Smoky Mountain Bible Institute
Biology Carbon 14 Dating 105

Welcome back to the lab – time, time and more time – we will continue our short detour from the topic of biology, and touch on chemistry and geology to give time a thorough treatment here. We will examine some radiometric dating methods like Carbon 14 and Isochron. We will also examine some others, like Dendrochronology (tree rings) and some methods that give much younger dates for the age of the earth.

So, let's examine Carbon 14 Dating (^{14}C), also referred to as radiocarbon dating. This method claims to be reliable for determining the age of fossils up to 60,000 years. Carbon-14 is primarily used to date once-living things (organic material). It can also be used to put time constraints on some inorganic material such as diamonds. Because of the rapid rate of decay of ^{14}C, it can only give dates in the tens of thousands of year range.

There are three different naturally-occurring varieties (isotopes) of carbon: ^{12}C, ^{13}C, and ^{14}C. Carbon-14 is used for dating because it is unstable (radioactive), while ^{12}C and ^{13}C are stable. Because it is radioactive, ^{14}C will decay (emit radiation) over time, and become a different element, nitrogen-14 ^{14}N. Carbon-14 is constantly being added to the atmosphere by cosmic rays from outer space, which contain high levels of energy. These rays bombard the earth's upper atmosphere, colliding with atoms in the atmosphere, which can cause them to come apart. Neutrons that come from these fragmented atoms collide with ^{14}N atoms (the atmosphere is made mostly of nitrogen and oxygen) and convert them into ^{14}C atoms. Once ^{14}C is produced, it combines with oxygen in the atmosphere to form carbon dioxide (CO^2). Because CO_2 gets incorporated into plants, this means that the food we eat contains ^{14}C, which is how living things accumulate ^{14}C in their life span.

Living things stop taking in ^{14}C when they die, and their radioactive ^{14}C decays into ^{14}N. The amount of ^{14}C in a dead organism becomes less and less over time, while the stable ^{12}C remains the same. Therefore, part of the dating process involves measuring the amount of ^{14}C. Scientists use a device called an "Accelerator Mass Spectrometer" (AMS) to determine the ratio of ^{14}C to ^{12}C, giving the test a currently-accepted accuracy rate of about 80,000 years. The half-life of ^{14}C is 5,730 years (based on currently-observed rates of decay). For example, a jar starting with all ^{14}C atoms at time zero will contain half ^{14}C atoms and half ^{14}N atoms at the end of 5,730 years (one half-life).

A core assumption in this dating method, invented by Dr. Willard Libby, has to do with the ratio of ^{14}C to ^{12}C. It is assumed that the ratio of ^{14}C to ^{12}C in the atmosphere has always been the same as it is today (1 to 1 trillion). However the amount of ^{14}C being produced in the atmosphere must equal the amount being removed to be in a steady state (also called "equilibrium"). If this is not true, the ratio of ^{14}C to ^{12}C is not a constant, which would make knowing the starting amount of ^{14}C in a specimen difficult if not impossible to accurately determine. As I mentioned in the last lesson, assumptions are extremely important. If the starting assumption is incorrect or even just a little off, all the calculations based on that assumption might give a correct number, but will lead to an incorrect conclusion. In Dr. Libby's original work, he noted that the atmosphere did not appear to be in equilibrium. This was a troubling idea for him since he believed the world was billions of years old and more than enough time had passed to achieve equilibrium. Dr. Libby's calculations showed that if the earth started with no ^{14}C in the atmosphere, it would take about 30,000 years to build up to a steady state (equilibrium). Dr. Libby chose to ignore this discrepancy (nonequilibrium state), and he attributed it to experimental error. However, the discrepancy has turned out to be very real and confirmed to exist today by much better instruments. The ratio of ^{14}C /^{12}C is not constant. The Specific Production Rate (SPR) of C-14 is known to be 18.8 atoms per gram of total carbon per minute. The Specific Decay Rate (SDR) is known to be only 16.1 disintegrations per gram per minute. What this means is if it takes about 30,000 years to reach equilibrium, and ^{14}C is still out of equilibrium, then the earth is not yet 30,000 years old.

Another interesting note: ^{14}C is found in diamonds and coal samples that are supposedly millions and billions of years old. How can something with a half-life of only 5730 years be found in things that are "supposedly" millions or billions of years old? I would submit that they are much younger than commonly believed.

A team of scientists, called the RATE Group (Radioisotopes and the Age of The Earth), put together some good research on this topic. They started in 1997, and worked for eight years investigating the age of the earth, challenging many commonly held old earth assumptions.

That is enough about Carbon 14. If you want to read more on the subject, I suggest you visit the Answers in Genesis website that was the primary source for much of this article. Next lesson: a little on the Isochron dating method, which has much in common with C14 assumptions of much greater age, and then later dendrochronology and some other methods that give much younger age of the earth.