ORIGIN OF THE EARTH

Since the Earth is a member of the solar system, it is commonly believed that the origin of the Earth is connected with that of the solar system. All the principal theories which have been advanced to explain the origin of the Earth, have in common the idea that the planets evolved from the Sun. Regarding the origin of the Earth a number of theories have been put forward but none of them can be said to be perfectly correct. Some of the important theories explaining the origin of the earth are as follows:

1. The earliest theory about the origin of the earth was advanced by the French philosopher Georges Buffon in 1745. According to this theory material was pulled out of the Sun by an external force such as gravitational pull resulting from the near collision of the Sun with another star. The cooling of the blobs of solar matter ejected from the Sun during the cataclysmic collsion gave rise to the planets of which the Earth is a member.

2. *Nebular Hypothesis* The first Nebular Hypothesis was advanced by the German philosopher Kant (1755) and then by the French mathematician Laplace (1796). According to this hypothesis, the planetary system is believed to have been evolved from a large, hot, gaseous nebula rotating in space (Latin 'nebula' means mist). The rotating nebula, according to the law of universal gravitation, became more compressed and compact with an increase in the speed of rotation. Gradual cooling with contraction in size and increasing concentration of mass towards the centre of the nebula led to an increase in the rate of rotation and a growth of centrifugal force. With the increased velocity of rotation, the centrifugal force around the equator of the mass eventually became equal to the gravitational attraction between the material at the outer rim of the disc and the central mass. As a result a ring of material was left while contraction of the remaining material continued. When the cen trifugal force exceeded the force of gravity in the equatorial zone of the nebula a ring of matter began to spin off along the whole periphery of the rotating disc. Thus successive rings of matter were formed and left behind the contracting mass. Further

of time is one year. The relationship between the half life period and the rate of decay has been found out to be as:

$T = 0.693/\lambda$ where T = half- life period ; λ = rate of decay

Usually the 'half life period' is determined and accordingly it is equated to find out the age of the earth.

The following are some of the common methods used for the purpose of determining the age of earth:

(a) *Uranium-lead method* Here two isotopes of uranium are used, U^{238} and U^{235}. The chemical element uranium, a heavy metal of atomic weight 238 spontaneously gives away X-rays and atoms of the helium gas and is ultimately converted into the chemical element-radium of weight 236. This element too continues emitting helium atoms till it is reduced to lead of atomic weight 206.

$$U^{238} \longrightarrow Pb^{206} + 8He^{4}$$

The half life of Uranium 238 is 4500 million years. One gram of uranium-238 will produce 1/7600,000,000 gram of stable lead.

Similarly the second isotope U^{235} undergoes sponta neous disintegration and ultimately gives rise to lead of atomic weight^{207}.

$$U^{235} \longrightarrow Pb^{207} + 7He^{4}$$

The half life of U-235 is 713 million years.

(b) *Thorium lead method* Thorium-232 through radioactive disintegration gives rise to lead 208. The half life period, in this case is 13,900 million years.

$$Th^{232} \longrightarrow Pb^{208} + 6He^{4}$$

(c) *Potassium argon method* Potassium, an element present in many minerals and rocks, have three isotopes K^{39}, K^{40} and K^{41}. Only K^{40} is radioactive. The radioactive transformation of K-^{40} consists in absorbing the electron by the nucleus with the nearest to its electronic shell. Thus, a radiogenic stable isotope of argon with exactly the same atomic weight (Ar^{40}) is

It has also been inferred that —

(a) the crust, mantle and core are separated by two sharp breaks, usually known as major discontinuities;

(b) the crust is having an average thickness of about 33 kms;

(c) the crust is composed of heterogeenous materials;

(d) the second major segment of the earth, i.e the mantle extends from below the crust to a depth of 2900 kms;

(e) the third major segment of the earth i.e. the core extends from below the mantle upto the centre of the earth;

The Crust It is the uppermost shell of the earth that covers the rocks of the interior thinly. Its thickness over the oceanic areas is generally 5 to 10 kms; whereas on the continental areas it is about 35 kms and the thickness ranges from 55 to 70 kms in orogenic belts. The Mohorovicic discontinuity marks its lower boundary.

From the study of the shallow focus earthquakes and artificial seismic explosions, it has been inferred that there are two zones of crustal rocks beneath the continents, although only one occurs beneath the oceans. In the continental regions, underneath a zone of superficial sediments, the crust can be divided into two layers, the upper layer called 'Sial' and the lower one 'Sima'. The boundary between the sial and the sima is called the Conrad Discontinuity.

(i) *Sial* It is also known as the upper continental crust. It consists of all types of rocks, igneous, sedimentary and metamorphic, which are exposed at the land surface. This layer is rich in silica and aluminium. The rocks in this layer are of granitic to grano dioritic composition.

The Conrad discontinuity which is located at a depth of 11 kms separates the sial layer from the underlying sima layer.

(ii) *Sima* It is also known as Lower Continental Crust. Its thickness is about 22 kms. It extends from the Conrad discontinuity up to the Mohorovicic discontinuity. This layer is rich in silica and magnesium and is basaltic in composition. It includes two parts:

(a) Outer Sima and (b) Inner Sima

Other such startling discoveries have been made by scientists who can now see deep inside the earth. Using for over past two years seismic tomography, which produces X-ray like images down to the core of the planet, they can photograph for the first time objects deep under the ground.

This technique will help to solve mysteries, that have baffled scientists for decades, such as why satellites do not fly smoothly in orbit but bob up and down like corks on water, rising and falling hundreds of feet on each tour, and why the day varies in length as the earth spins jerkily on its axis.

Analysing these recent findings the "Washington Post" said in an article that the answers to these small puzzles and to the greater ones, such as what makes the continents move, lie deep inside the earth and are just beginning to emerge as geophysicists work with seismic tomography.

Harvard, the Massachusetts Institute of Techonology, the California Institute of Technology and the University of California at San Diego have teams working with the new tomographic technology.

One recent discovery is that the earth's core, a 4000-mile-diameter ball of molten iron, is not the perfect sphere as depicted in geology texts in this century. The tomography images show vast mountains and valleys six or seven miles high and deep. which are upside down because they are made of rock while the core inside them is hot liquid iron.

As they are upside down in relation to the earth's surface, the features on the surface of the earth's core have been dubbed "anti-continents" and "anti-oceans."

Some researchers believe that these mountains have oceans of lighter density iron between them, thus making the upside down array somewhat like anti-continents and anti-oceans 1800 miles deep.

At the centre of the core the pressure is so great that not even temperatures of 12,000 degrees fahrenheit can keep the iron liquid. It is compressed into a solid again, in hexagonal crystals lined so that signals passed through them are as if they were a single thousands-mile wide crystal.

Even as recently as 10 years ago researchers had no idea at all