



# Plain of Six Glaciers, Lake Louise, AB



## Learning Objectives

- <https://macearthscience.weebly.com/unit-ii.html>
- Watch the movie too.



- Click the link to get to the Learning Objectives.
- Watch Timelapse of the Entire Universe

## 1.1 Earth Science

- All sciences that seek to understand and Earth's neighbors in space
- Earth Science includes
  - Geology – literally the “study of Earth”
    - Physical and Historical Geology
  - Oceanography – a study of the ocean
  - Meteorology – the study of the atmosphere and the processes that produce weather
  - Astronomy – the study of the universe

# Earth Science is Environmental Science

- Natural hazards
  - Hurricanes, tornados, floods, earthquakes, etc.
- Resources
  - Minerals, fossil fuels, water, air, etc.
- People Influence Earth processes



- Natural hazards include Hurricanes, Tsunamis, Volcanos, and Tornadoes.



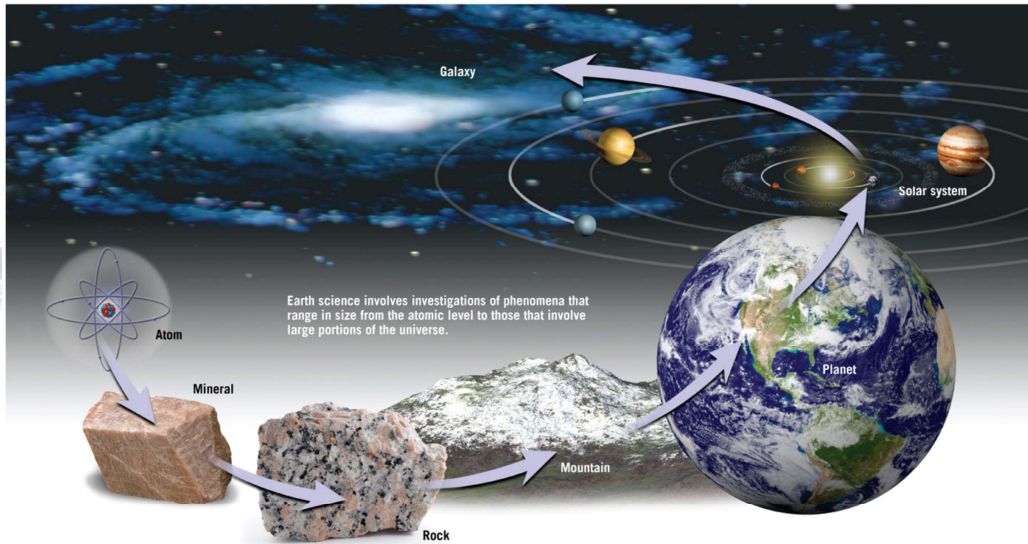
- People influence Earth Processes: trash, smog, mining, etc.

# Earth Science: Scales of Space and Time

- Geologic Time
  - Span of time since Earth's formation
  - Earth is 4.6 billion years old
  - Concept of "recent" is different
- Geologic Time Scale
  - Divides history of Earth into different units



From the really, really small to the really, really big.



## Powers of Ten

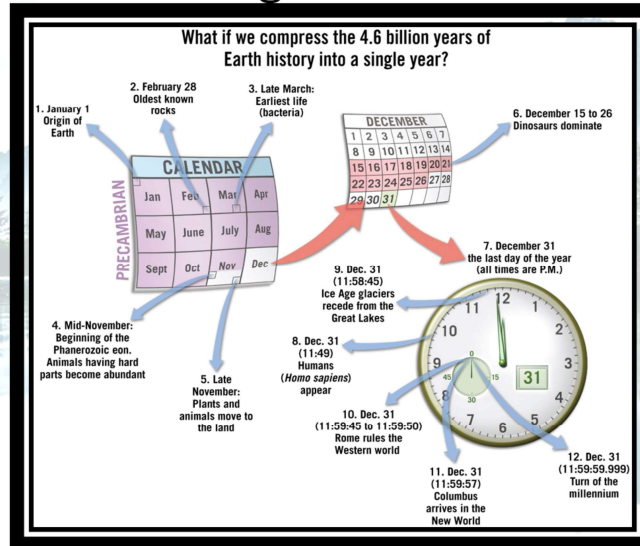
- <http://macearthscience.weebly.com/unit-2.html>



10

- Click link and watch Powers of Ten video.

# Magnitude of Geologic Time



11

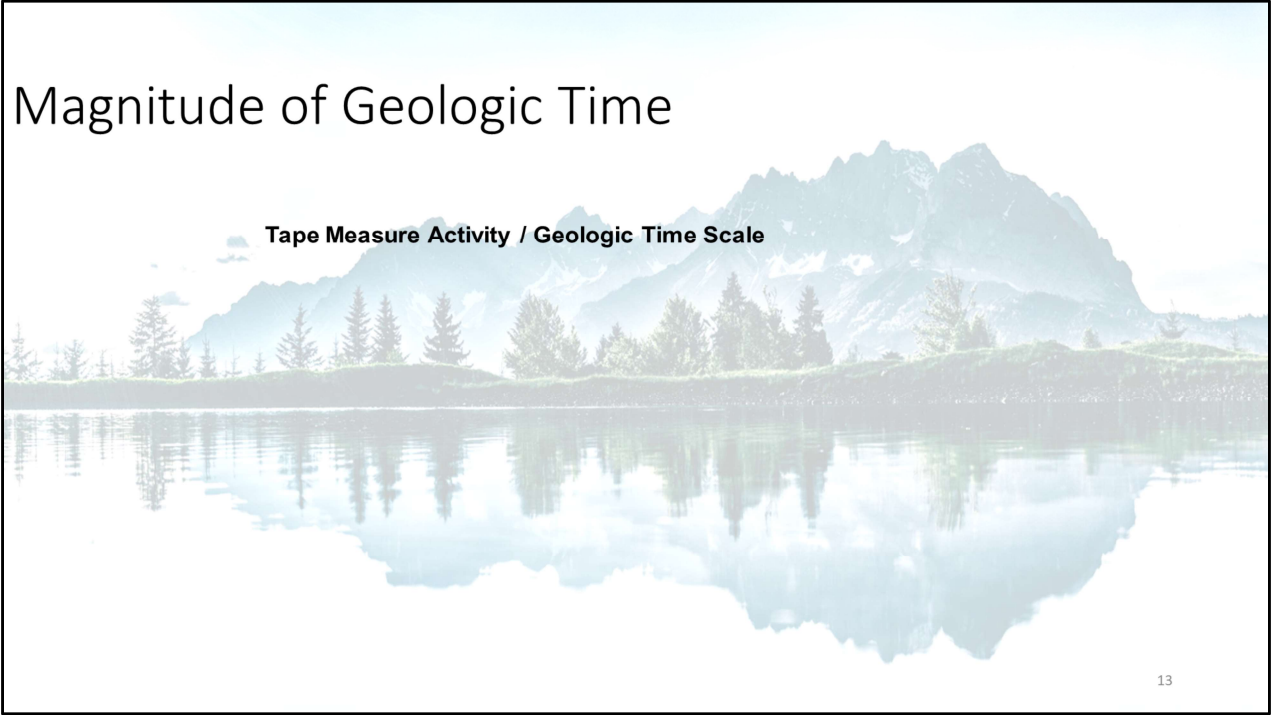
# Understanding Geologic Time

<http://macearthscience.weebly.com/unit-2.html>

TED Talk – Understanding Geologic Time.

# Magnitude of Geologic Time

**Tape Measure Activity / Geologic Time Scale**



13

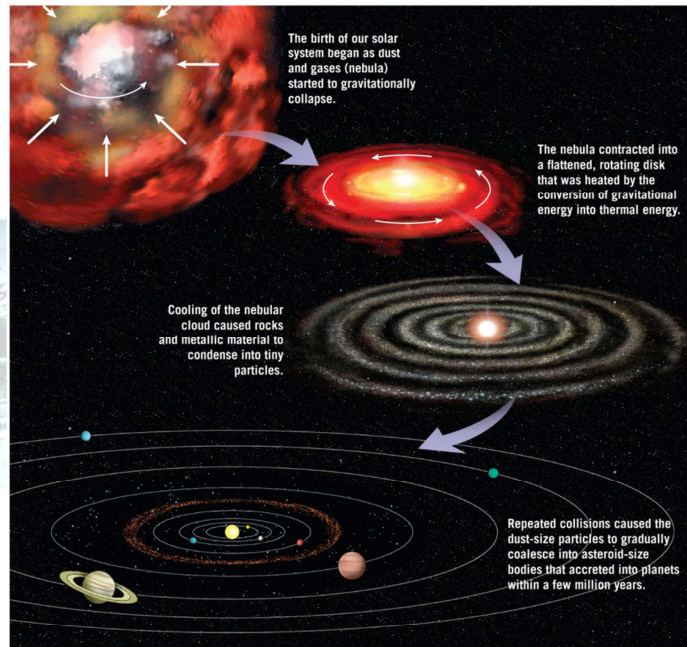
## Check Questions 1.1

1. List and briefly describe the sciences that collectively make up Earth science.
2. Name the two broad subdivisions of geology and distinguish between them.
3. List at least four different natural hazards.
4. Aside from natural hazards, describe another important connection between people and Earth science.
5. List two examples of size/space scales in Earth science that are at opposite ends of the spectrum.
6. How old is Earth?
7. If you compress geologic time into a single year, how much time has elapsed since Columbus arrived in the New World?

## 1.3 Early Evolution of Earth

- Origin of Earth
  - Most researchers believe that Earth and the other planets formed at essentially the same time
- Nebular theory
  - Solar system evolved from an enormous rotating cloud called the solar nebula
  - Nebula was composed mostly of hydrogen and helium
  - About 5 billion years ago the nebula began to contract
  - Assumes a flat, disk shape with the protosun (pre-Sun) at the center
  - Inner planets begin to form from metallic and rocky clumps
  - Larger outer planets began forming from fragments with a high percentage of ices

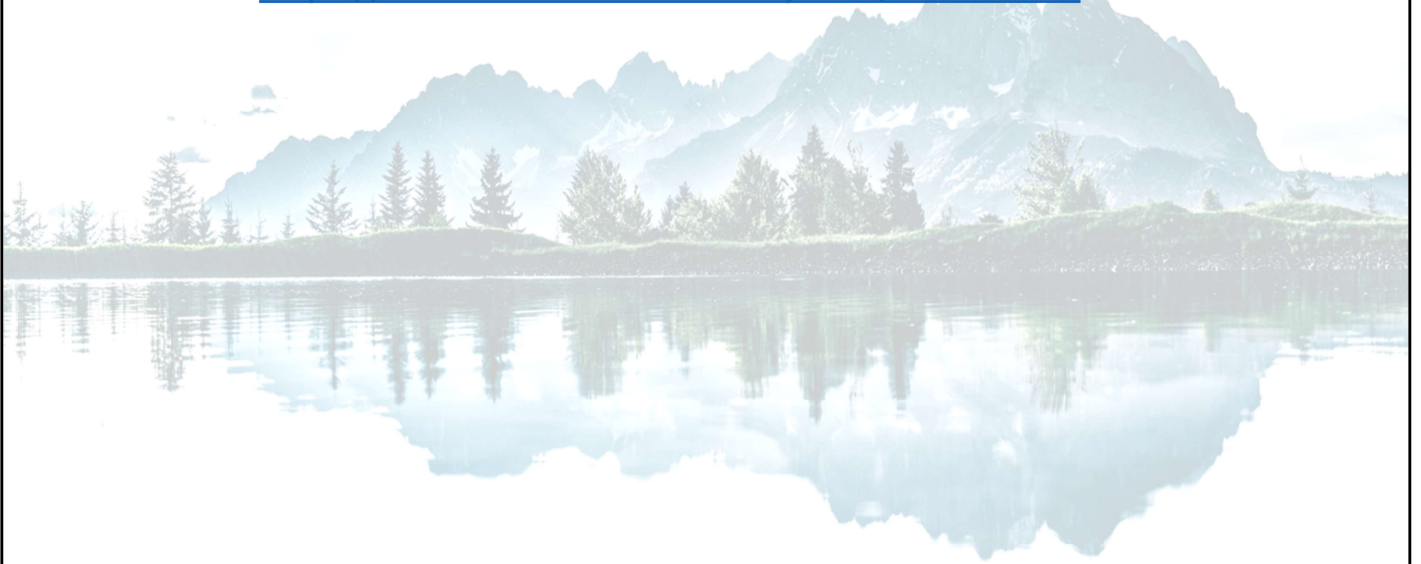
# The Nebular Theory





# The Nebular Theory

- <https://macearthscience.weebly.com/unit-ii.html>



17

- Click link, watch movie.

## Check Questions 1.3

1. Name and briefly outline the theory that describes the formation of our solar system.
2. List the inner planets and the outer planets. Describe basic differences in size and composition.

## 1.4 Early Evolution of Earth

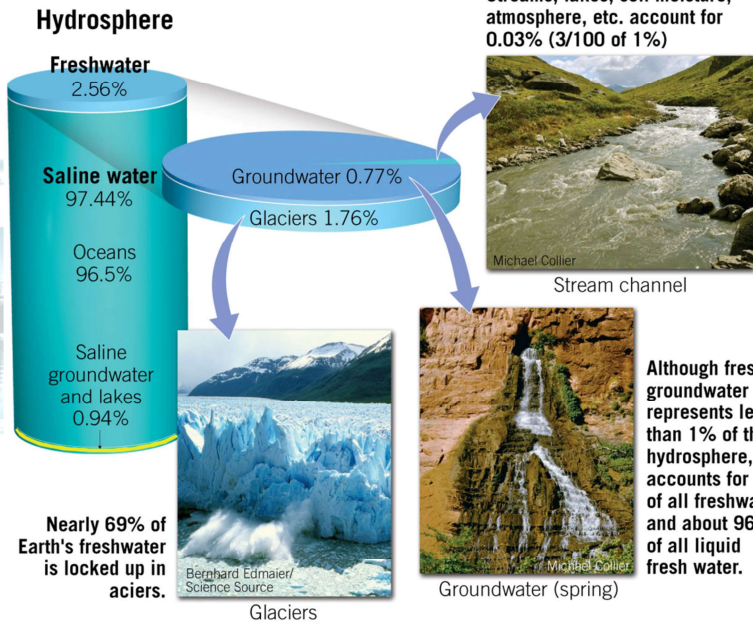
- Formation of Earth's layered structure
  - As Earth formed, the decay of radioactive elements and heat from high-velocity impacts caused the temperature to increase
    - Iron and nickel began to melt and sink toward the center
    - Lighter rocky components floated outward, toward the surface
  - Gaseous material escaped from Earth's interior to produce the primitive atmosphere

# Earth's Spheres

- **Hydrosphere**

- Ocean – the most prominent feature of the hydrosphere
  - Nearly 71 percent of Earth's surface
  - About 97 percent of Earth's water
- Also includes fresh water found in streams, lakes, and glaciers, as well as that found underground

# Hydrosphere

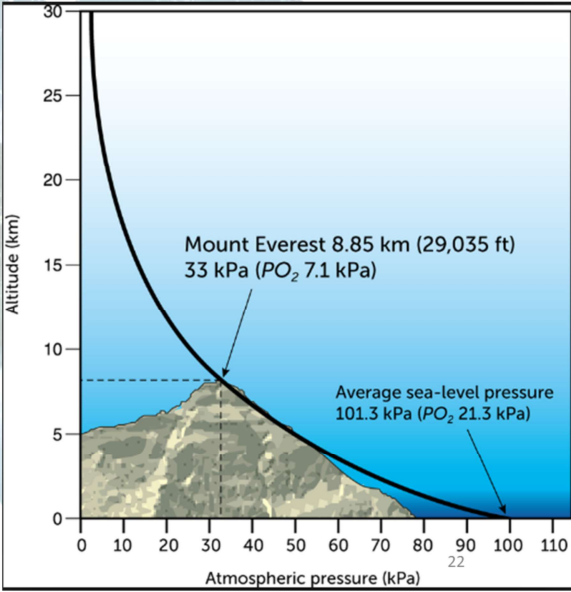


21

- Know the relative proportions of the water sources.

# Earth's Spheres

- Atmosphere
  - Thin, tenuous blanket of air
  - One half lies below 5.6 kilometers (3.5 miles)



## Earth's Spheres



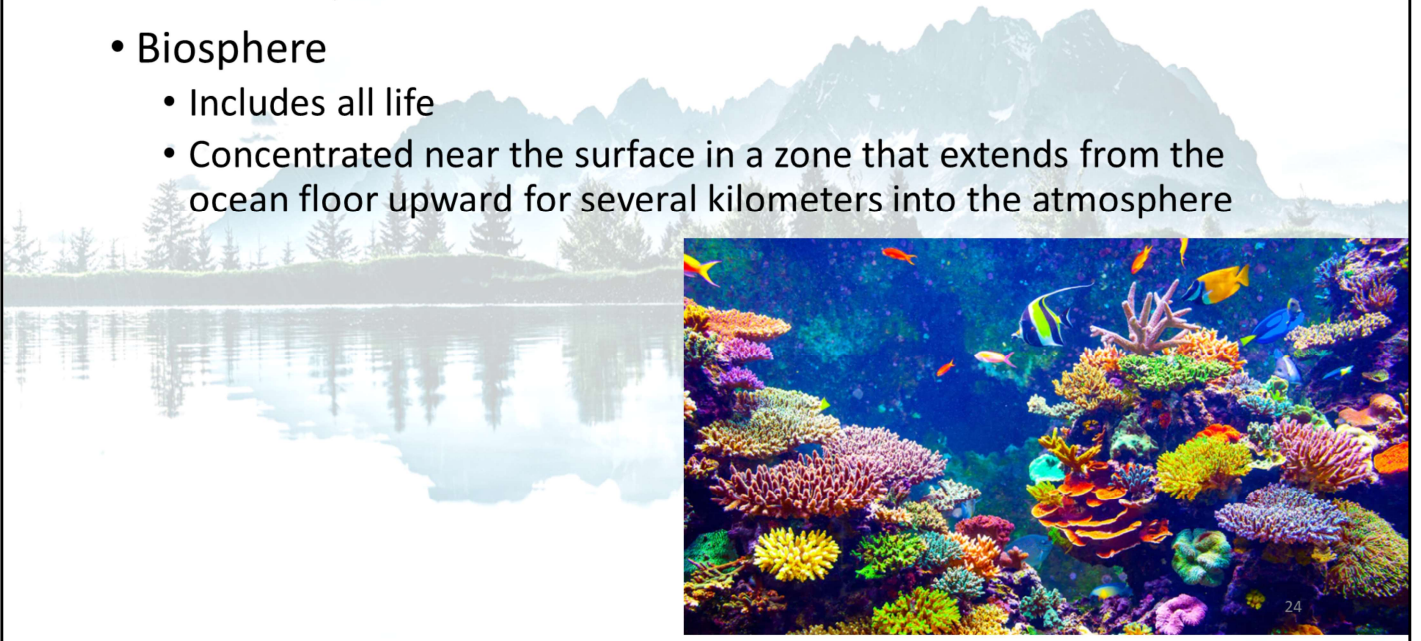
23

- This photo shows the thinness of our atmosphere.

# Earth's Spheres

- Biosphere

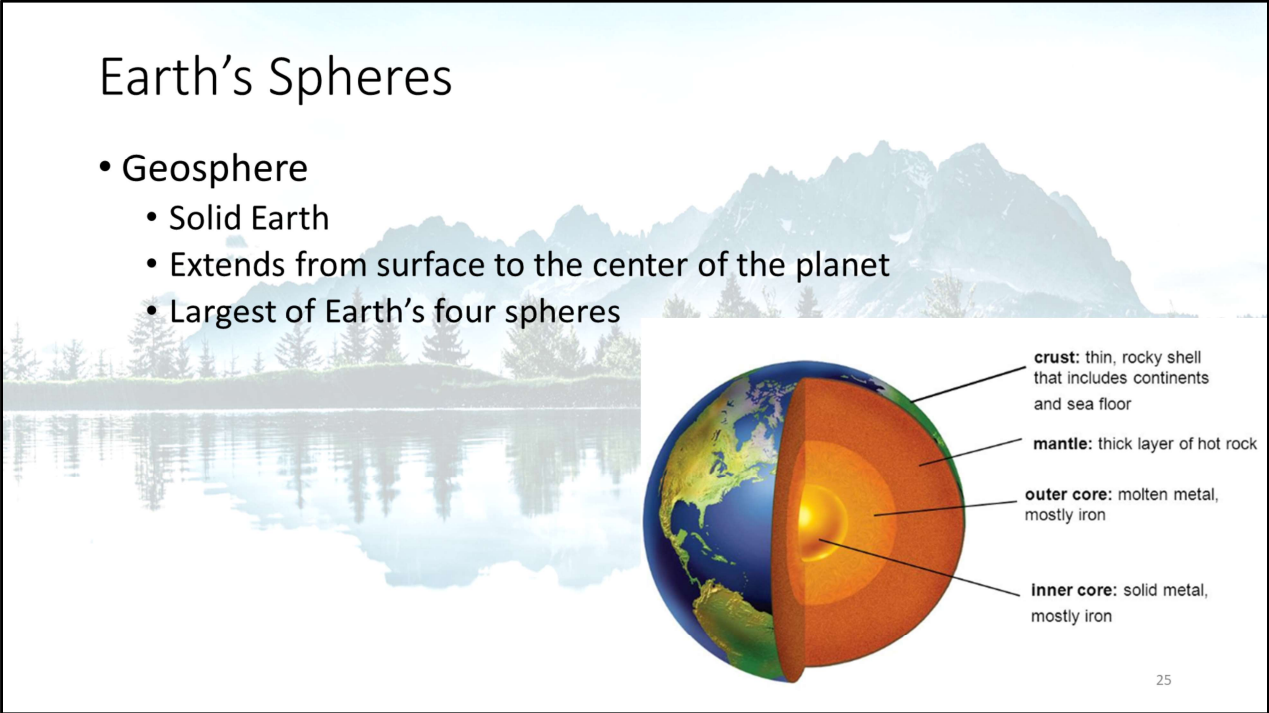
- Includes all life
- Concentrated near the surface in a zone that extends from the ocean floor upward for several kilometers into the atmosphere





# Earth's Spheres

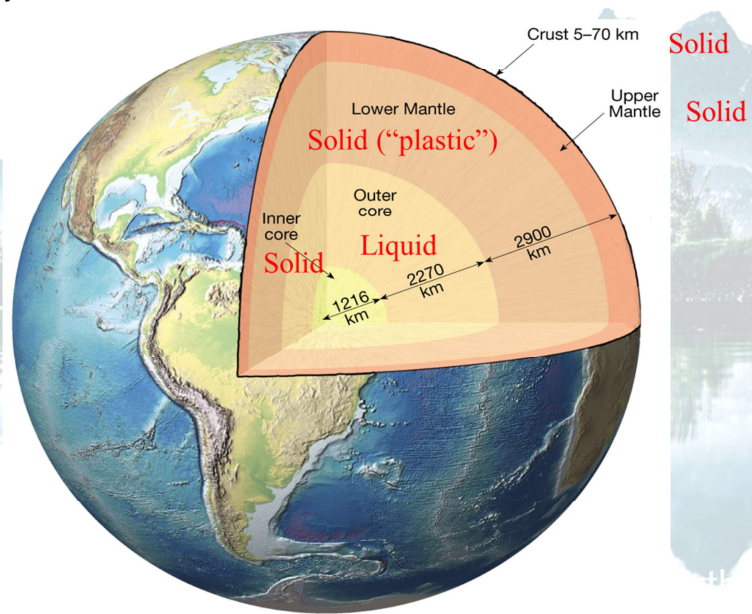
- Geosphere
  - Solid Earth
  - Extends from surface to the center of the planet
  - Largest of Earth's four spheres



## Check Questions 1.4

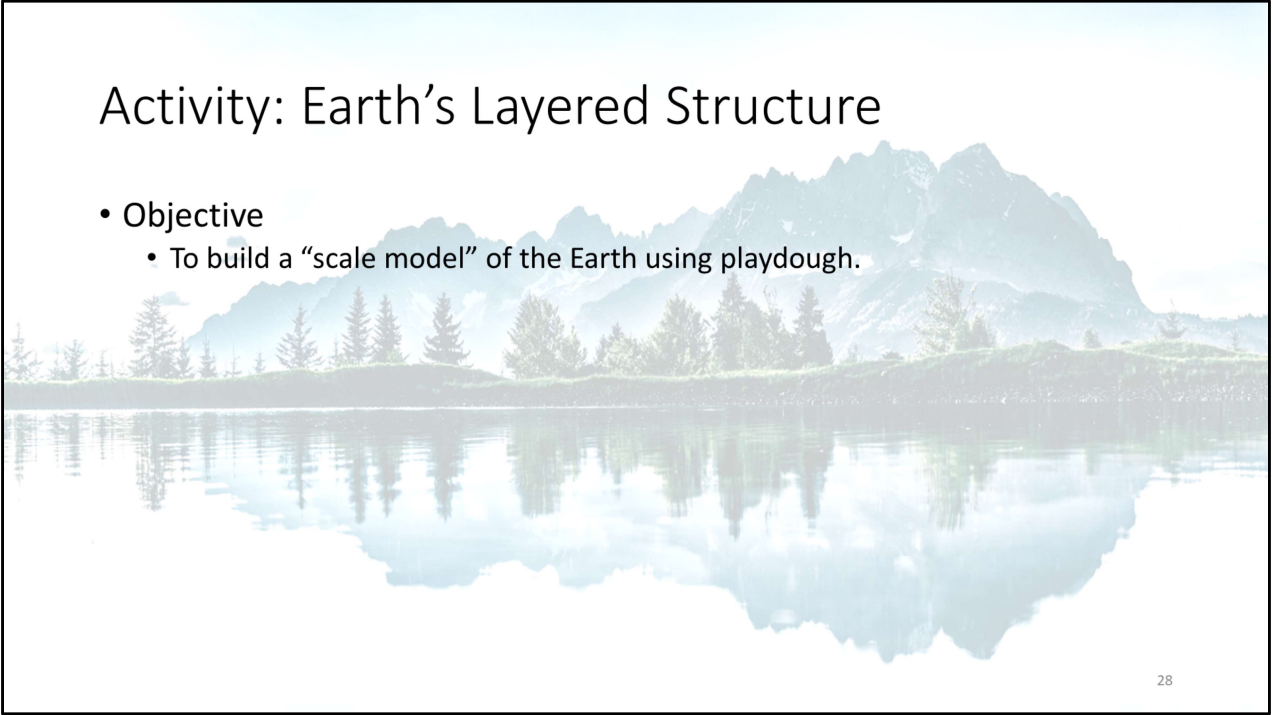
1. List Earth's four spheres.
2. Compare the height of the atmosphere to the thickness of the geosphere.
3. How much of Earth's surface do oceans cover? How much of the planet's total water supply do oceans represent?
4. To which sphere does **soil** belong?

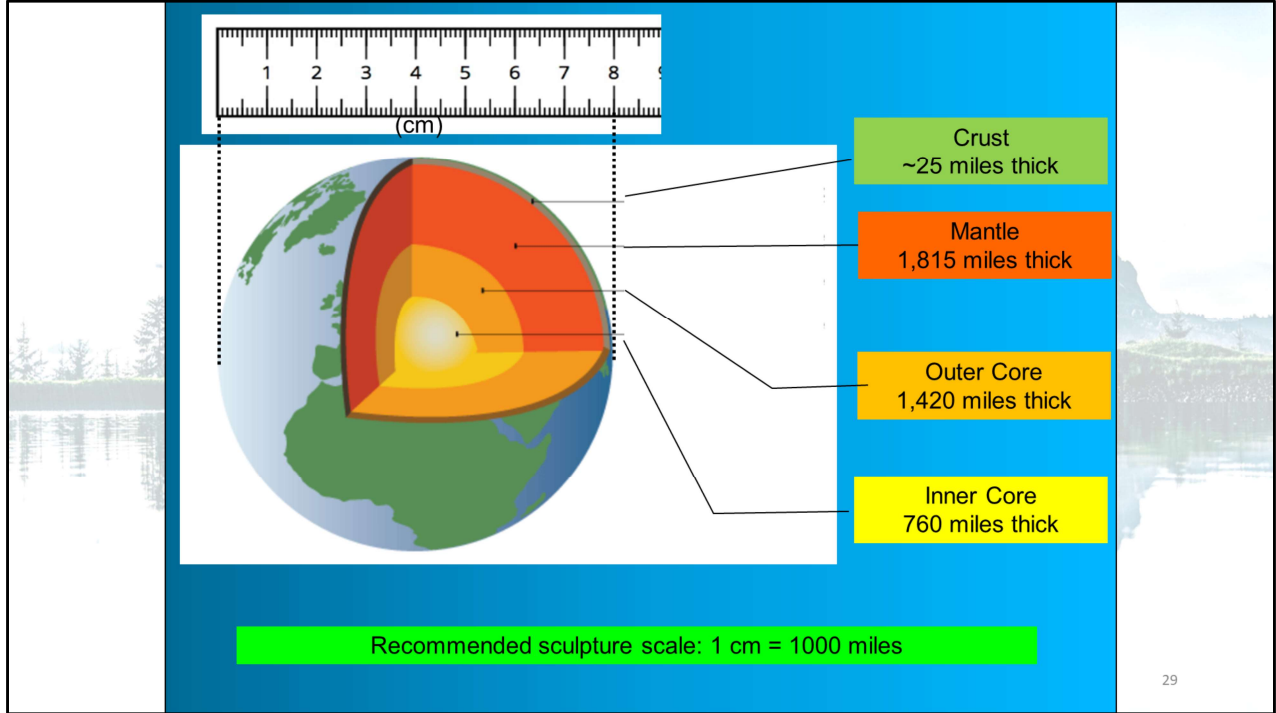
# Earth's layered structure



## Activity: Earth's Layered Structure

- Objective
  - To build a “scale model” of the Earth using playdough.



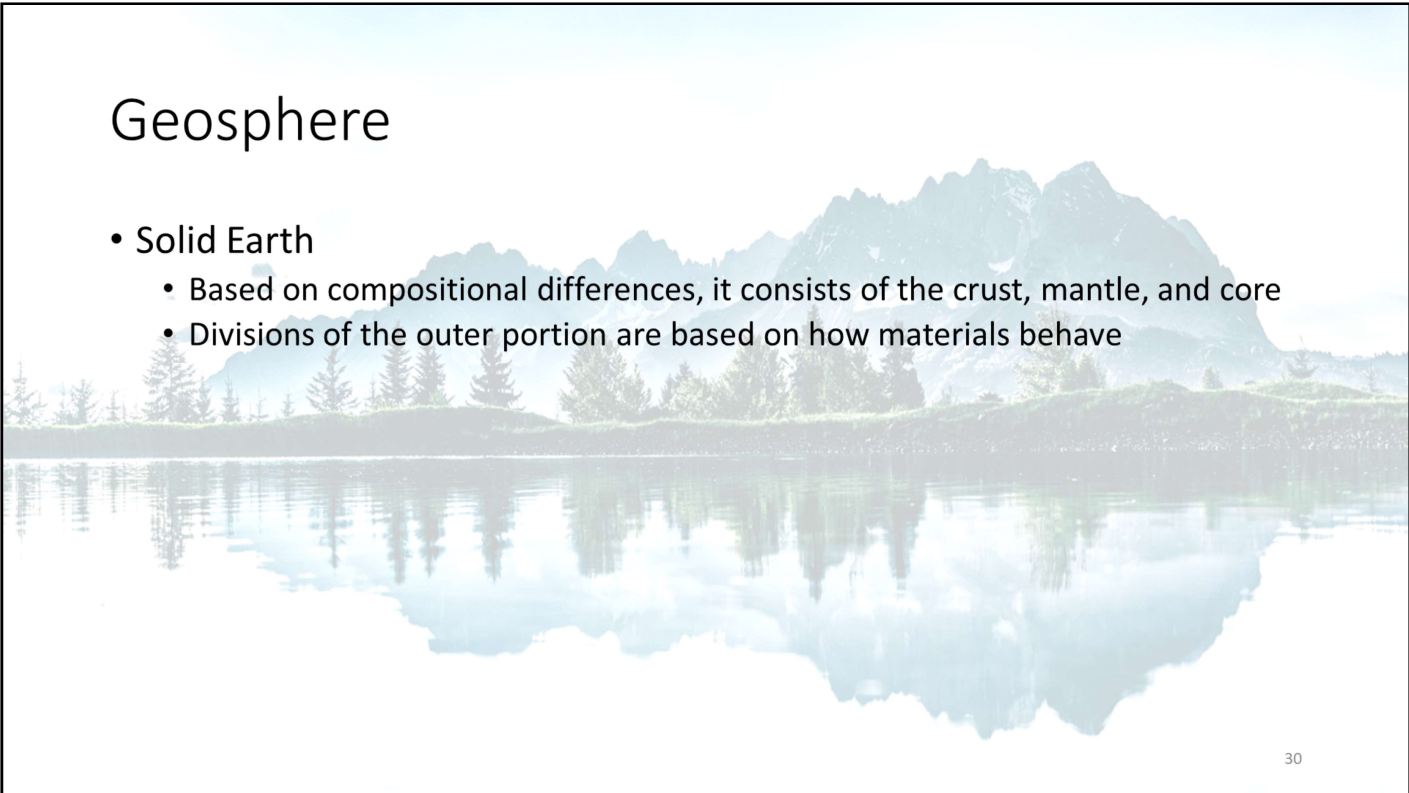


- This slide part of the activity

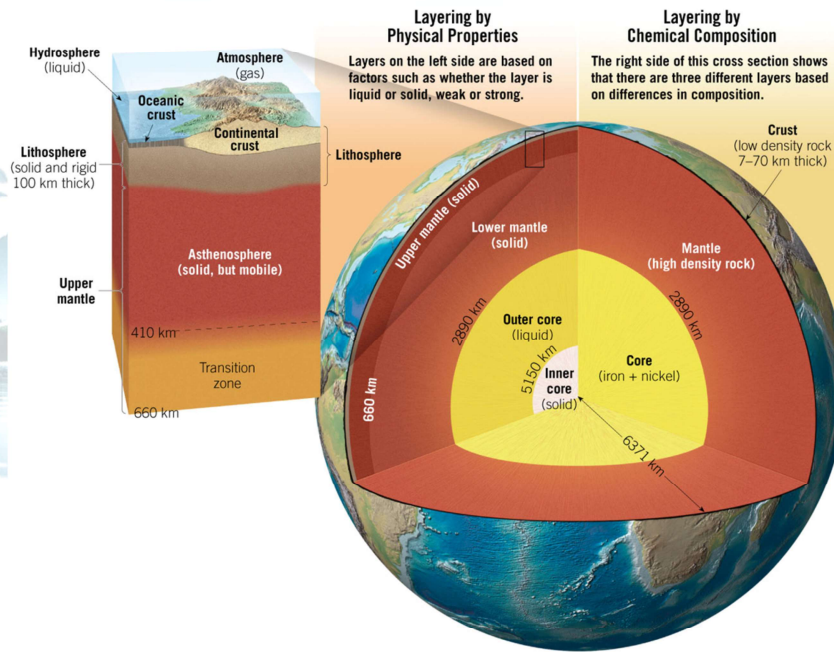
# Geosphere

- Solid Earth

- Based on compositional differences, it consists of the crust, mantle, and core
- Divisions of the outer portion are based on how materials behave

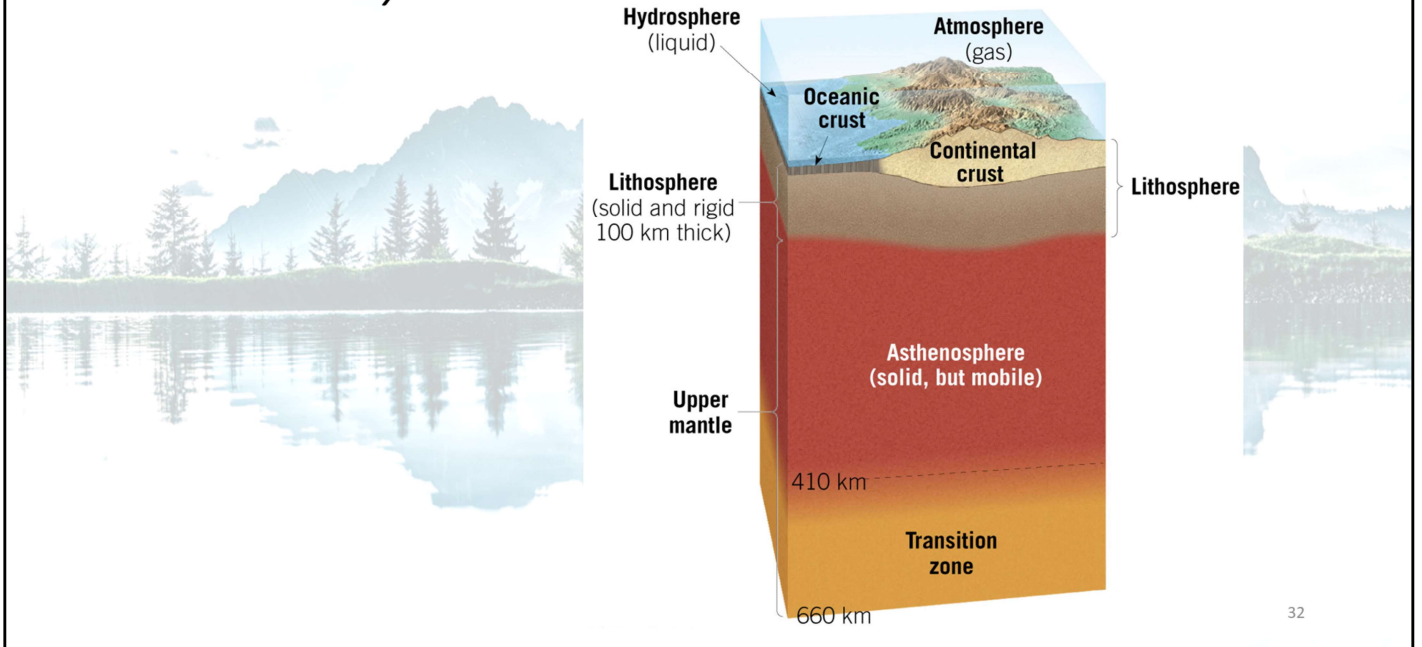


# Earth's Layered Structure



# Earth's Layered Structure

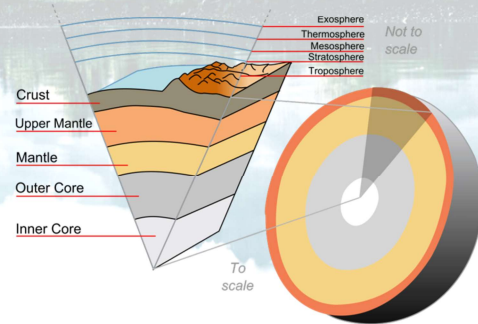
## Earth's layered structure





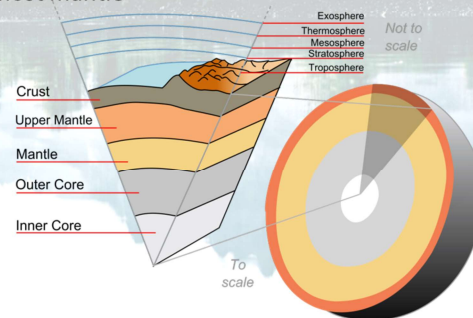
# Geosphere

- Crust
  - Earth's relatively thin, rocky outer skin
  - Continental crust
    - Less dense, many rock types
    - Granitic
  - Oceanic crust
    - Dense, basaltic rock



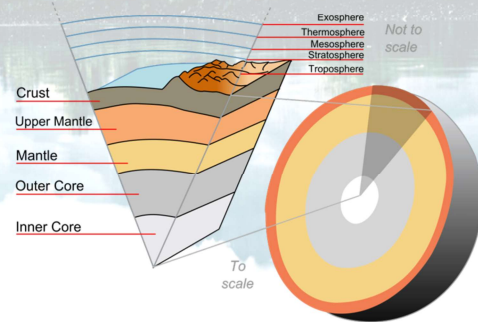
# Geosphere

- Mantle
  - Solid, rocky shell
  - More than 82 percent of Earth's volume
- Upper mantle
  - Lithosphere – entire crust and uppermost mantle
  - Asthenosphere – relatively soft layer
- Lower mantle
  - Very hot, strengthens with depth



# Geosphere

- Core
  - Iron-nickel alloy
- Outer core
  - Liquid layer
  - Earth's magnetic field
- Inner core
  - Solid





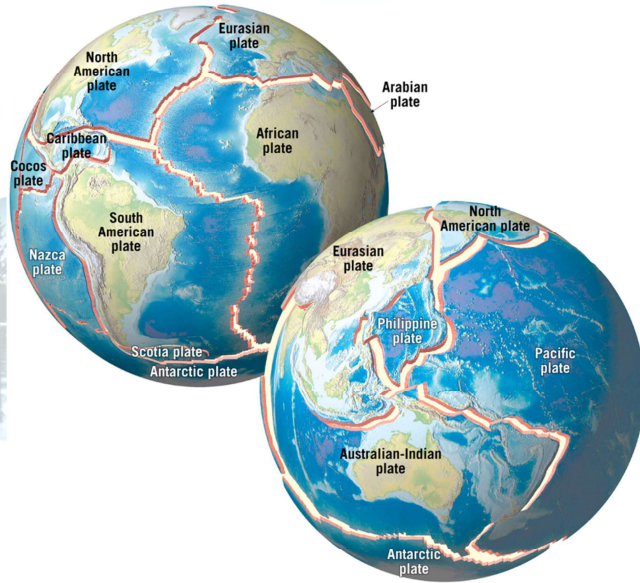
- Turning Point slides removed.

# The Mobile Geosphere

- Plate tectonics
  - Earth's lithosphere is broken into slabs (lithospheric plates) that are in continuous motion.



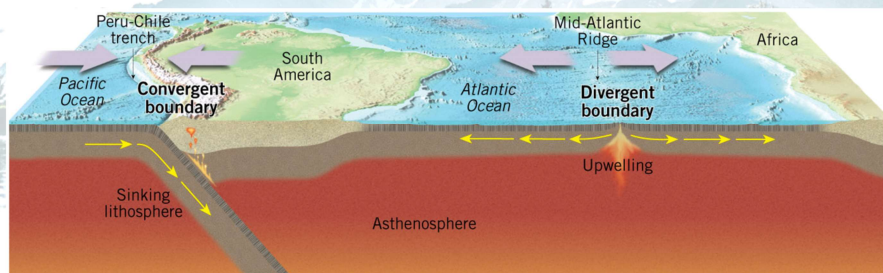
# Earth's Major Lithospheric Plates



# Plate Motion

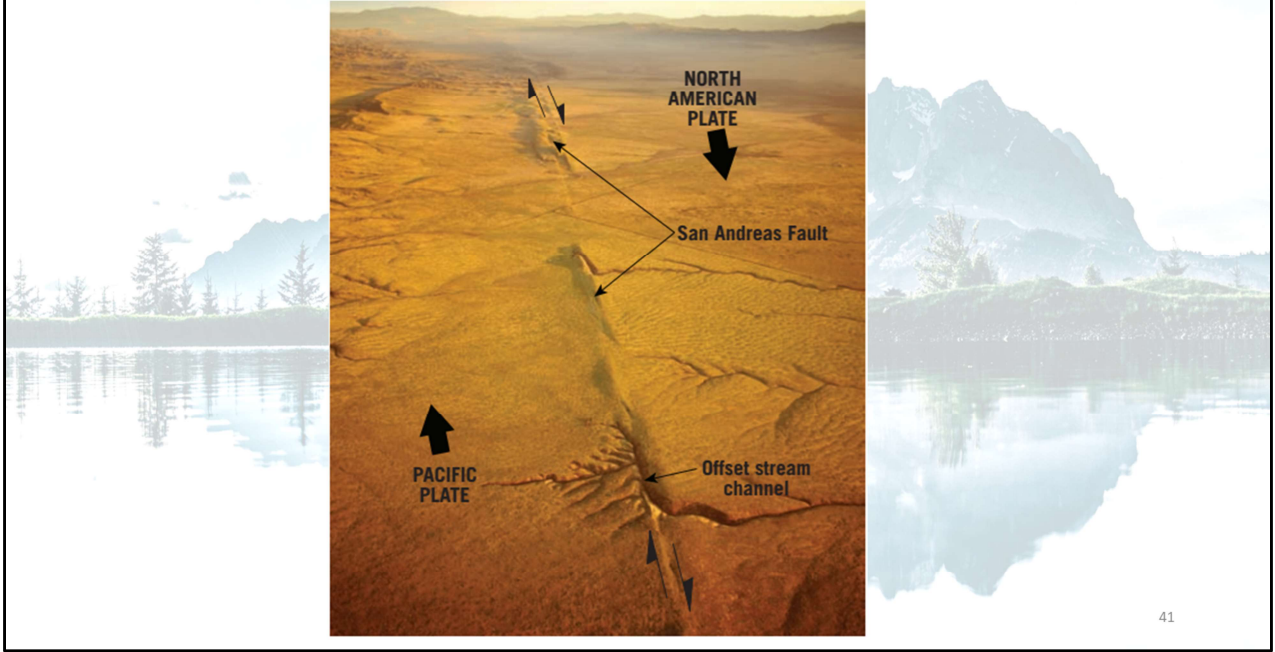
- Plates move very slowly
- Three types of plate boundaries
  - Divergent – plates pull apart
  - Convergent – plates move together
  - Transform fault – plates slide past each other

# Convergent and Divergent Boundaries





# Transform Boundary



## The Face of Earth

- Continents
  - Flat features that average 0.8 km (0.5 mi) in elevation
  - Granitic rocks
- Ocean basins
  - Average 3.8 km (2.8 mi) below sea level
  - Basaltic rocks

## Major Features of Continents

- Mountain Belts
  - Principally the circum-Pacific belt and the Alps/Himalayas
- Stable Interior
  - Shields – expansive, flat regions of deformed crystalline rock
  - Stable platforms – deformed rocks covered by sedimentary rocks.

# The Continents

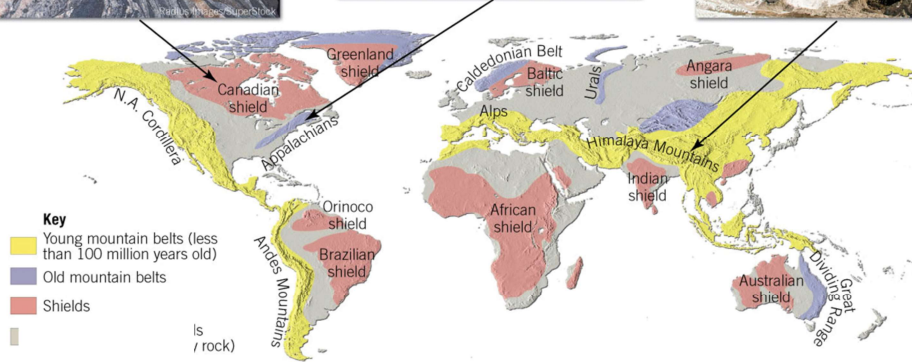
The Canadian shield is an expansive region of ancient Precambrian rocks, some more than 4 billion years old. It was recently scoured by Ice Age glaciers.



The Appalachians are old mountains. Mountain building began about 480 million years ago and continued for more than 200 million years. Erosion has lowered these once lofty peaks.



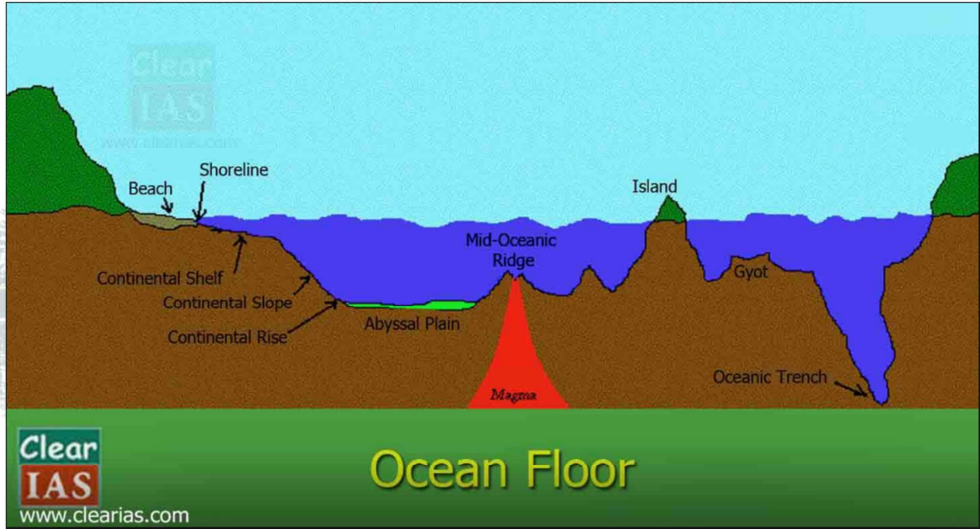
The rugged Himalayas are the highest mountains on Earth and are geologically young. They began forming about 50 million years ago and uplift continues today.



## Major Features of Ocean Basins

- Continental Margins
- Deep-Ocean Basins
- Oceanic Ridge





## Major Features of Ocean Basins

- Deep-Ocean Basins
  - Between continental margins and oceanic ridges
  - Abyssal plains – flat features of deep-ocean basins
  - Deep-ocean trenches – deep depressions in ocean floor
  - Seamounts – submerged volcanic structures

## Major Features of Ocean Basins

- **Oceanic Ridge**
  - Also called mid-ocean ridge
  - Includes Mid-Atlantic Ridge and East Pacific Rise
  - Continuous mountain belt that winds around globe
  - Many layers of igneous rock



# Earth as a System

- Earth is a dynamic body with many separate but highly interacting parts or spheres
- Earth system science studies Earth as a system composed of numerous parts, or subsystems
- System – any size group of interacting parts that form a complex whole

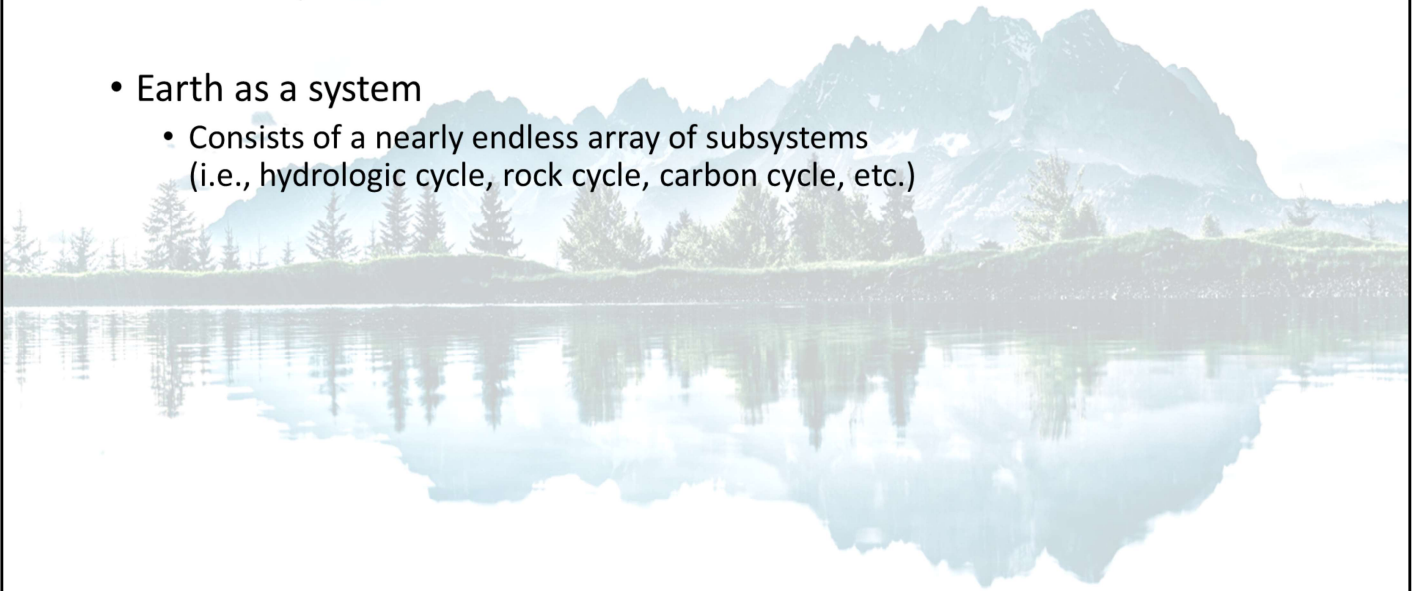
# Earth as a System

- System

- Closed systems are self-contained (e.g., an automobile cooling system)
- Open systems – both energy and matter flow into and out of the system (e.g., a river system)

# Earth System Science

- Earth as a system
  - Consists of a nearly endless array of subsystems (i.e., hydrologic cycle, rock cycle, carbon cycle, etc.)



# Earth System Science



- Earth as a system
  - Sources of energy
    - Sun – drives external processes such as weather, ocean circulation, and erosional processes
    - Earth's interior – drives internal processes including volcanoes, earthquakes, and mountain building
  - Humans are part of the Earth system

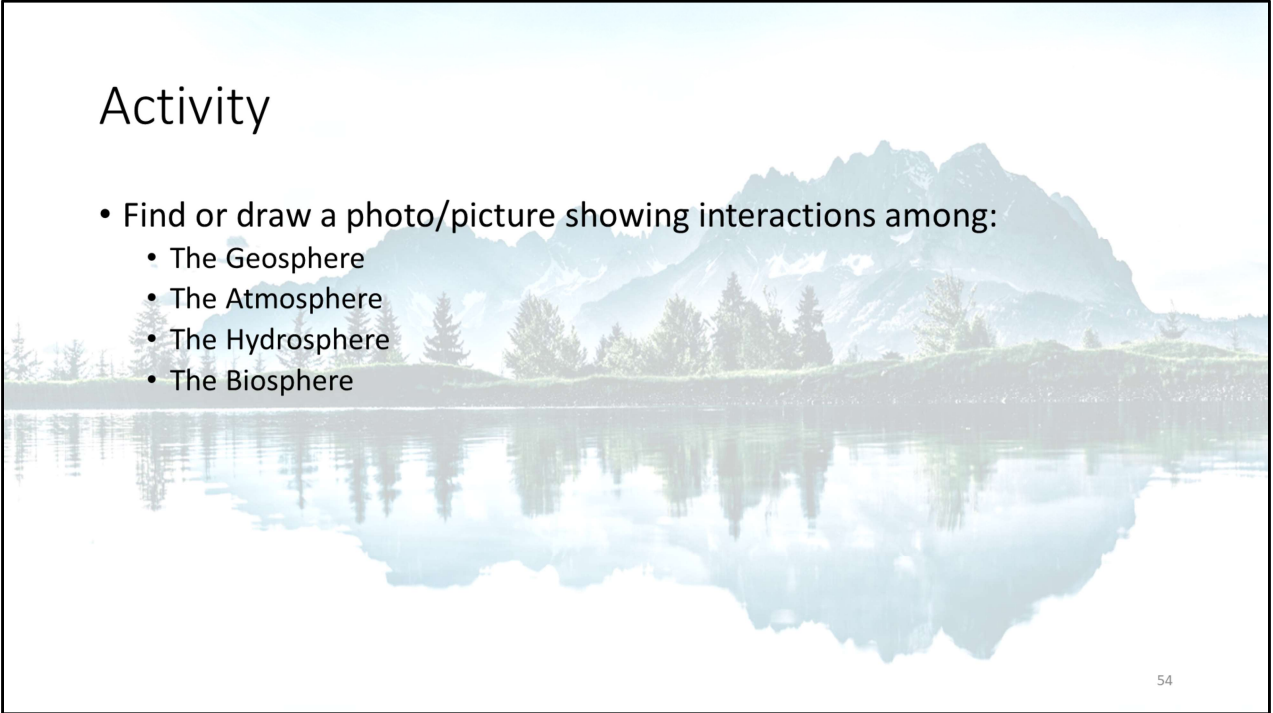
## Interaction among Earth's Spheres



53

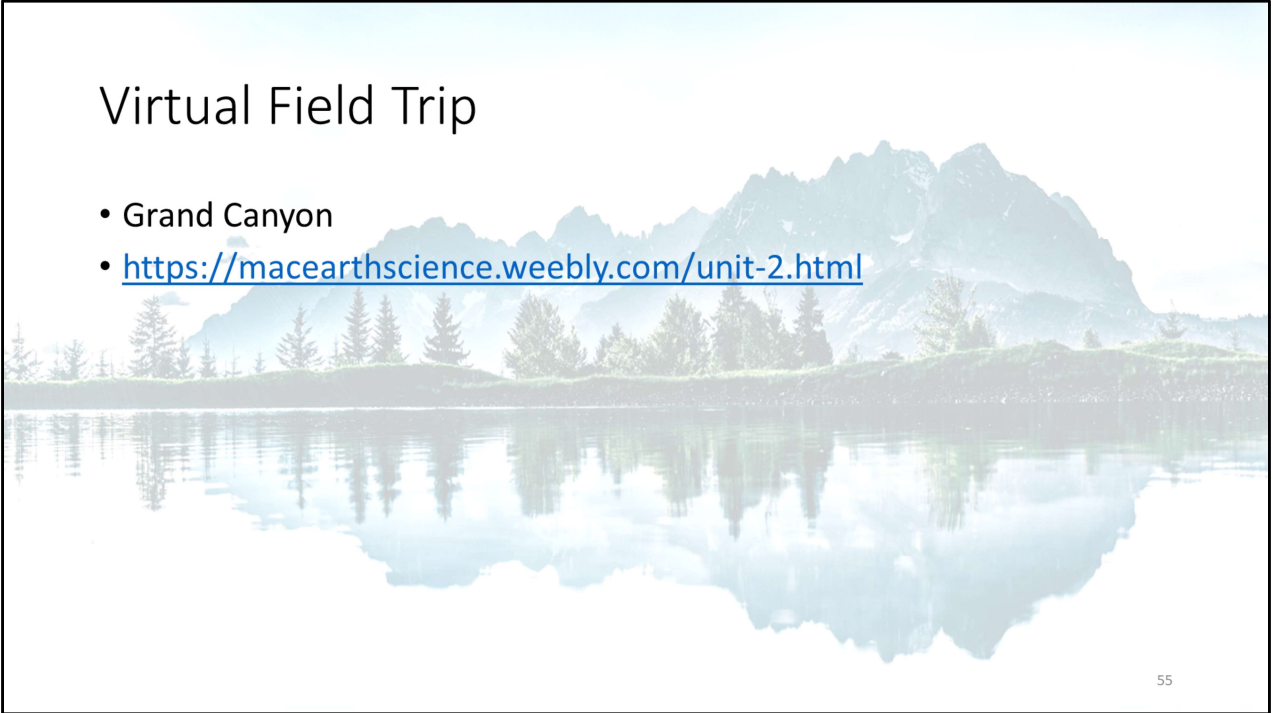
## Activity

- Find or draw a photo/picture showing interactions among:
  - The Geosphere
  - The Atmosphere
  - The Hydrosphere
  - The Biosphere



## Virtual Field Trip

- Grand Canyon
- <https://macearthscience.weebly.com/unit-2.html>





- South rim of Grand Canyon. October, 2017.





- Turning Point Slides removed.