Unit: II

Origin of Continents and Oceans: Continental Drift Theory – Plate Tectonics- Isostasy

Origin of Continents and Oceans:

A continent is one of Earth's seven main divisions of land. The continents are, from largest to smallest: Asia, Africa, North America, South America, Antarctica, Europe, and Australia. Together, the continents add up to about 148 million square kilometers of land.

Building the Continents

The Earth formed 4.6 billion years ago from a great, swirling cloud of dust and gas. The continuous smashing of space debris and the pull of gravity made the inside of Earth heat up. As the heat increased, some of Earth's rocky materials melted and rose to the surface, where they cooled and formed a crust. Heavier material sank toward Earth's center. Eventually, the earth came to have three main layers: the core, the mantle, and the crust.

The crust and the top portion of the mantle form a rigid shell around the earth that is broken up into huge sections called tectonic plates. The heat from inside the earth causes the plates to slide around on the molten mantle. Today, tectonic plates continue to slowly slide around the surface, just as they have been doing for hundreds of millions of years. Geologists believe the interaction of the plates, a process called plate tectonics, contributed to the creation of continents.

The ocean covers 70 percent of the Earth's surface. It contains about 1.35 billion cubic kilometers (324 million cubic miles) of water, which is about 97 percent of all the water on Earth. The ocean makes all life on Earth possible, and makes the planet appear blue when viewed from space. Earth is the only planet in our solar system that is definitely known to contain liquid water.

Although the ocean is one continuous body of water, oceanographers have divided it into four principal areas: the Pacific, Atlantic, Indian, and Arctic Oceans. The Atlantic, Indian, and Pacific Oceans merge into icy waters around Antarctica. Some oceanographers define this as a fifth ocean, most commonly called the Southern Ocean.

Ocean Formation

After the Earth began to form about 4.6 billion years ago, it gradually separated into layers of lighter and heavier rock. The lighter rock rose and formed the Earth's crust. The heavier rock sank and formed the Earth's core and mantle.

The ocean's water came from rocks inside the newly forming Earth. As the molten rocks cooled, they released water vapor and other gases. Eventually, the water vapor condensed and covered the crust with a primitive ocean. Today, hot gases from the Earth's interior continue to produce new water at the bottom of the ocean.

Continental Drift Theory:

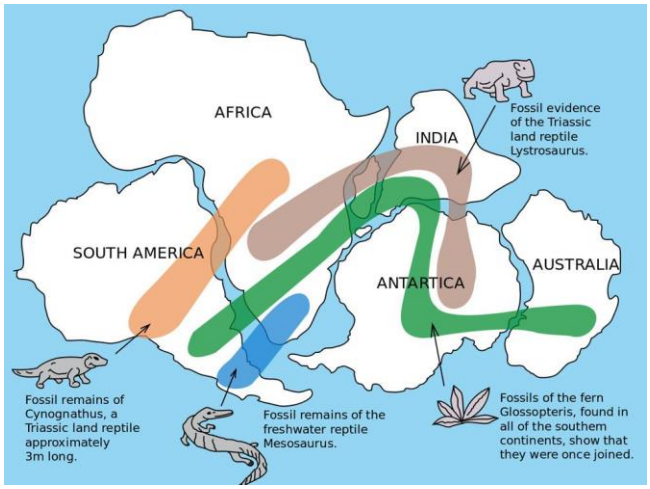
Continental drift describes one of the earliest ways geologists thought continents moved over time. Today, the theory of continental drift has been replaced by the science of plate tectonics.

The theory of continental drift is most associated with the scientist Alfred Wegener. In the early 20th century, Wegener published a paper explaining his theory that the continental landmasses were "drifting" across the Earth, sometimes plowing through oceans and into each other. He called this movement continental drift.

Pangaea

Wegener was convinced that all of Earth's continents were once part of an enormous, single landmass called Pangaea.

Wegener, trained as an astronomer, used biology, botany, and geology describe Pangaea and continental drift. For example, fossils of the ancient reptile mesosaurus are only found in southern Africa and South America. Mesosaurus, a freshwater reptile only one meter (3.3 feet) long, could not have swum the Atlantic Ocean. The presence of mesosaurus suggests a single habitat with many lakes and rivers.



Wegener also studied plant fossils from the frigid Arctic archipelago of Svalbard, Norway. These plants were not the hardy specimens adapted to survive in the Arctic climate. These fossils were of tropical plants, which are adapted to a much warmer, more humid environment. The presence of these fossils suggests Svalbard once had a tropical climate.

Finally, Wegener studied the stratigraphy of different rocks and mountain ranges. The east coast of South America and the west coast of Africa seem to fit together like pieces of a jigsaw puzzle, and Wegener discovered their rock layers "fit" just as clearly. South America and Africa were not the only continents with similar geology. Wegener discovered that the Appalachian Mountains of the eastern United States, for instance, were geologically related to the Caledonian Mountains of Scotland.

Plate Tectonics:

Before the Tharp-Heezen map of the seafloor was published in 1977, scientists had little understanding of the geological features that characterized the seafloor, especially on a global scale. The data and observations represented by the Tharp-Heezen map became crucial factors in the acceptance of the theories of plate tectonics and continental drift. The theory of plate tectonics states that the Earth's solid outer crust, the lithosphere, is separated into plates that move over the asthenosphere, the molten upper portion of the mantle. Oceanic and continental plates come together, spread apart, and interact at boundaries all over the planet.

Each type of plate boundary generates distinct geologic processes and landforms. At divergent boundaries, plates separate, forming a narrow rift valley. Here, geysers spurt super-heated water, and magma, or molten rock, rises from the mantle and solidifies into basalt,

forming new crust. Thus, at divergent boundaries, oceanic crust is created. The mid-ocean ridge, the Earth's longest mountain range, is a 65,000 kilometers (40,390 miles) long and 1,500 kilometers (932 miles) wide divergent boundary. In Iceland, one of the most geologically active locations on Earth, the divergence of the North American and Eurasian plates along the Mid-Atlantic Ridge can be observed as the ridge rises above sea level.

At convergent boundaries, plates collide with one another. The collision buckles the edge of one or both plates, creating a mountain range or subducting one of the plates under the other, creating a deep seafloor trench. At convergent boundaries, continental crust is created and oceanic crust is destroyed as it subducts, melts, and becomes magma. Convergent plate movement also creates earthquakes and often forms chains of volcanoes. The highest mountain range above sea level, the Himalayas, was formed 55 million years ago when the Eurasian and Indo-Australian continental plates converged. The Mediterranean island of Cyprus formed at a convergent boundary between the African and Eurasian plates. Hardened mounds of lava, called pillow lavas, were once on the bottom of the ocean where this convergence occurred, but have been pushed up and are now visible at the surface.

Isostasy:

Earth's layers constantly interact with each other, and the crust and upper portion of the mantle are part of a single geologic unit called the lithosphere. The lithosphere's depth varies, and the Mohorovicic discontinuity (the Moho)—the boundary between the mantle and crust—does not exist at a uniform depth. Isostasy describes the physical, chemical, and mechanical differences between the mantle and crust that allow the crust to "float" on the more malleable mantle. Not all regions of Earth are balanced in isostatic equilibrium. Isostatic equilibrium depends on the density and thickness of the crust, and the dynamic forces at work in the mantle.