PLATE TECTONICS

Unit Overview

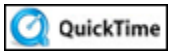
In this unit we will learn about what the continents sit on and how they move. We will also explore the process on how many of earth's landforms are created and how the rock cycle connects to all of these processes.

Earthquakes and Volcanic Eruptions

On May 18, 1980, Mount St. Helens, in the state of Washington, erupted explosively sending tons of volcanic ash and dust into the air and causing massive destruction in its path. Hot ash and rocks started forest fires and melted the snow on the upper slopes of the mountain side. This caused floods and mud slides that wiped out buildings and roadways. The explosion flattened millions of trees, scattering them like toothpicks. The volcanic ash fell from the sky and formed thick layers over a wide area many miles away. This destroyed crops and wildlife while blanketing homes, businesses and roads with a fine, choking dust that took weeks to haul away. In all, 57 people died and millions of dollars of damage was done to the surrounding area.

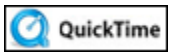
In the late afternoon of October 17, 1989, the fans and players of the San Francisco Giants and Oakland A's were preparing for the start of a World Series game to be held at Candlestick Park in San Francisco when a massive earthquake struck the area. As the shock waves of the quake rippled through

the crust, the ground rose and fell like waves in an ocean. Buildings cracked, some fell and fires broke out as underground gas mains exploded. The death toll reached 43, with most of the casualties occurring when a large portion of the nearby double-decker freeway collapsed. The earthquake also caused millions of dollars of property damage including sufficient damage to Candlestick Park so that the World Series games had to be scheduled elsewhere.

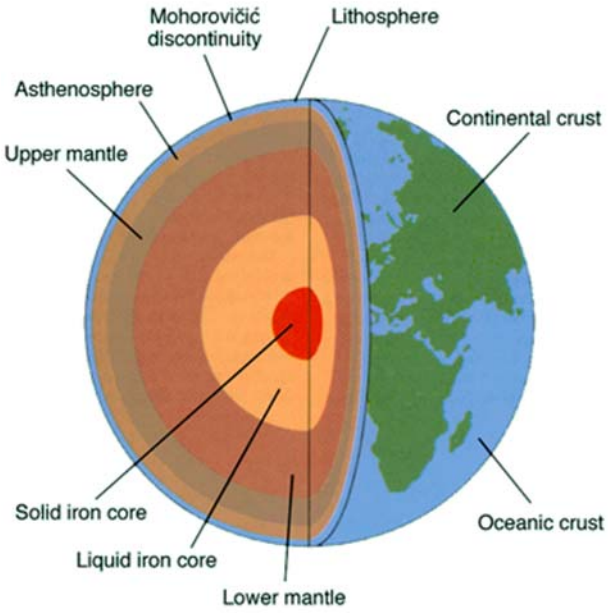


What Is It Like Below the Surface of the Earth? (01:17)

Both earthquakes and volcanic eruptions occur because the outer shell of the earth is broken into 30 large, rigid sections called **TECTONIC PLATES.** These plates vary in size. The continents are embedded in the tops of these plates, and some plates carry both continents and ocean floor. There are continental plates and oceanic plates. The continental plates are made of light continental crust. Oceanic plates are made of very dense oceanic crust. All of the tectonic plates make up the earth's **LITHOSPHERE.** A layer of molten rock at temperatures between 2400^{o}F and 3600^{o}F under the plates is called the **ASTHENOSPHERE.**



What Are the Lithosphere and the Asthenosphere? (01:17)



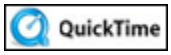
As the plates move on the asthenosphere they interact with each other at their boundaries. There are three types of boundaries. The first boundary type is **CONVERGENT.** This is when one edge of a plate sinks under the edge of a neighboring plate. This process is called **SUBDUCTION.**

QuickTime What Is Plate Tectonics? (00:50)

The second boundary type is **DIVERGENT.** Here, plates separate away from each other and new lithosphere forms. When this separation occurs on continents, it is called **RIFTING** and creates gaps into which water flows to form major waterways like rivers and lakes. When rifting occurs on the ocean floor, it is referred to as **SEA-FLOOR SPREADING.** Scientists have measured as much as one square mile of new ocean crust per year from this process. Since the overall size of the lithosphere has not increased, scientists' reason that the same amount of crust is destroyed at **SUBDUCTION ZONES** as is formed by rifting. Earthquakes and volcanoes occur at both of these types of boundaries.

The third boundary type is called a **TRANSFORM PLATE BOUNDARY.** Plates slide horizontally against each other, neither creating nor destroying

lithosphere. This sliding motion is very slow and continuous. Tremendous pressures build up in these regions and sometimes “snap” releasing enormous amounts of stored energy through the crust. Powerful earthquakes, like the ones described earlier in the lesson, occur along these plate boundaries also called **FAULTS.** The transform fault in California is known as the **SAN ANDREAS FAULT.**



In What Ways Do the Major Plates Move? (01:25)

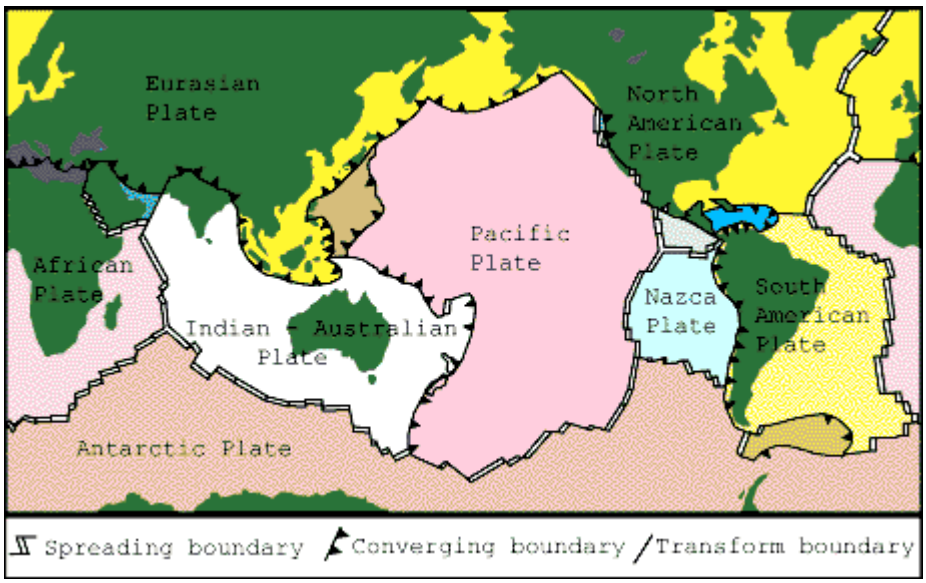
Developments in technology over the last 100+ years have produced devices to provide better detection of the earth’s movements. In 1893, John Milne invented a **SEISMOGRAPH** to detect and measure seismic waves, the waves of energy that ripple through the crust during an earthquake. The record of waves, called **SEISMOGRAMS,** is used to calculate the strength of an earthquake. Charles Richter, an American seismologist, developed a scale in 1935 to rank the magnitude of the strength of an earthquake. Each number on this scale represents ground motion ten times greater than the

next lower number. The highest recorded magnitude of an earthquake was as 8.3 on the **RICHTER SCALE.**

QuickTime How Does Plate Movement Generate Earthquakes? (01:43)

Laser beams have also been used to accurately measure the movements along a fault. The amount of time it takes for a laser beam to strike a reflector and bounce back can detect subtle movements of the crust. Scientists use this data along with observations of water levels in wells, changes in the tilt of the earth's surface and even changes in animal behavior to predict earthquake and volcanic activity. Better detection methods will allow for better warning systems to save lives and property.

QuickTime How Does Plate Movement Generate Volcanoes? (01:01)

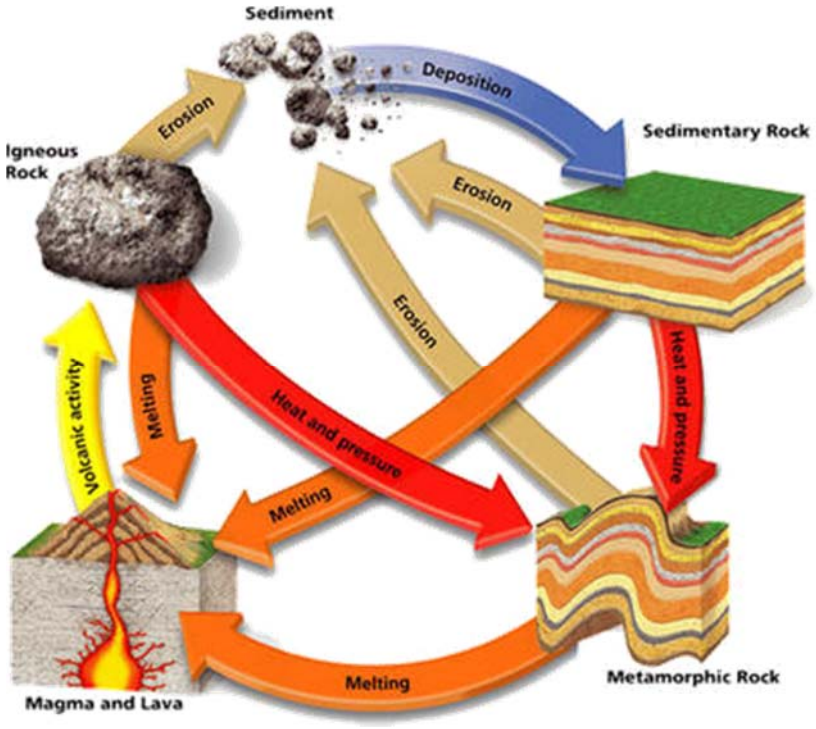


Based on a map prepared by the U.S. Geological Survey.

The outer surface of the earth is made of 12 major plates and several smaller plates. These plates move towards each other (convergent boundaries), away from each other (spreading or divergent boundaries) or slide past each other (transform boundaries). Volcanoes are associated with convergent boundaries, where ocean plates are subducted under ocean or continental

plates, with spreading boundaries, where new ocean plates are created, and with hot spots.

The **ROCK CYCLE** is how rock can change throughout earth's crust. Throughout all the boundaries and types of movements through tectonic plates you can see rock in all its forms. Since it is a cycle we can start anywhere. Although it is circular, it has many paths. Let's start with **IGNEOUS ROCK.** This type of rock is formed when magma is cooled or when magma **CRYSTALIZES.** You can see all the minerals it is made up of. Igneous rock can then be eroded into sediments, and then the sediments packed down to form sedimentary rock. **SEDIMENTARY ROCK** is compressed sediment; you can see the lines of the different types of sediment. An example of sedimentary rock is sand stone. Sedimentary rock can be eroded and be converted back to sediments. When sedimentary rock is under heat and pressure, which is called **METAMORPHISM,** it changes to metamorphic rock. **METAMORPHIC ROCK** contains the same minerals as sedimentary rock; the heat a pressure just changes the look of the rock. Metamorphic rock can be eroded just all the other types of rock. When metamorphic rock will eventually melt and become magma. Once that magma cools it becomes igneous rock and the cycle continues.



Matter, Minerals, and Rocks: The Rock Cycle (06:14)

For additional information on Plate Tectonics, view the PDF documents below:

What is a Tectonic Plate?
What is a Theory?
Developing the Theory
Inside the Earth
Magnetic Striping
Seafloor Spreading
Earthquakes and Volcanoes
North American Continent
Plate Tectonics and People

To view images of volcanoes by regions, click on the following link http://volcano.und.nodak.edu/vwdocs/volc_images/volc_images.html and/or to view the Home Page, click on the PDF File.

Now answer questions 1 through 20.