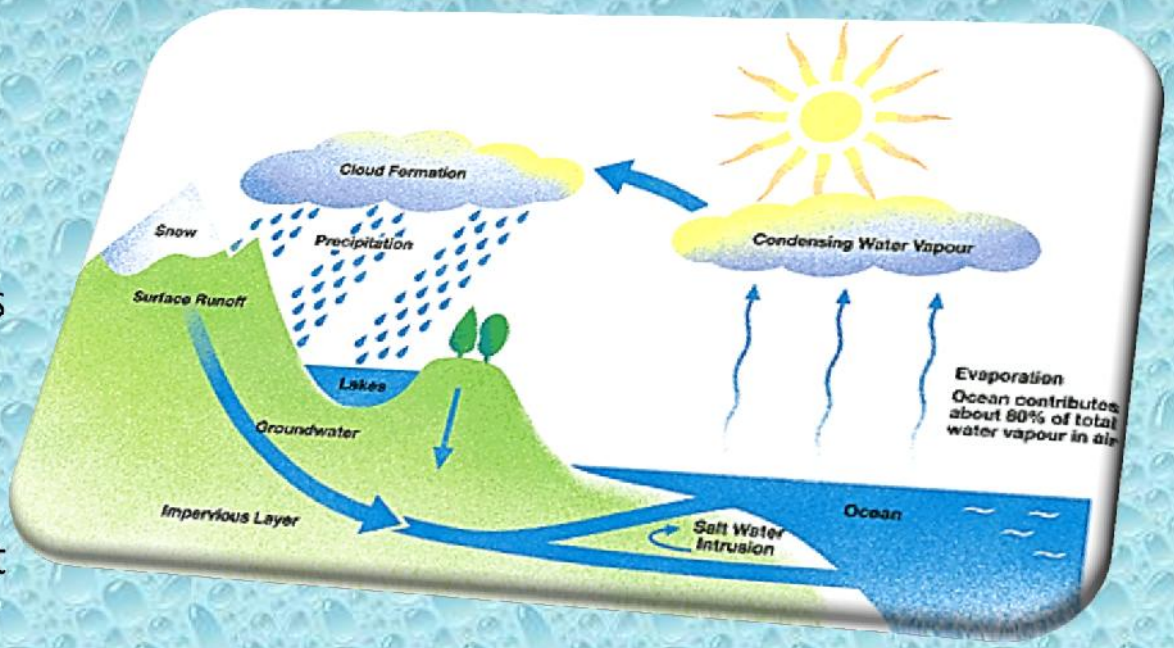
The Water Cycle

- During the **water cycle,** solar energy heats the surface of oceans, seas, and lakes. This causes some of the surface water to evaporate into the atmosphere. The water vapor rises until it becomes cooler. The water vapor then condenses into tiny droplets small enough to float in the atmosphere as clouds.

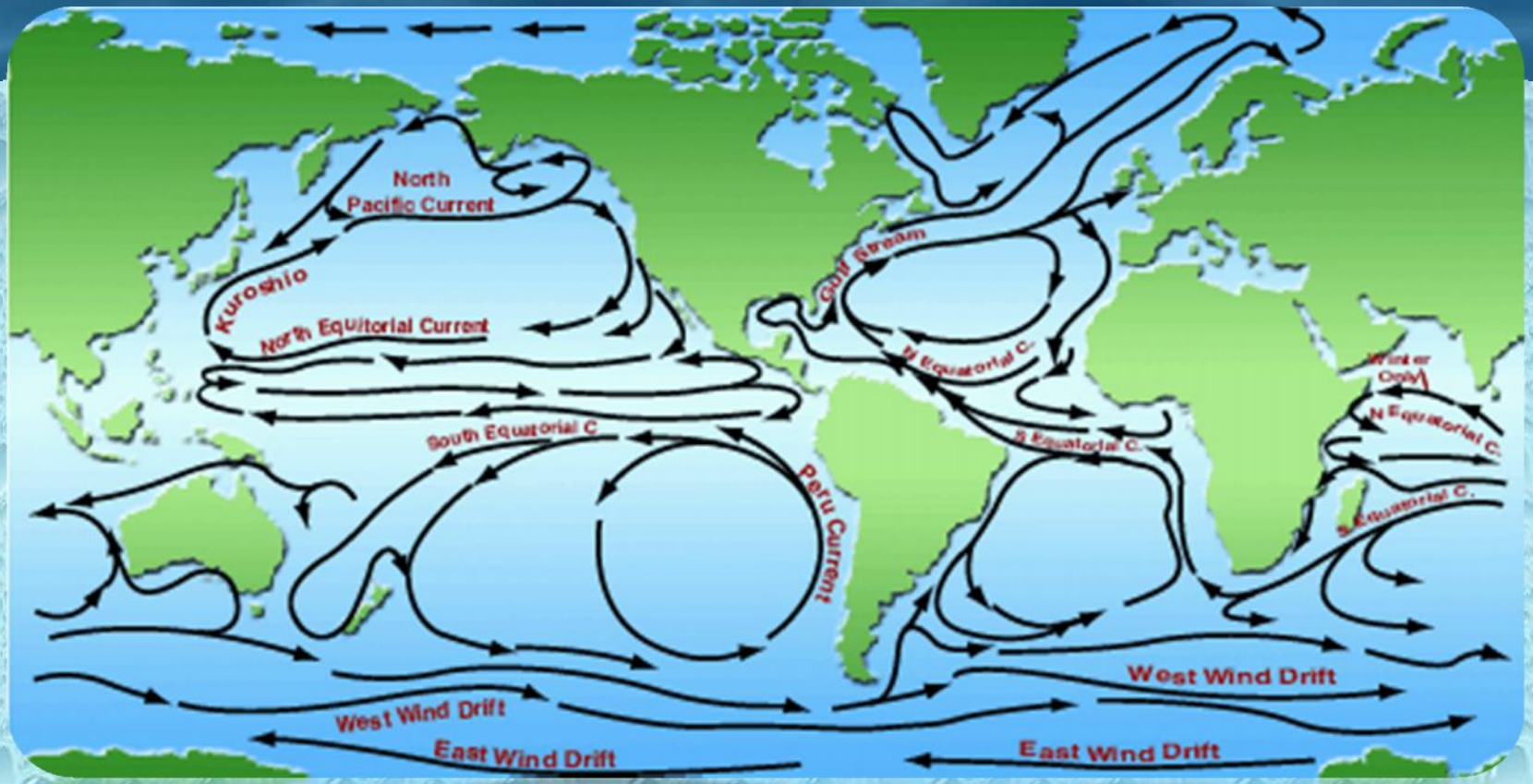


The Water Cycle

- When the droplets grow larger and heavier, they fall back to Earth's surface as **precipitation** – rain, snow, hail. Some precipitation returns to the ocean, but some falls on land where it is absorbed by the ground or forms lakes, streams and rivers. Some of this precipitation evaporates, but the rivers and much of the groundwater eventually drains back into the oceans.



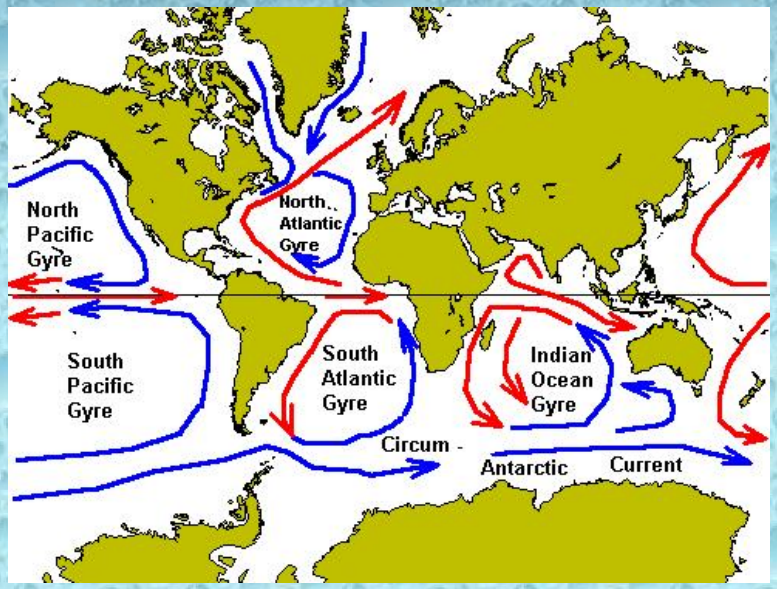
Tides and Currents



- Earth's ocean waters are in constant motion. This can be seen in the movement of tides and currents.

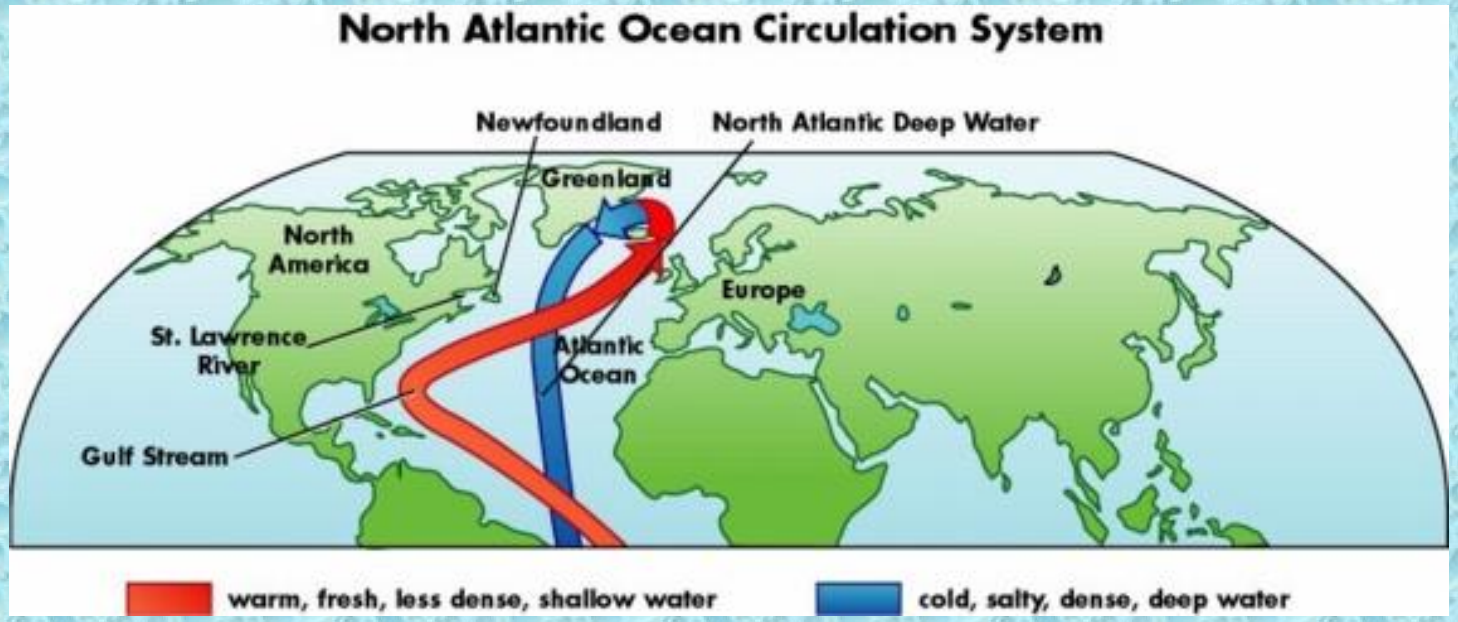
Currents

- Ocean currents are movements of the ocean's waters.
- These currents occur both at the ocean's surface and below. Surface currents are mainly caused by the spinning of Earth and winds.
- At the equator, the spinning of Earth and winds push surface water towards the west. This sets in motion large circular surface currents.
- Water heated by the sun moves away from the equator, carrying heat energy towards the polar regions.
  - For example, the **Gulf Stream** carries warm water towards Great Britain, making that country warmer than it would otherwise be. This transfer of energy helps maintain a balance – carrying warm water from the tropics to colder regions, and cold water from the polar regions towards the tropics.



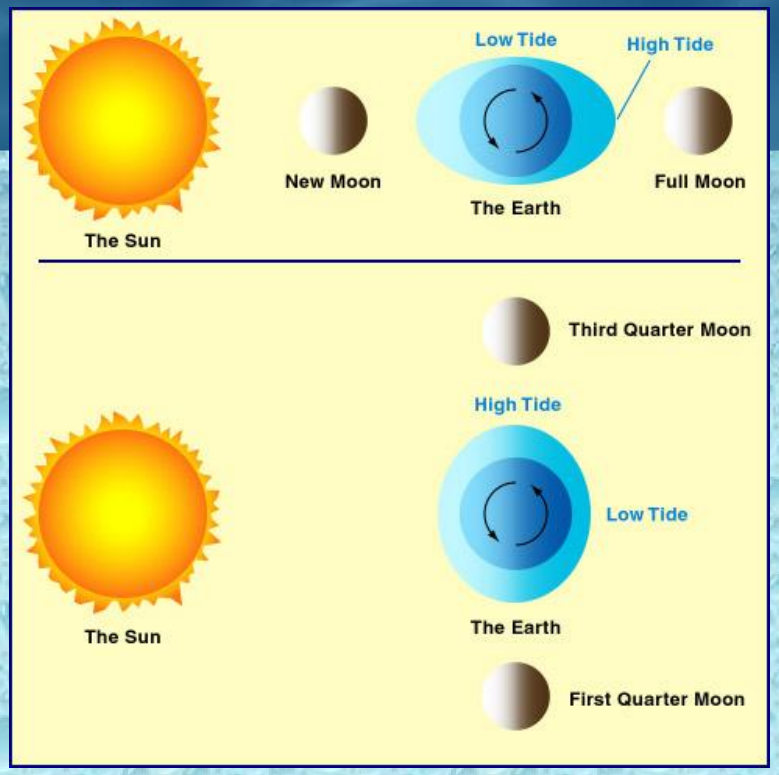
Currents

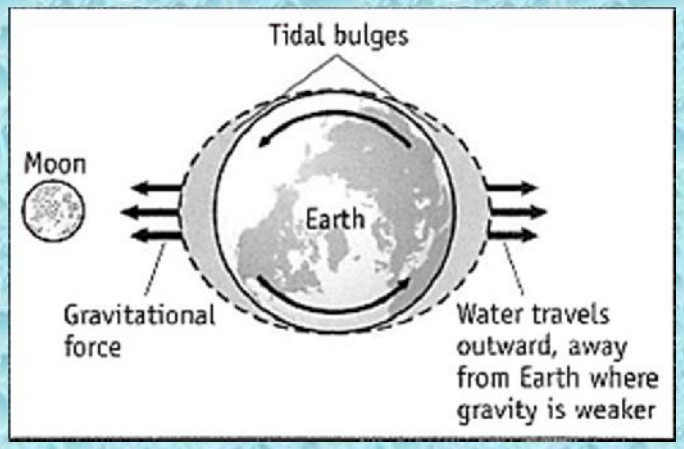
- Below the ocean's surface, its waters actually separate into different layers based on their density.
- Cold, salty water is more dense than warm, less salty water. At the poles, cold, salty water sinks. It then slowly moves towards the equator, pushing warmer water away. During this process, this cold water gradually warms up as it absorbs heat from the layers of water above it. This slow buy steady circulation of the ocean's deep waters takes hundreds of years.



Tides

- Each day, the surface level of the oceans rises and falls during *high* and *low tide*. Tides are caused by the gravitational pull of the moon on Earth's ocean waters. Ocean waters directly facing the moon bulge towards the moon, creating **high tide**, a time when sea levels are at their highest.





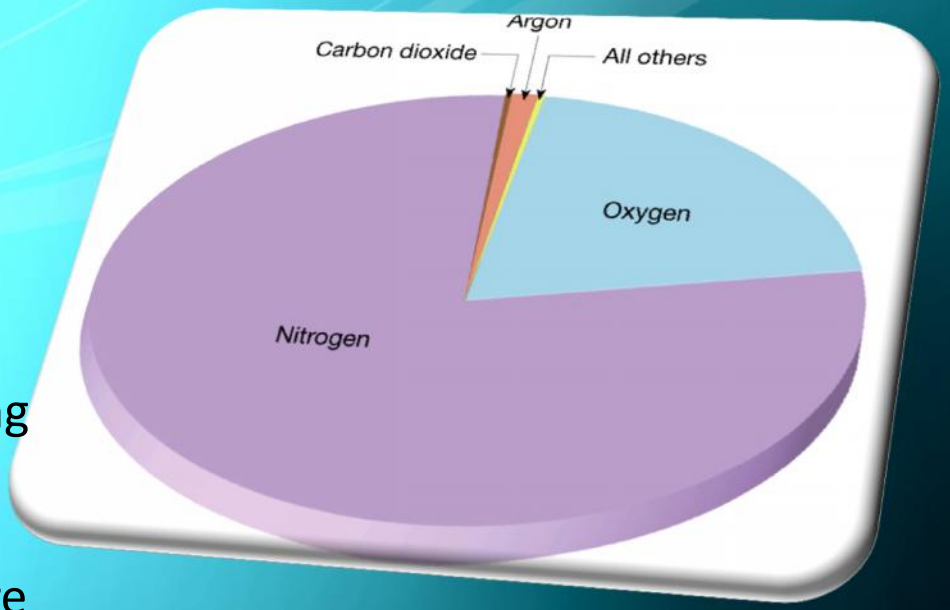
- On the opposite side of Earth is another hide tide, caused by the force of Earth's spin where the moon's pull is weakest.
- Sea levels become highest when the moon and sun are both lined up on the same side of Earth, and lowest when they are on opposite sides.

Atmosphere and Biosphere

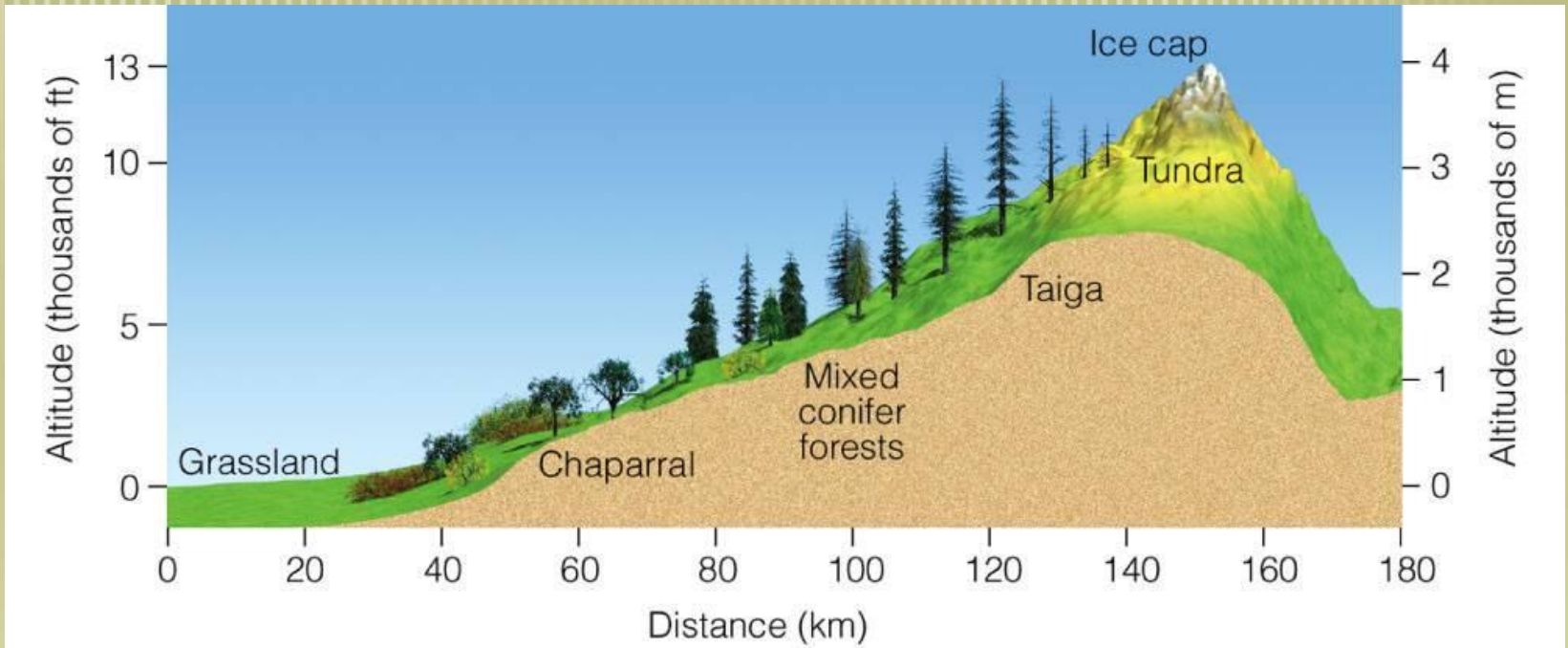
- **Atmosphere.** The spinning of Earth, the unequal heating of air by the sun, the evaporation of water, and the effect of various landforms on the air result in **weather** or differences in temperature, wind, and precipitation. **Climate** is an area's average weather. Earth's tilt as it orbits the sun causes our seasons.
- **Biosphere.** Differences in climate give rise to **biomes** – geographic regions that support different kinds of life – forests, grasslands, deserts and tundra.

The Atmosphere and Climate

- Around Earth is an envelope of gases known as the **atmosphere.**
- It consists mainly of nitrogen (78%) and oxygen (21%). The atmosphere absorbs solar radiation, moderates temperatures, and distributes water.
- **Weather** refers to conditions in the atmosphere closest to Earth, including humidity, winds, and precipitation (*rain snow,* or *hail*).
- Different processes in the atmosphere lead to differences in **climate,** the average weather conditions of a place over a long period of time.

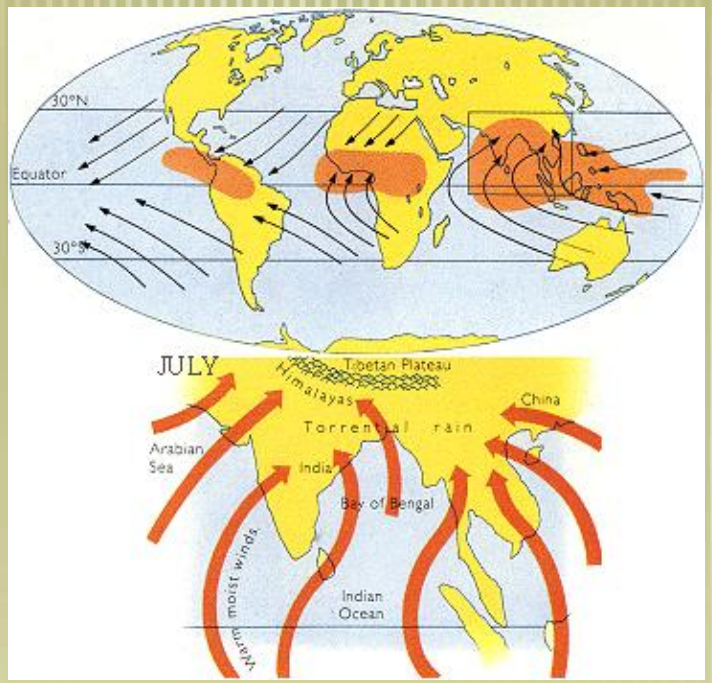


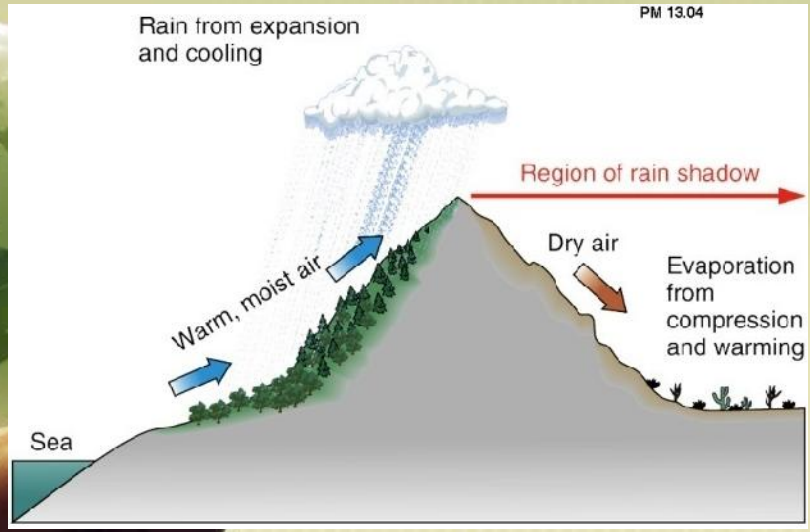
The Geography of Weather



- Weather is affected by latitude, elevation (*height above sea level*), wind patterns, ocean currents, and mountain barriers.
  - For example, temperatures are generally warmer the closer an area is to the equator. Temperatures tend to decrease as you move away from the equator to higher latitudes. Temperatures are also cooler at higher **elevations,** such as on mountains or high plateaus. Geographers refer to different climates at different altitudes in the same area as **vertical climates.**

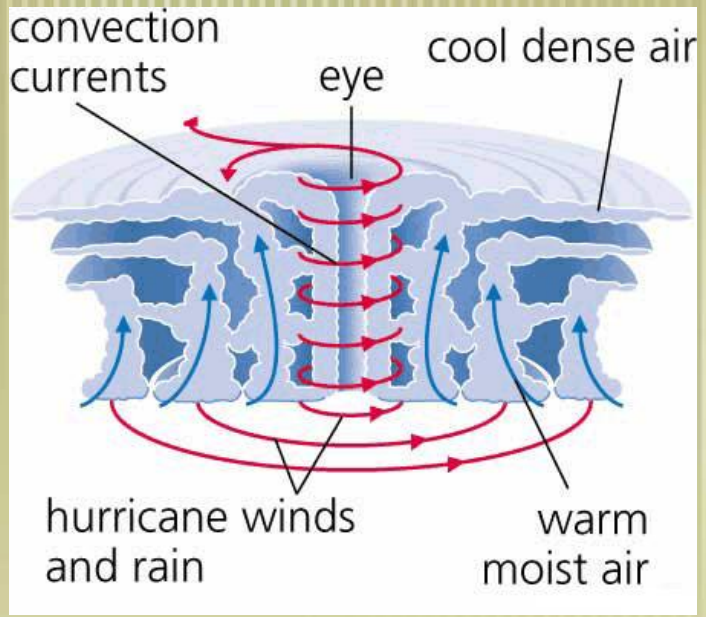
The Geography of Weather





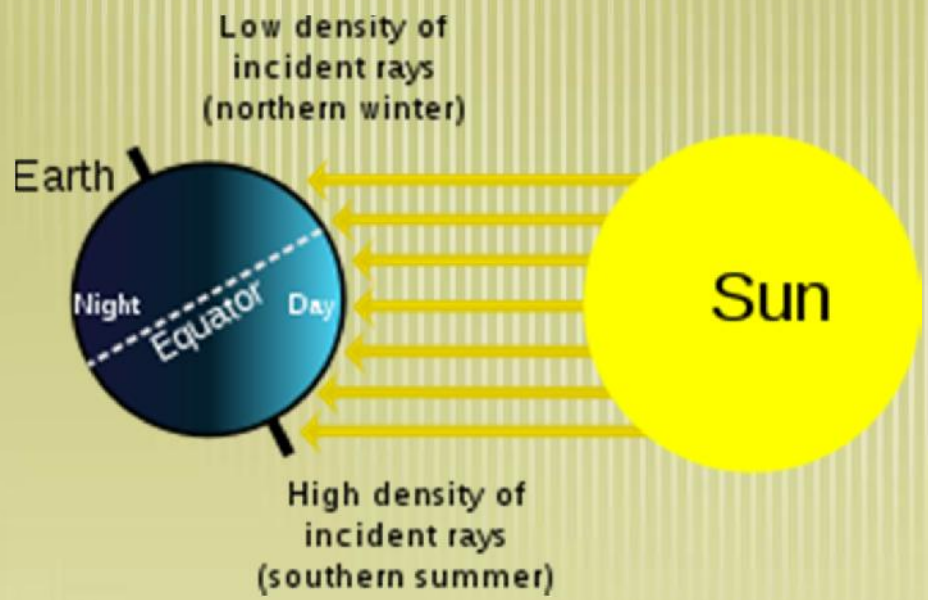
- Winds are influenced by Earth's spin.
- Depending on the location of a place, winds may bring moist air and rain, such as the **monsoons;** or they may leave an area dry.
- Distance from major bodies of water also affects climate. Because air cools as it rises over a mountain barrier, the ocean side of a mountain often has heavy rainfall. The air loses moisture and is drier when it reaches the other side of the mountain.

The Geography of Weather



- **Tropical hurricanes** occur in tropical regions in late summer and early fall when the ocean water is very warm.
- The warm ocean water evaporates so quickly that it creates an area of low pressure. Air around a rising air column begins to spiral at high speeds. The hot air rises until it cools and condenses – releasing energy and causing heavy rains, strong winds, and dangerous lightning strikes.

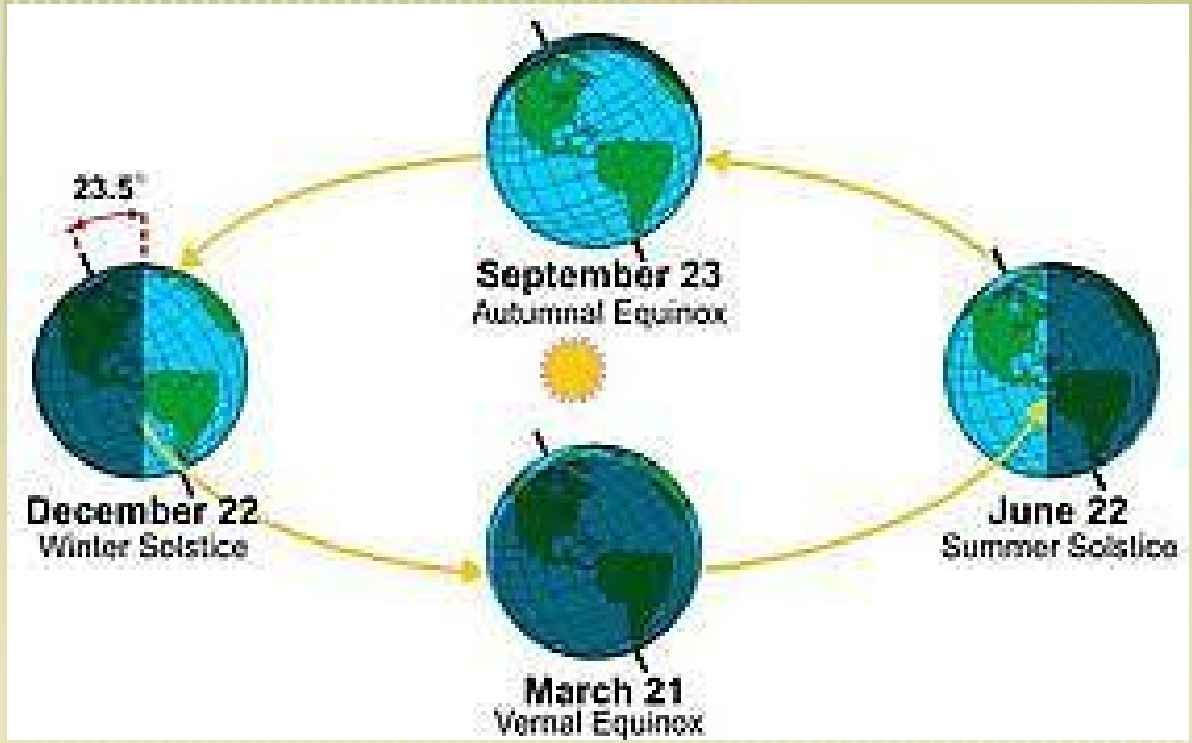
Earth's Seasons



- The Earth tilts on its axis as it revolves around the sun. Because of this tilt, the sun's rays hit the Northern Hemisphere longer and more directly in summer than in winter. The sun appears to rise higher in the sky, temperatures are warmer, and the days are longer.
- When it is summer in the Northern Hemisphere, it is winter in the Southern Hemisphere. This is because the Southern Hemisphere is tilting away from the sun and receives less direct solar rays.

Earth's seasons

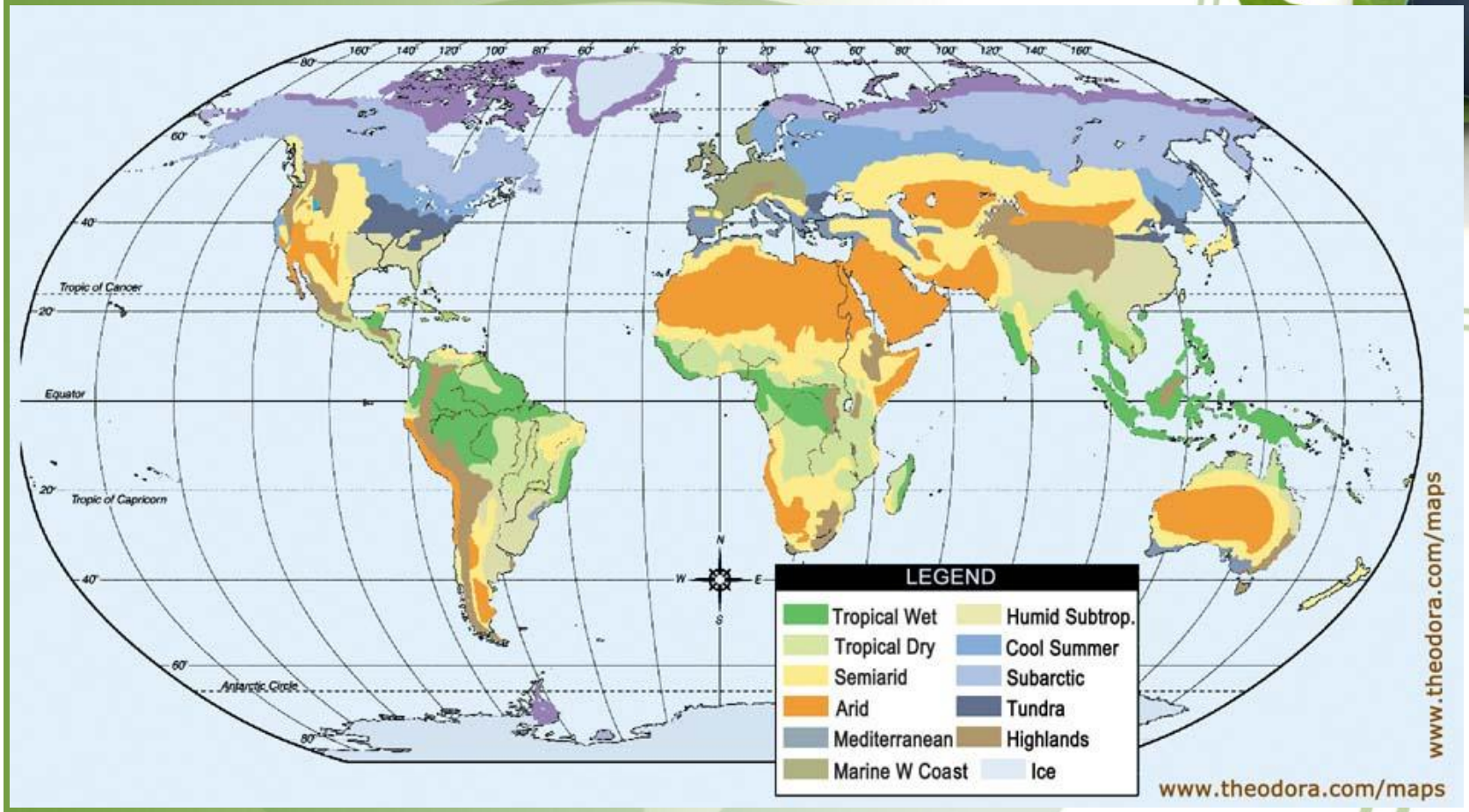
- Because seasons are caused by Earth's tilt, seasonal differences are greatest at the poles and least at the equator. The area around the equator is not affected by Earth's tilt. Area near the equator are always warm because they receive the sun's direct rays. The two poles are very different. In the summer, each pole has 24 hours of sunlight, while in the winter, the sun never rises in areas around the North or South pole.



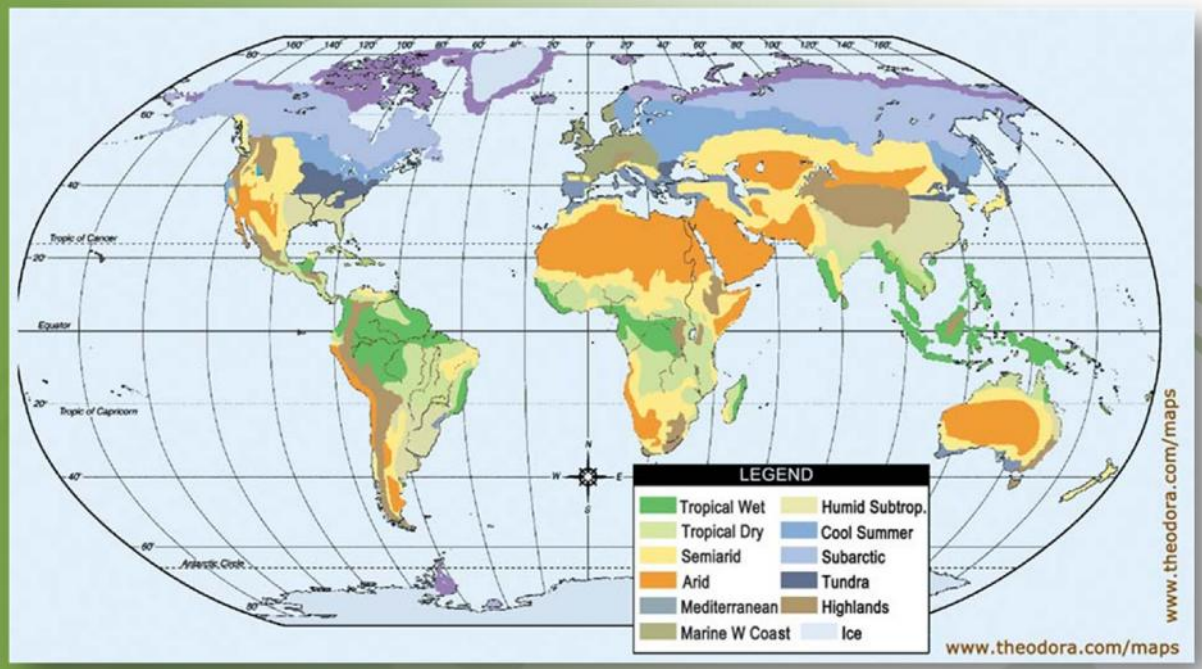
The Biosphere: Climate and Biomes

- The **biosphere** refers to all life on Earth. Weather patterns and climate influence what kinds of plants and animals can successfully live in a particular geographic location. Based on the interaction of climate, landforms, bodies of water, and soils, scientists have identified several different **biomes,** or distinct geographic regions with their own particular types of plant and animal life.

Distribution of Climate Regions



- Our world is home to a variety of climates. Some geographers divide the world into regions based on similarities in climate, including average temperatures and rainfall. Climate zones are most affected by latitude and elevation.



- **High-Latitude Climates.** The North and South Poles have similar "polar climates" with very cold winter temperatures.
- **Mid-Latitude Climates.** Places in the middle latitudes with low elevations generally have warm summers and cool winters. These are also known as "moist mid-latitude climates," with either mild or cold winters, or as "**temperate** climates."
- **Low-Latitude Climates.** Central Africa, Central America, Northern South America, South Asia and Southeast Asia have warm and humid climates. These are sometimes called "**tropical** moist climates." North Africa, the Middle East, Western Australia, and Asia have warm and dry climates. In these areas, the evaporation of water can be greater than precipitation.

APPLYING WHAT YOU HAVE LEARNED

Select one continent and compare its climate regions with the description of its major physical characteristics described in **Chapter 5:** *A World Gazetteer.*

★ What factors — such as latitude, elevation, and mountain barriers — affect the climate of that continent?

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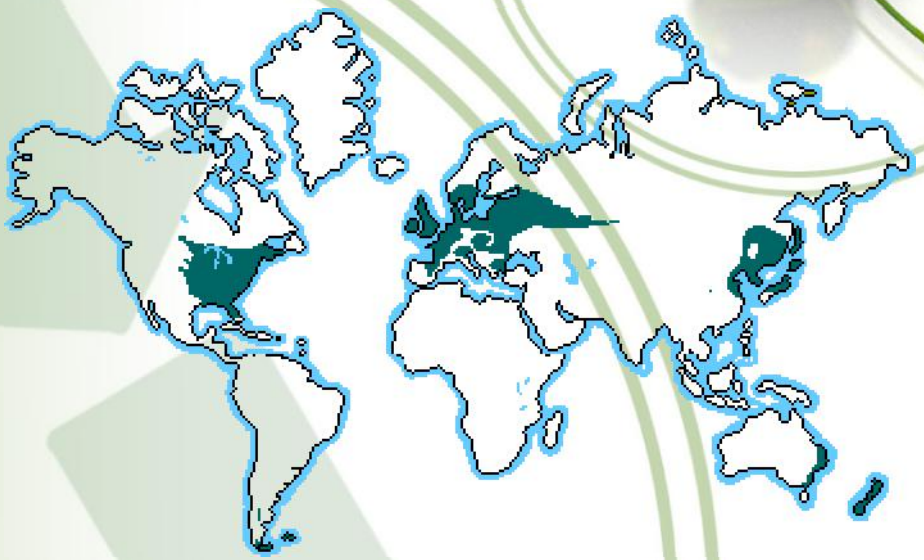
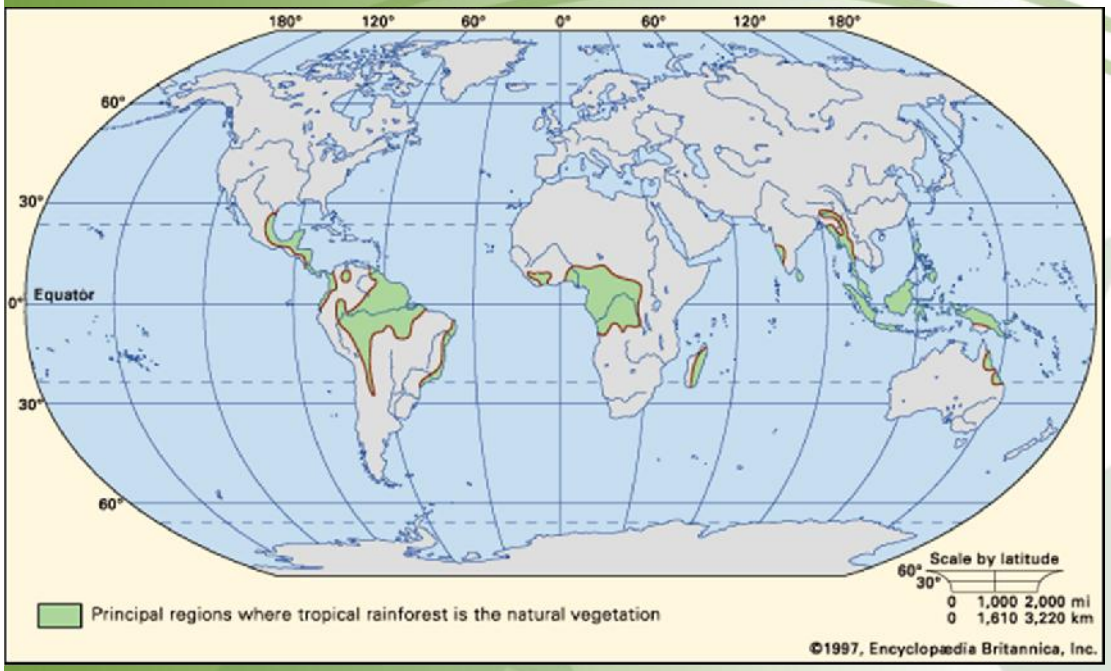
★ How does this continent's climate affect its physical features? State your answer in outline form or in a flow chart.

Temperate Deciduous Forest



- **Temperate deciduous forests** develop in mid-latitude regions where there is ample rain and moderate temperatures with cool winters. Trees change colors in fall and lose their leaves in winter. There is a wide range of plant and animal life.

Tropical Rain Forests

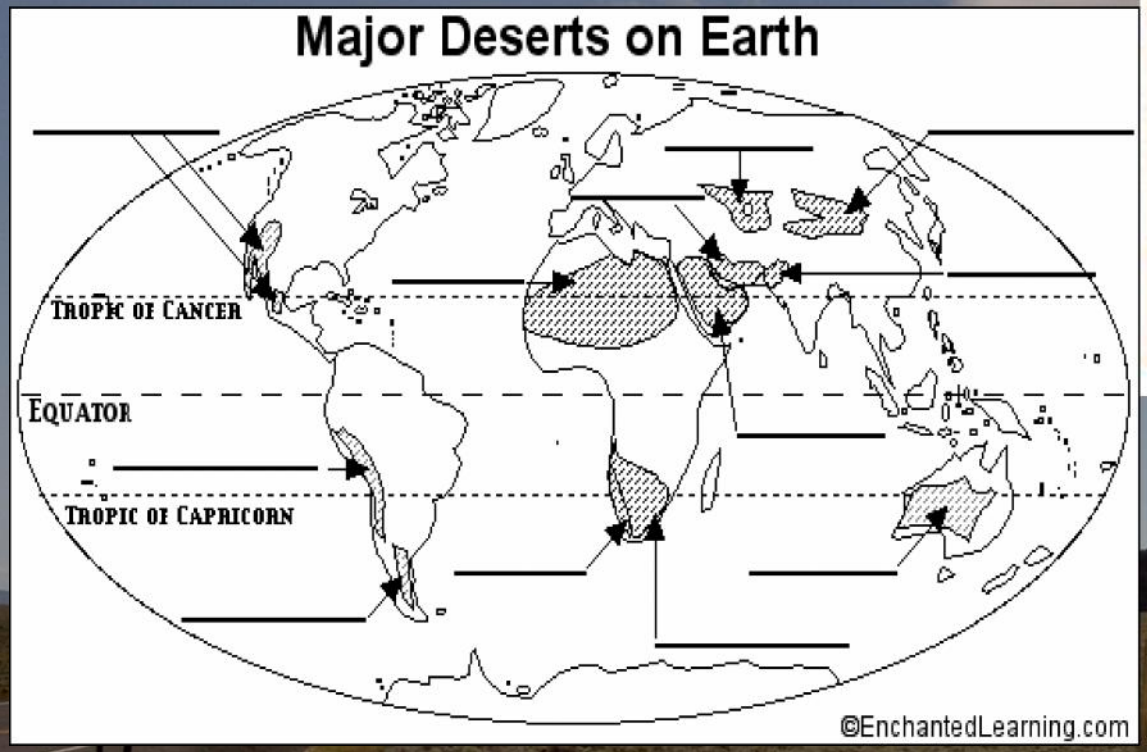


- **Tropical rainforests** develop in tropical areas near the equator where there is ample rainfall and warm temperatures year-round. Large trees cover the area with their leaves, forming a canopy. Despite the rapid growth of trees, the topsoil is actually very thin. Tropical rainforests are marked by a great abundance of animal and plant life, displaying greater biological diversity than any other biome.

Grasslands and Savanna or Steppes

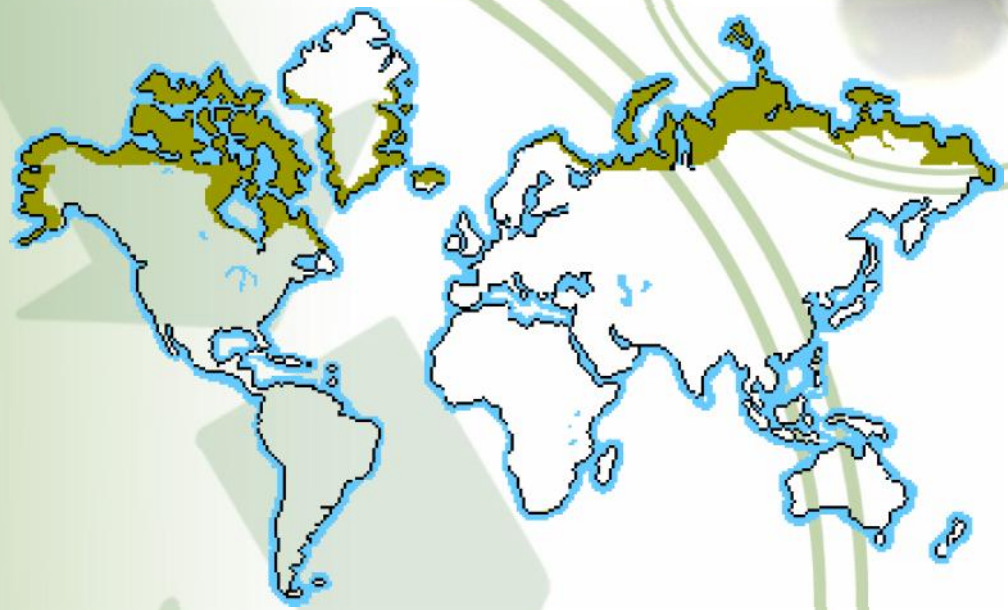
- **Grassland** areas exist where the climate is drier and there is not enough rainfall to support large amounts of trees. Instead, grasses dominate these areas with large grazing animals, like cattle, antelope or bison. **Savannas** are grasslands with some trees.

Deserts



- **Deserts** are regions that receive less than 10 inches of rainfall annually. Deserts in the tropical latitudes, such as the Sahara desert, have their own special forms of plant and animal life, which have adapted to the lack of water and extremes of temperature. Cacti, for example, store water in their stems.

Tundra



- **Tundra** is found closer to the polar regions. The soil of the tundra is so cold that trees cannot grow. Much of the ground is frozen part of the year. Tundras constitute a distinct biome, with their own plant and animal life, including grasses, small shrubs, large mammals and birds that migrate to these regions in the warmer spring and summer months.

★ In what way are climate regions and biomes related?

_____

_____

_____

CHAPTER STUDY CARDS

Tectonic Plate Movement

★ **Lithosphere.**
- Crust and top layer of mantle
- It is divided into shifting tectonic plates.

★ **Effects:**
- Earthquakes
- Volcanoes
- Seafloor spreading
- Mountains
- Rift valleys

★ **Other Forces affecting Earth's Surface:**
- **Weathering.** Rocks broken apart by wind, water, ice, and organisms.
- **Erosion.** Rocks and particles are broken down and carried to a new location.

Hydrosphere

★ The hydrosphere is made up of all water on Earth's surface.

★ Seventy percent of Earth's surface is covered by oceans.

★ The gravitational pull of the moon causes **tides** — a cyclic rise and fall of the oceans.

★ Ocean water is moved by surface and deep-sea currents.

★ **The Water Cycle.** Water circulates through evaporation, condensation, precipitation, and run-off.

Atmosphere and Weather

- The atmosphere is an envelope of gases around Earth. It is mainly made up of nitrogen and oxygen.
- The gases of the atmosphere absorb solar radiation, moderate temperatures and distribute water.
- Weather consists of temperature, humidity, precipitation, and wind. The atmosphere creates distinct weather patterns.
- Heating of the atmosphere and Earth's spin create wind patterns. Surface features like mountains also affect weather.

Climate

- **Average Weather Conditions.** Weather conditions of a place are affected by its:
  - Latitude
  - Elevation
  - Winds
  - Ocean currents
  - Mountain barriers
- **Climate Regions.** Regions based on similarities in climate. Examples include:
  - Polar Climates
  - Tropical Climates
- **Biomes.** Variations in climate lead to distinct regions based on similarities of plant and animal life: temperate forests, tropical rainforests, grasslands, deserts, and tundras.