Chapter 3

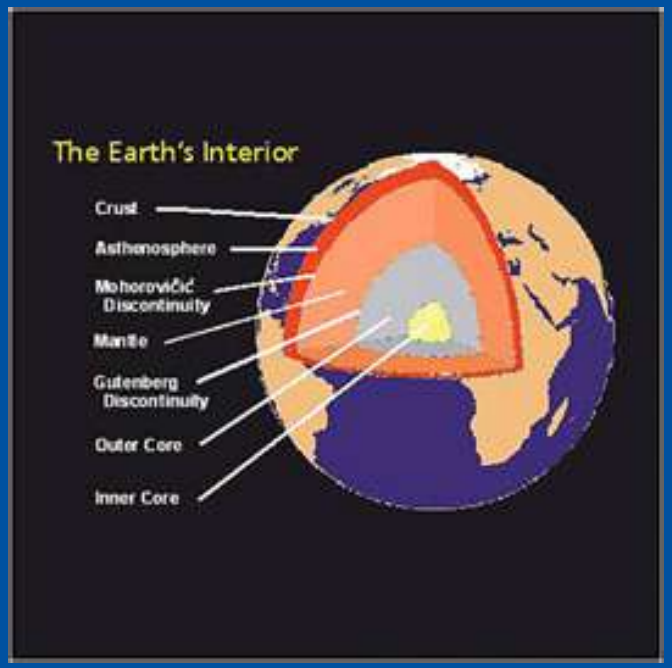
The Dynamic Earth

Section 1: The Geosphere

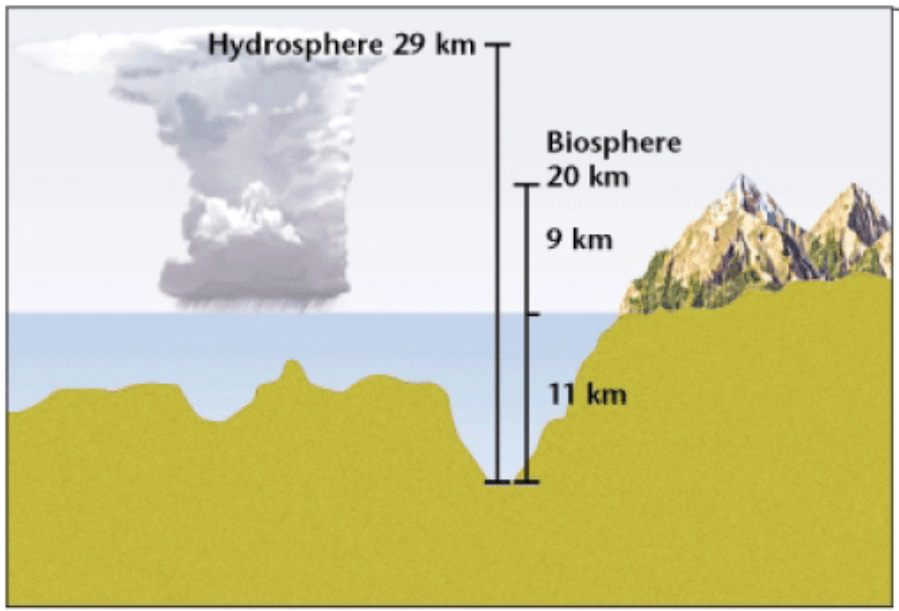
DAY 1

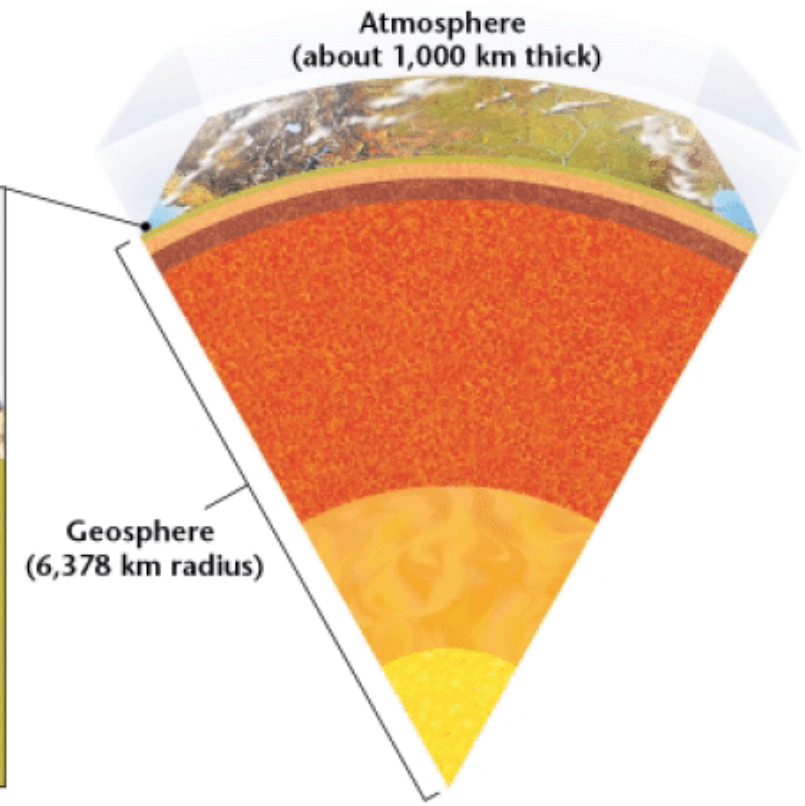
The Earth as a System

- The Earth is an integrated system that consists of **rock, air, water, and living things** that all interact with each other.
- Scientists divided this system into four parts:
  - **The Geosphere (rock)**
  - **The Atmosphere (air)**
  - **The Hydrosphere (water)**
  - **The Biosphere (living things)**



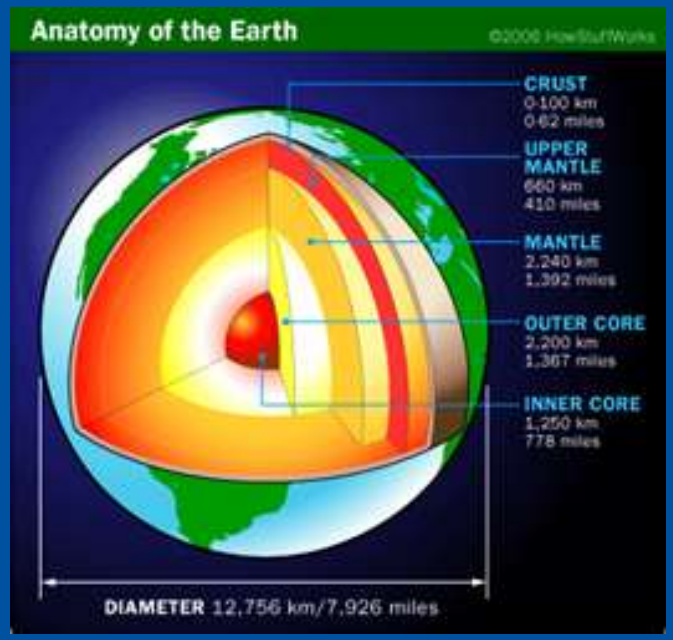
The Earth as a System





The Earth as a System

- The **geosphere** is the mostly solid, rocky part of the Earth that extends from the center of the core to the surface of the crust.
- The atmosphere is the mixture of gases that makes up the air we breathe.
- Nearly all of these gases are found in the first **30 km** above the Earth's surface.

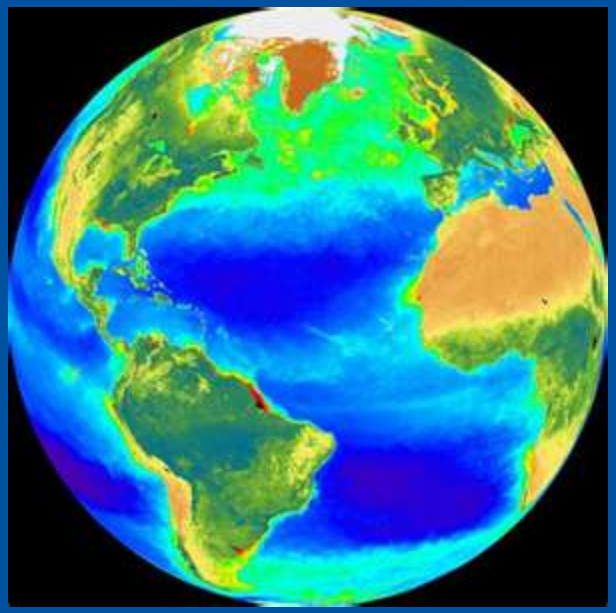


The Earth as a System

- The hydrosphere makes up all of the **water on or near the Earth's surface**.
- Much of this water is in the **oceans**, which cover nearly three-quarters of the globe.
- However, water is also found in the atmosphere, on land, and in the soil.

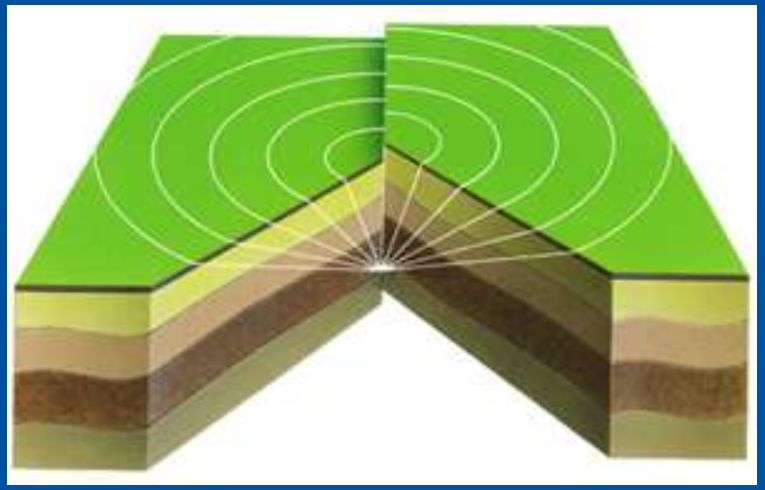
The Earth as a System

- The **biosphere** is the part of the Earth where life exists.
- It is a thin layer at the Earth's surface that extends from about **9 km** above the Earth's surface down to the bottom of the ocean.
- The biosphere is therefore made up of parts of the geosphere, the atmosphere, and the hydrosphere.



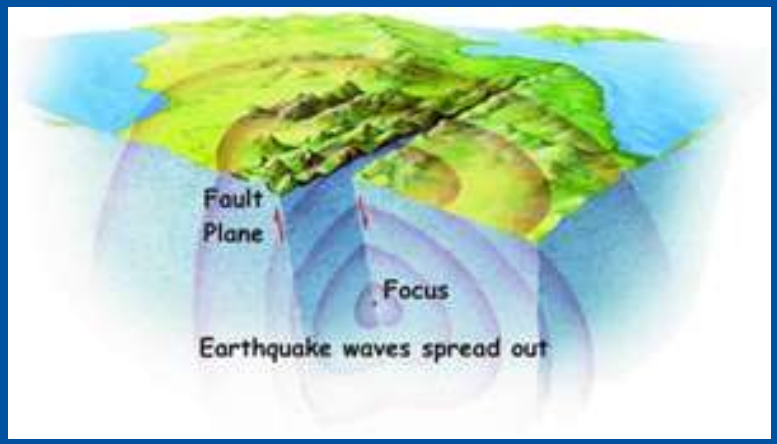
Discovering Earth's Interior

- Scientists use **seismic waves** to learn about Earth's interior.
- Seismic waves are the same waves that travel through Earth's interior during an earthquake.
- A similar process would be you tapping on a melon to see if it is ripe.

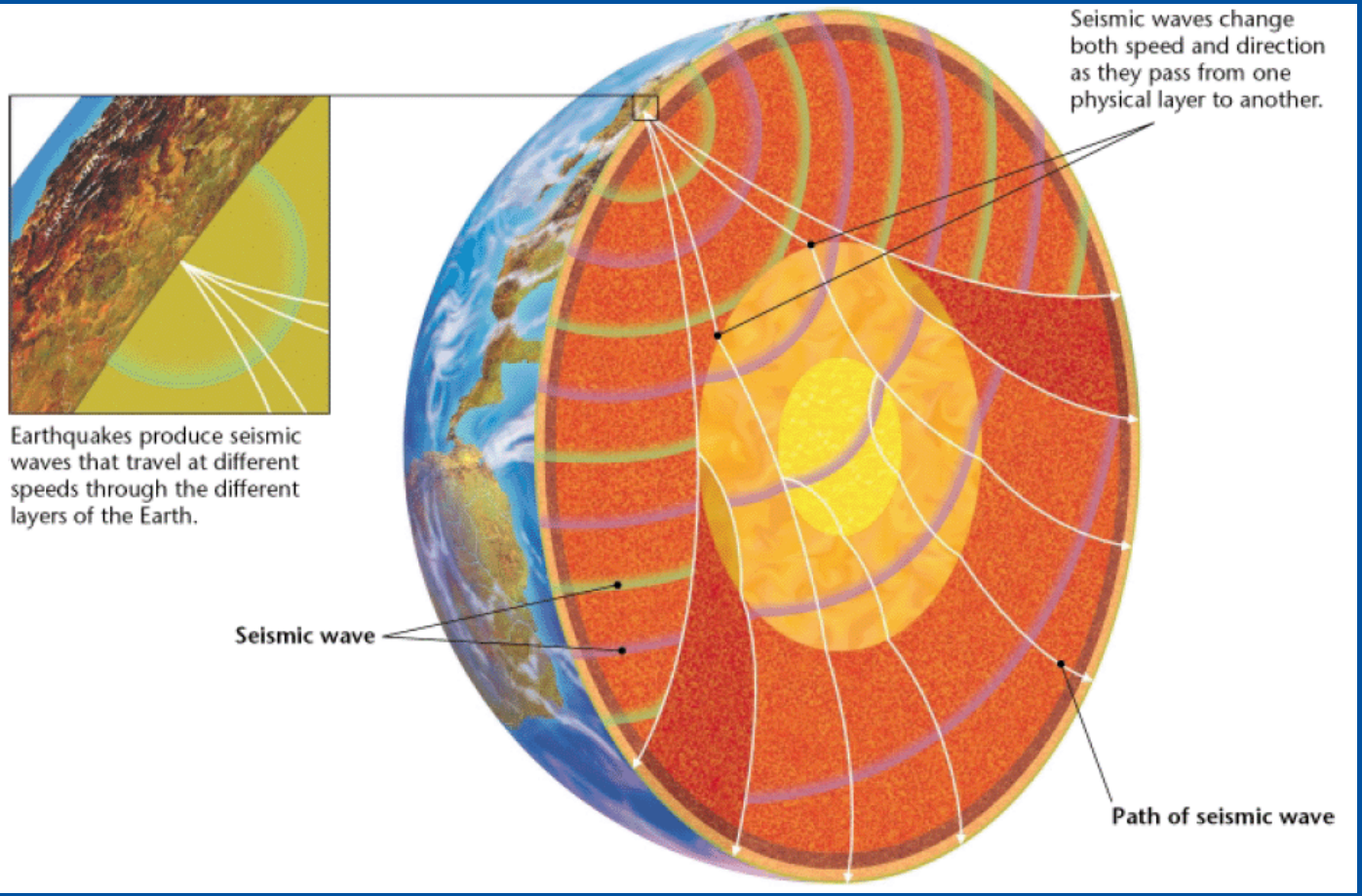


Discovering Earth's Interior

- A seismic wave is **altered by the nature of the material** through which it travels.
- Seismologists measure changes in the **speed and direction** of seismic waves that penetrate the interior of the planet.
- With this technique, seismologists have learned that the Earth is made up of different layers and have inferred what substances make up each layer.

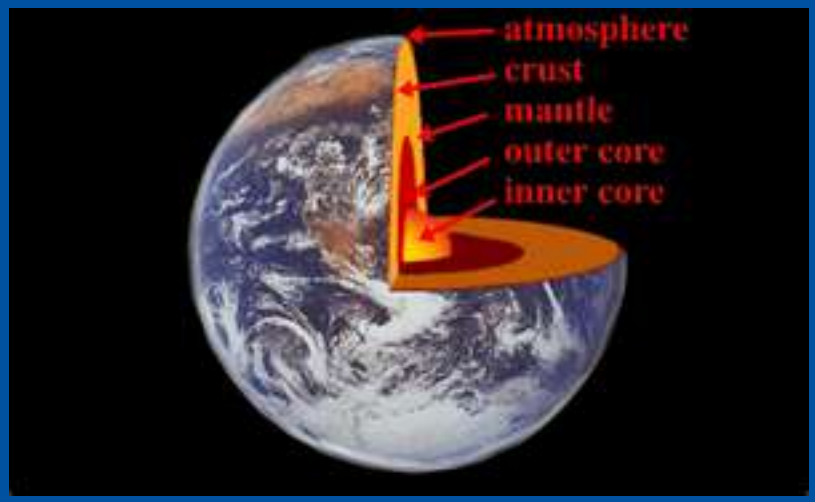


Discovering Earth's Interior



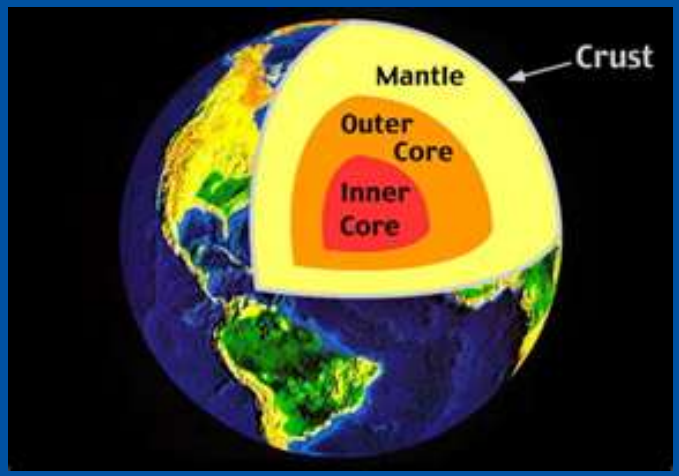
The Composition of the Earth

- Scientists divide the Earth into three layers:
  - **The crust**
  - **The mantle**
  - **The core**
- These layers are made up of progressively denser material toward the center of the Earth.



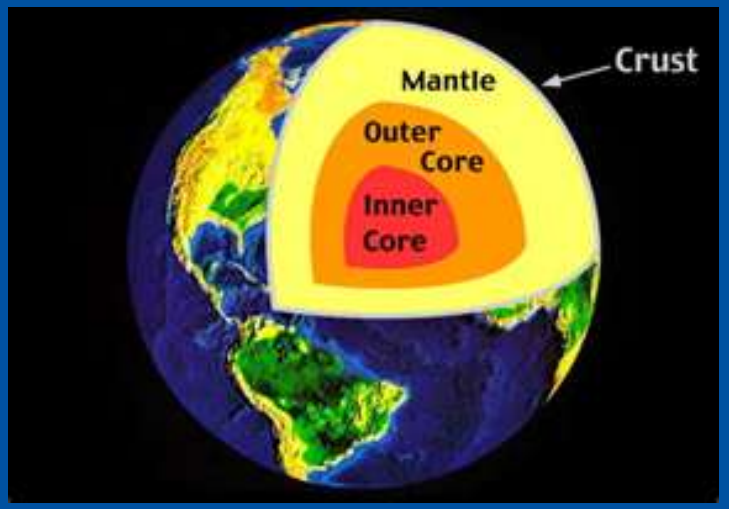
The Composition of the Earth

- The **crust** is the thin and solid outermost layer of the Earth above the mantle.
- It is the **thinnest layer**, and makes up less than **1** percent of the planet's mass.
- It is 5 km to 8 km thick beneath the oceans and is 20 km to 70 km thick beneath the continents.



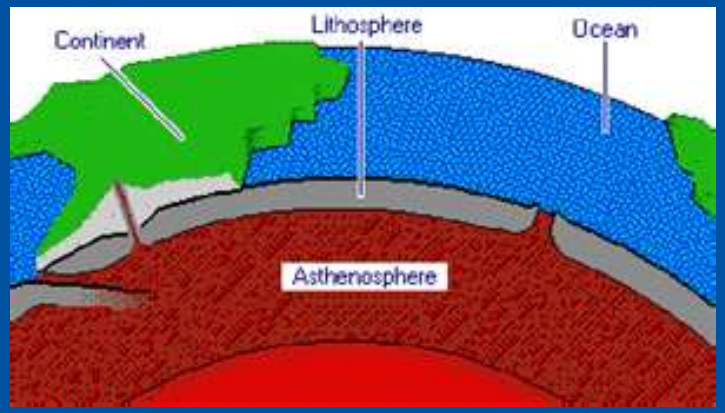
The Composition of the Earth

- The **mantle** is the layer of rock between the Earth's crust and core.
- The mantle is made of rocks of medium density, and makes up **64** percent of the mass of the Earth.
- The **core** is the central part of the Earth below the mantle, and is composed of the densest elements.



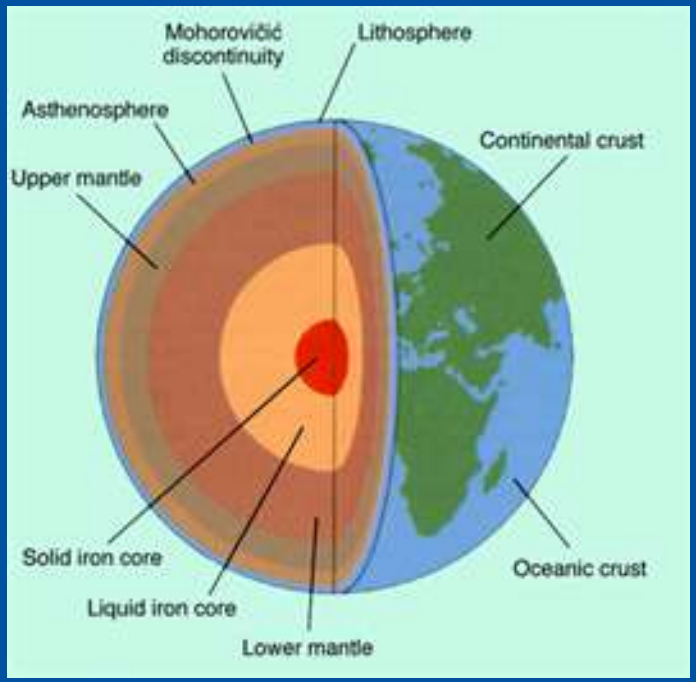
The Structure of the Earth

- The Earth can be divided into **five** layers based on the physical properties of each layer.
- The **lithosphere** is the solid, outer layer of the Earth that consists of the crust and the rigid upper part of the mantle.
- It is a cool, rigid layer that is 15 km to 300 km thick and is divided into huge pieces called **tectonic plates**.



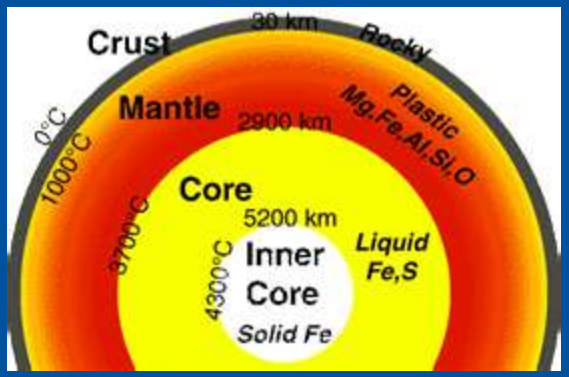
The Structure of the Earth

- The **asthenosphere** is the solid, plastic layer of the mantle beneath the lithosphere.
- It is made of **mantle rock** that flows slowly, which allows tectonic plates to move on top of it.
- Beneath the asthenosphere is the **mesosphere**, the lower part of the mantle.

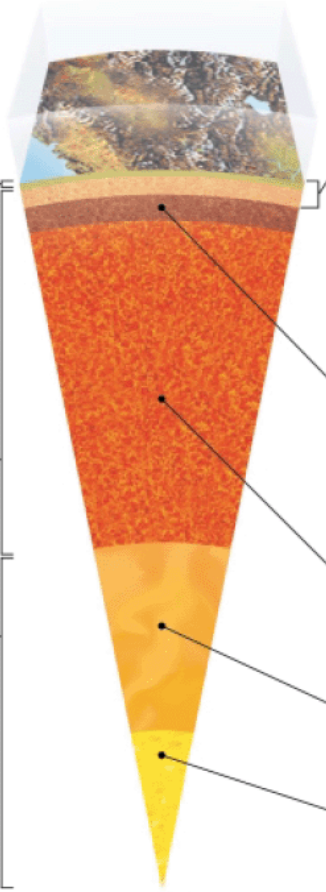


The Structure of the Earth

- The Earth's **outer core** is a dense liquid layer.
- At the center of the Earth is a dense, solid inner core, which is made up mostly of **iron and nickel**.
- Although the temperature of the inner core is estimated to be between 4,000°C to 5,000°C, it is solid because it is under enormous pressure.
- The inner and outer core make up about **one-third** of Earth's mass.



Earth's Layers



Crust 5–70 km thick; the solid, brittle, outermost layer of the Earth; continental crust is thick and made of lightweight materials, whereas oceanic crust is thin and made of denser materials

Mantle 2,900 km thick; the layer of the Earth between the crust and the core; made of dense, iron-rich minerals

Core 3,428 km radius; a sphere of hot, dense nickel and iron at the center of the Earth

Lithosphere 15–300 km thick; the cool, rigid, outermost layer of the Earth; consists of the crust and the rigid, uppermost part of the mantle; divided into huge pieces called tectonic plates, which move around on top of the asthenosphere and can have both continental and oceanic crust

Asthenosphere 250 km thick; the solid, plastic layer of the mantle between the mesosphere and the lithosphere; made of mantle rock that flows very slowly, which allows tectonic plates to move on top of it

Mesosphere 2,550 km thick; the "middle sphere"; the lower layer of the mantle between the asthenosphere and the outer core

Outer Core 2,200 km thick; the outer shell of Earth's core; made of liquid nickel and iron

Inner Core 1,228 km radius; a sphere of solid nickel and iron at the center of the Earth

Plate Tectonics

- **Tectonic plates** are blocks of lithosphere that consist of the crust and the rigid, outermost part of the mantle and glide across the underlying asthenosphere.
- The continents are located on tectonic plates and move around with them.
- The major tectonic plates include the Pacific, North America, South America, Africa, Eurasian, and Antarctic plates.

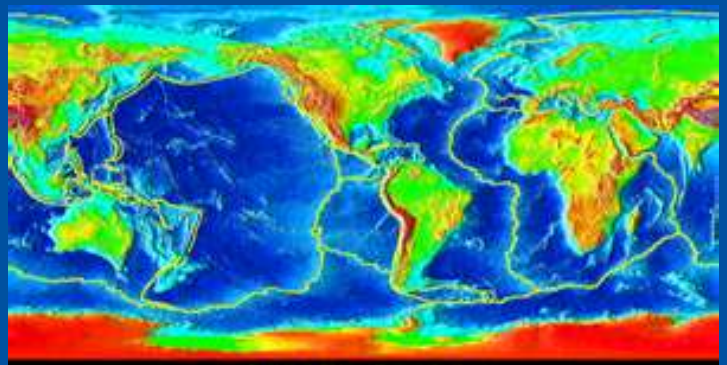

Crustal Plate Boundaries

Plate Boundaries

- Much of the geological activity at the surface of the Earth takes place at the boundaries between tectonic plates.
- Tectonic plates may **separate, collide, or slip** past one another.
- Enormous forces are generated with these actions causing mountains to form, earthquakes to shake the crust, and volcanoes to erupt along the plate boundaries.

Plate Tectonics and Mountain Building

- Tectonic plates are continually moving around the Earth's surface.
- When tectonic plates collide, slip by one another, or pull apart, enormous forces cause rock to **break and buckle**.
- Where plates collide, the crust becomes thicker and eventually forms mountain ranges, such as the Himalaya Mountains.

YouTube

Plate Tectonics

Earthquakes

- A **fault** is a break in the Earth's crust along which blocks of the crust slide relative to one another.
- When rocks that are under stress suddenly break along a fault, a series of ground vibrations, known as **earthquakes**, is set off.
- Earthquakes are occurring all the time. Many are so small that we cannot feel them, but some are enormous movements of the Earth's crust that cause widespread damage.

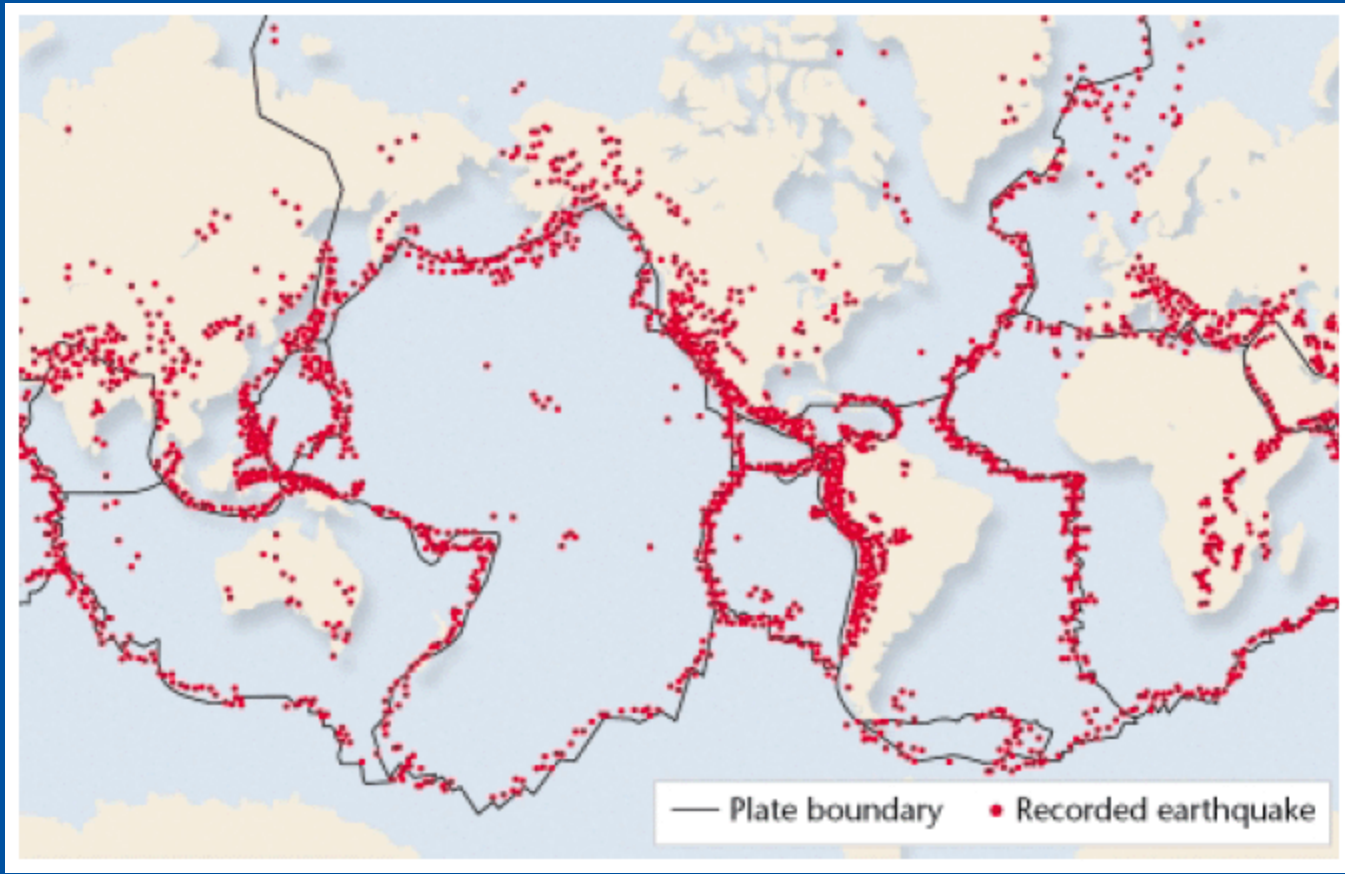
Earthquakes

- The measure of the energy released by an earthquake is called **magnitude**.
- The smallest magnitude that can be felt is 2.0, and the largest magnitude ever recorded is 9.5. Magnitudes greater than 7.0 cause widespread damage.
- Each increase of magnitude by one whole number indicates the release of **31.7** times more energy than the whole number below it.

Where do Earthquakes Occur?

- The majority of earthquakes take place at or near tectonic plate boundaries because of the enormous stresses that are generated when tectonic plates separate, collide, or slip past each other.
- Over the past 15 million to 20 million years, large numbers of earthquakes have occurred along the San Andreas Fault in California, where parts of the North America plate and the Pacific plate are slipping past one another.

Where do Earthquakes Occur?



Earthquake Hazard

- Scientists cannot predict when earthquakes will take place. However, they can help provide information about where earthquakes are likely to occur helping people prepare.
- An area's **earthquake-hazard level** is determined by past and present seismic activity.
- Earthquake-resistant buildings, built in high-risk areas, are slightly flexible so that they can sway with the ground motion preventing them from collapsing.

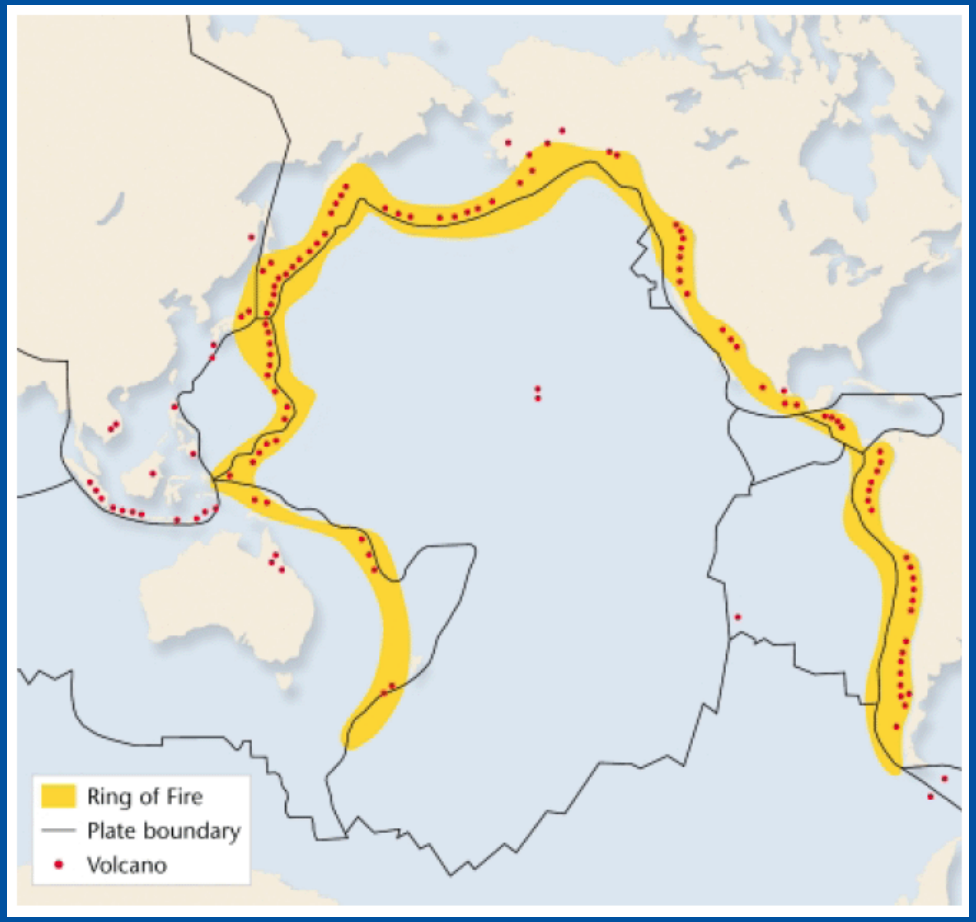
YouTube

EarthQuakes

Volcanoes

- A **volcano** is a mountain built from magma, or melted rock, which rises from the Earth's interior to the surface, and can occur on land or in the sea.
- Volcanoes are often located near tectoni plate boundaries where plates are either colliding or separating from one another.
- The majority of the world's active volcanoes on land are located along tectonic plate boundaries that surround the **Pacific Ocean**.

Volcanoes: The Ring of Fire



Local Effect of Volcanic Eruptions

- Clouds of host ash, dust, and gases can flow down the slope of a volcano at speeds of up to **200 km/hr** and sear everything in their path.
- During an eruption, volcanic ash can mix with water and produce mudflow that runs downhill.
- In addition, ash that falls to the ground can cause buildings to collapse under its weight, bury crops, damage the engines of vehicles, and cause breathing difficulties.

Global Effects of Volcanic Eruptions

- Major volcanic eruptions can change Earth's climate for several years.
- In large eruptions, clouds of volcanic ash and sulfur rich gases may reach the upper atmosphere, and spread across the planet **reducing the amount of sunlight that reaches the Earth's surface**.
- The reduction in sunlight can cause a drop in the **average global surface temperature**.

Erosion

- The Earth's surface is continually battered by wind and scoured by running water, which moves rocks around and changes their appearance.
- **Erosion** is the process in which the materials of the Earth's surface are loosened, dissolved, or worn away and transported form one place to another by a natural agent, such as wind, water, ice or gravity.
- Erosion wears down rocks and makes them smoother as times passes. Older mountains are therefore smoother than younger ones.

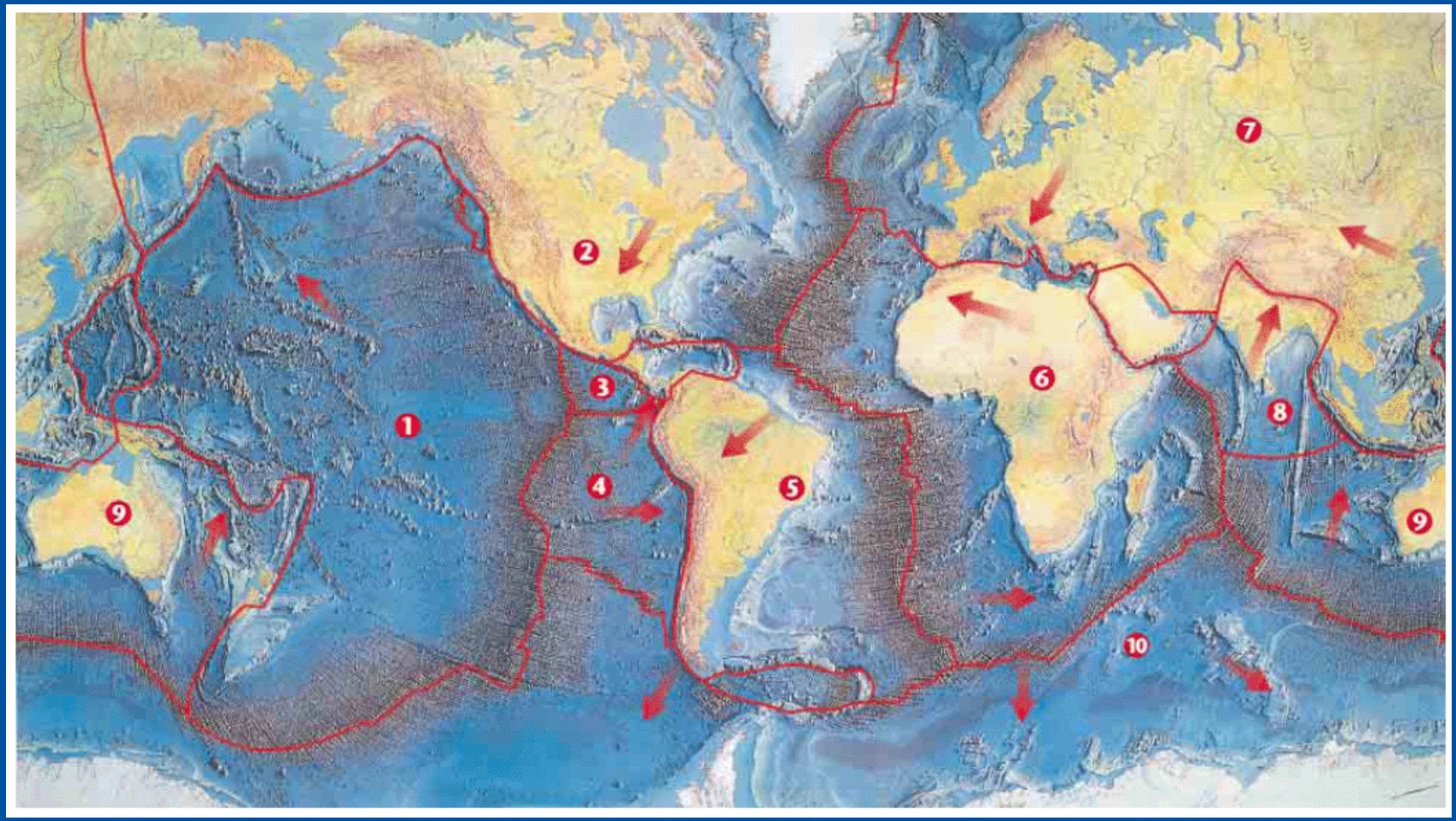
Water Erosion

- Erosion by both rivers and oceans can produce dramatic changes on Earth's surface.
- Waves from ocean storms can erode coastlines to give rise to a variety of landforms,
- Over time, rivers can carve deep gorges into the landscape.

Wind Erosion

- **Wind** also changes the landscape of the planet.
- In places where few plants grow, such as beaches and deserts, wind can blow soil away very quickly.
- Soft rocks, such as sandstone, erode more easily than hard rocks, such as granite do.

Tectonic Plates

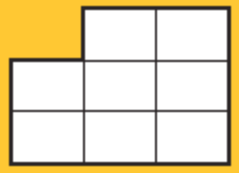


Graphic Organizer – page 616

Graphic Organizer

Comparison Table

Create the **Graphic Organizer** entitled "Comparison Table" described in the Appendix. Label the columns with "Local Effects" and "Global Effects." Label the rows with "Volcanic Eruptions" and "Earthquakes." Then, fill in the table with details about the characteristics and the effects of each type of natural disaster.



1. Draw a chart like the one shown. Your chart can have as many columns and rows as you want.
2. In the top row, write the topics that you want to compare.
3. In the left column, write characteristics of the topics in the appropriate boxes.