Determination of age of fossils

The age of various fossils is ascertained by determining the age of the rock in which they are found, using **radiometric dating techniques**. Radioactive isotopes of Uranium (^{238}U, ^{236}U), Thorium (^{232}U) and Potassium (^{40}K) are used for determining the age of rocks and strata. Uranium and Thorium are found most frequently in an igneous rock called Pegmatite, while ^{40}K is a component of some sedimentary rocks. The sanadine and biotite fractions of the volcanic rock bentonite are important sources of Potassium-40 used in **potassium- argon dating** of associated plant fosils.

These radioactive isotopes are also called **geological clocks**. The decay of radioactive isotopes leads to stable isotopes, releasing energy in the process.

When the radioisotopes of Uranium and Thorium disintegrate, they ultimately produce a stable form of Lead, Helium and heat. ^{236}U, after passing through 14 intermediary radioactive stages, will yield ^{206}Pb plus 8He and heat. Again the rate at which any isotope decays, and gives rise to stable isotope is constant. The rate at which 1 gram of ^{236}U decays into ^{206}Pb is 1/7,600,000 gram of lead in 1 year. Thus, by measuring relative quantities of radioactive isotopes and the stable isotope, the age of the rock and the plants present can be calculated. Another way of expressing the same idea is to calculate the rate of decay in terms of the half-life of the radioisotope. Uranium -238 has a half-life of $4.50X\ 10^9$ or 4500 m.y. If the ^{206}Pb in Pegmatite rock is the product of the decay of ^{238}U from the time Pegmatite was formed, then the ratio of ^{238}U to ^{206}Pb will give an indication of the age of the rock. Normally Pegmatite rocks do not contain plant fossils, so the age of fossiliferous sedimentary rocks can be determined through the above process only when Pegmatite intrude such sedimentary strata. But this increases chances of error.

<u>Potassium- Argon technique</u> is more suitable for age determination of the sedimentary rocks containing plant fossils, because the Potassium containing minerals are a part of the depositional materials in which the specimens are embedded. When ^{40}K decays it gives rise to ^{40}Ca and ^{40}A. Argon-40, an inert gas, makes up 12% of the end product of decay, while Ca-40 makes up the rest 88%. Measurement of the known amount of ^{40}A derived from a unit of ^{40}K in a specific amount of time will give a fairly accurate dating of sedimentary rocks.

The radioactive Uranium, Thorium and Potassium can be used to determine the age of rocks older than 100,000 years; but it will give erroneous result on younger rocks. Use of radioactive carbon (^{14}C), or **<u>carbon dating</u>** as it is called, is frequently used in estimating the age of biological specimens back to about 6000 years, since half-life of carbon is very short (5,568+30yrs). Carbon dating technique was developed by W.F.Libby (1955). Carbon-14 is formed when nitrogen atoms were bombarded by cosmic rays in the upper atmosphere. It is assumed that the rate of ^{14}C formation has been constant in the past so that a predictable number of ^{14}c atoms have been produced and become mixed evenly through living matter, past and present. The ^{14}C becomes incorporated in living systems by the process of photosynthesis. In this process ^{14}C is fixed when CO_2 is taken from the atmosphere and utilised in carbohydrate produced by the green plant. Further mixing is accomplished in animals when they, in turn, ingest the ^{14}C- containing carbohydrate. Incorporation and mixing ceases when the individual plant or animal dies and the accumulated ^{14}C decays. The amount of ^{14}C which remains in the plant material can be estimated and age determination can be done with accuracy within 2-3%.