Carbon Dating – What Is It And How Does It Work?

This is how carbon dating works: Carbon is a naturally abundant element found in the atmosphere, in the earth, in the oceans, and in every living creature. C-12 is by far the most common isotope, while only about one in a trillion carbon atoms is C-14. C-14 is produced in the upper atmosphere when nitrogen-14 (N-14) is altered through the effects of cosmic radiation bombardment (a proton is displaced by a neutron effectively changing the nitrogen atom into a carbon isotope). The new isotope is called *"radiocarbon"* because it is radioactive, though it is not dangerous. It is naturally unstable and so it will spontaneously decay back into N-14 after a period of time. It takes about 5,730 years for half a sample of radiocarbon to decay back into nitrogen. It takes another 5,730 for half of the remainder to decay, and then another 5,730 for half of what's left then to decay and so on. The period of time that it takes for half of a sample to decay is called a *"half-life."*

Radiocarbon oxidises (that is, it combines with oxygen) and enters the biosphere through natural processes like breathing and eating. Plants and animals naturally incorporate both the abundant C-12 isotope and the much rarer radiocarbon isotope into their tissues in about the same proportions as the two occur in the atmosphere during their lifetimes. When a creature dies, it ceases to consume more radiocarbon while the C-14 already in its body continues to decay back into nitrogen. So, if we find the remains of a dead creature whose C-12 to C-14 ratio is half of what it's supposed to be (that is, one C-14 atom for every two trillion C-12 atoms instead of one in every trillion) we can assume the creature has been dead for about 5,730 years (since half of the radiocarbon is missing, it takes about 5,730 years for half of it to decay back into nitrogen). If the ratio is a quarter of what it should be (one in every four trillion) we can assume the creature has been dead for 11,460 years (two half-lives). **After about 10 half-lives, the amount of radiocarbon left becomes too miniscule to measure and so this technique isn't useful for dating specimens which died more than 60,000 years ago. Another limitation is that this technique can only be applied to organic material such as bone, flesh, or wood. It can't be used to date rocks directly.**

Carbon Dating – The Premise

- Carbon dating is a dating technique predicated upon three things.
- The rate at which the unstable radioactive C-14 isotope decays into the stable non-radioactive N-14 isotope.
- The ratio of C-12 to C-14 found in a given specimen.
- And the ratio C-12 to C14 found in the atmosphere at the time of the specimen's death.

Carbon Dating – The Controversy

Carbon dating is controversial for a couple of reasons. First of all, it's predicated upon a set of questionable assumptions. We have to assume, for example, that the rate of decay (that is, a 5,730 year half-life) has remained constant throughout the unobservable past. However, there is strong evidence which suggests that radioactive decay may have been greatly accelerated in the unobservable past. **We must also assume** that the ratio of C-12 to C-14 in the atmosphere has remained constant throughout the unobservable past (so we can know what the ratio was at the time of the specimen's death). And yet we know that *"radiocarbon is forming 28-37% faster than it is decaying,"* which means it hasn't yet reached equilibrium, which means the ratio is higher today than it was in the unobservable past. We also know that the ratio decreased during the industrial revolution due to the dramatic increase of CO_2 produced by factories. This man-made fluctuation wasn't a natural occurrence, but it demonstrates the fact that fluctuation is possible and that a period of natural upheaval upon the earth could greatly affect the ratio. Volcanoes spew out CO_2 which could just as effectively decrease the ratio.

Specimens which lived and died during a period of intense volcanism would appear older than they really are if they were dated using this technique. The ratio can further be affected by C-14 production rates in the atmosphere, which in turn is affected by the amount of cosmic rays penetrating the earth's atmosphere. The amount of cosmic rays penetrating the earth's atmosphere is itself affected by things like the earth's magnetic field which deflects cosmic rays. Precise measurements taken over the last 140 years have shown a steady decay in the strength of the earth's magnetic field. This means there's been a steady increase in radiocarbon production (which would increase the ratio).

And finally, this dating scheme is controversial because the dates derived are often wildly inconsistent. For example, *"one part of Dima [a famous baby mammoth discovered in 1977] was 40,000 RCY [Radiocarbon Years], another was 26,000 RCY, and wood found immediately around the carcase was 9,000-10,000 RCY."* [Walt Brown, *'In the Beginning'*; 2001, p 178]