Radiometric Dating and the Age of the Earth

A Brief Note on Atomic Structure

All atoms consist of a positively charged nucleus, which is surrounded by negatively charged electrons. The positive charges are carried by atomic particles called **protons** and the negative charges are carried by particles called **electrons.**

The simplest atom is the Hydrogen Atom. This has a nucleus of just one proton, which is surrounded by one electron.

The proton is inconceivably small – a millionth of a millionth (or a trillionth) of a millimetre in diameter and is very dense – about a thousand trillion times as heavy as water. It weighs 1846 times as much as the electron, which is of similar size, but may not exist as a particle but as a “cloud” of negative charge. However, it is clear from these measurements that an atom is nearly all empty space.

There are ninety-two naturally occurring elements, and as we ascend the scale to bigger atoms, each new atom has one additional proton, and this must be counterbalanced by one more electron. Thus all atoms are electrically neutral – **the number of protons in the nucleus always equals the number of electrons surrounding it**.

The nuclei of heavier atoms contain an additional particle called the **neutron,** which as its name implies, is neutral and carries no charge. It is really a proton and an electron in combination and therefore weighs slightly more than a proton.

Why are neutrons necessary? It is because particles with the same charge (such as positively charged protons) would repel each other, and a nucleus containing many protons could not exist. It simply would fly apart. Usually there are at least an equal number of neutrons as protons in any nucleus. However, there is still a tremendous repulsive force in the nucleus, which is counterbalanced by what physicists call the **Strong Nuclear Force.** Without this, no atoms bigger than Hydrogen could exist.

Moderately sized atoms are very stable, but heavy atoms may not be stable and this instability makes them radioactive. They spontaneously disintegrate and lose a particle. ***If an atom loses a proton (or protons), it becomes another atom or element,*** and to counterbalance this, an electron has to be lost also. If an atom loses or gains a neutron, it will still be the same element, but it will weigh slightly different. This form of the element is called an ***isotope.*** It will have the same chemical properties as the original atom, but its physical properties will be slightly different.

Sometimes a neutron will be converted to a proton and an electron, and this also converts the original atom into a new atom or element. If electron *capture* occurs, this results in a proton being converted into a neutron. Here again, since the atom has now *lost* a proton, it is changed into another atom or element.

Let us return to the hydrogen atom. Hydrogen has two *isotopes* called Deuterium and Tritium.

Deuterium has a neutron as well as a proton in its nucleus. It is therefore about twice as heavy as hydrogen, and hence it is called *heavy hydrogen.* When hydrogen combines with oxygen it forms water H_2O. If *heavy hydrogen, or deuterium* combines with water, it forms *heavy water* or D_2O. This is just like ordinary water, but its physical properties are different: it has a slightly different density, freezing point and boiling point.

Tritium is very heavy hydrogen, and its nucleus contains **two neutrons** and one proton. It is unstable and therefore radioactive, but its radiation is very weak. It is very useful to be incorporated into compounds of biological interest and track their path through the body.

Radiocarbon Dating. What does this really tell us?

What is Radioactive Carbon?

The Carbon Atom has three isotopes:

Ordinary Carbon. The nucleus or this most abundant isotope of carbon has 6 protons and 6 neutrons. It is therefore called in physics textbooks ^{12}C. For simplicity's sake I will call it C-12. It is stable and not radioactive.
Carbon -13 (usually written ^{13}C). Its nucleus contains 6 protons and 7 neutrons and comprises about 1% of natural carbon. It is stable and therefore not radioactive.
Carbon – 14 (usually written ^{14}C). Its nucleus contains 6 protons and 8 neutrons. Only about one carbon atom in a million million or trillion consists of C-14, but it is unstable and radioactive, decaying to nitrogen -14 or N-14. A neutron of the C-14 is converted to a proton with the emission of an electron. Its radiation is very weak, and special techniques have been developed to detect it and estimate its amount.

Rate of Decay of C-14

As a general principle, if, for example, we start with one gram of C-14 (or any other radioactive element), and measure the time it takes to disintegrate to *half a gram*, let us say it takes X years. Then let us measure the time one-half gram takes to disintegrate to one-quarter of a gram. We would still find it took X years. And if we take our quarter gram and measure the time for it to take to disintegrate to one-eighth of a gram, we would still find it took the same time – X years.

In other words, the time for *any mass* of carbon (or any other radioactive element) to disintegrate to *one half of that mass*, irrespective of this initial mass, it will still take X years – the same time. This *time* is called the ***HALF-LIFE*** of the radioactive element. In the case of C-14, the *half-life* is 5730 years.

Half-lives of radioactive elements vary greatly, from microseconds (millionths of a second) to billions of years.

Examples of Radioactive Decay

Whenever an atom undergoes a radioactive decay, a particle is expelled from the nucleus. This may be:

(1) A high-speed electron. This is called a β particle, one negative charge (-). This results from the conversion of a neutron to a proton and the electron. Because there is an extra proton formed, i.e. another positive charge on the nucleus, transmutation into another element occurs.

(2) A helium nucleus. This is called an α particle. It contains 2 protons and 2 neutrons and has a charge of (++). The element loses these four heavy particles, and thus another element is formed. The Helium nuclei will acquire 2 electrons from the environment and become Helium atoms.

(3) Sometimes an atom emits a γ ray. These γ rays are very short wave, or highly energetic, electromagnetic radiation. (In the whole spectrum, radio waves are the longest, micro- and infra-red come next, then visible (light) rays, then ultraviolet rays, X-rays and γ rays. The energy increases as the wave-length decreases).

Radioactive Element	Product(s) of Radio Decay	Half Life
Carbon-14	Nitrogen-14	5730 years
Potassium-40	Argon-40	1.25 billion years
Uranium-238	Lead-206 (stable)	4.5 billion years

To give an idea of how complex radioactive decay can be, let us take the disintegration of Uranium-238 comprising 15 stages:

Isotope	Type of Radiation Emitted	Half-Life
Uranium-238	α	4.47 billion years
Thorium-234	β	24 days
Protactinium-234	β	6.7 hours
Uranium-234	α	240,000 years
Thorium-230	α	77,000 years
Radium-226	α	1602 years

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Radon-222	α	3.8 days
Polonium-218	α	3.1 minutes
Lead-214	β	27 minutes
Bismuth-214	β	20 minutes
Polonium-214	α	0.000164 seconds
Lead-210	β	22 years
Bismuth-210	β	5 days

Polonium-210	α	138 days
Lead-206		STABLE

Notice the extreme differences in times of disintegration, from U-238, 4.47 billion years to Polonium-214, 164 microseconds. Note that the stages below the line of asterisks have comparatively short half-lives.

Principle of Radiocarbon Dating

Carbon-14 combines with atmospheric oxygen to form $^{14}CO_2$ or radio active carbon dioxide and is taken up by plants and animals and occurs in equilibrium throughout their bodies. When the animal dies, however, no more radio carbon dioxide is taken in, and what is left begins to decay. If the radio carbon is measured after death, it is possible to calculate the time that has elapsed since the death of the animal. Hence the remains of animals and indeed any organic remains can be dated. This can be applied to historic remains, say, of Egyptian mummies.

Because the half-life of C14 is comparatively short (5730 years), and the energy of the electrons (β-ray emission) is so small, previous techniques only allowed carbon dating to be accurately determined for objects not more than 100,000 years old (17.5 half lives.) But a recently introduced and more sensitive technique using the **ACCELERATOR MASS SPECTROMETER**, has been used, which detects ***individual carbon atoms*** **not just their emitted electrons.** The limit of sensitivity is in the range of 0.1 to 0.5% of today's C-14/C ratio. In fact the limit of detection is 0.01% of today's value. And, what is most significant is that the C-14/C ratio of samples taken from the geological column is uncorrelated with their positions in the geological record. If we assume that the C-14/C in these samples when they died was close to today's value, then the dates work out to be from 44,000 to 57,000 years, including coal samples which, according to evolutionists, are dated hundreds of millions of years old. All this suggests that the whole geological column was deposited contemporaneously only thousands of years ago during a global cataclysm.

Another factor which may have influenced the amount of C-14 in the early earth, is the changing earth's magnetic field. This halves itself every 1400 years and hence would have been much stronger 6,000 years ago. The earth's magnetic field shields the earth from cosmic rays and this would decrease the rate of formation of C-14 from N-14.

But surely, 44,000 to 57,000 years ago is vastly outside the Biblical time frame of only 6,000 years. Yes, but before the cataclysm, all the carbon, in the form of coal, oil, natural gas and shale today, would make the initial C-14/C 300 to 700 times lower than what it is today, and this would reduce the ages perhaps by a factor of 10. This would reduce the time scale to about 5,000 years. Many experiments have been done to check that the small amounts of C-14 are not due to any form of contamination – a claim which is usually made by evolutionists. But creationists have checked this carefully and other arguments that evolutionists have suggested, and conclude that the measured amounts of C-14 are real. This destroys the evolutionist's multibillion year paradigm.

In addition to this, several diamonds from a variety of locations, originating in the magma also are datable by this method to about 58,000 years. These would normally be considered by the evolutionist to be billions of years old.

URANIUM-238 DECAY

The half-life of U-238 is 4.47 billion years. Surely this could be used to prove that the earth is very ancient.

But there is evidence that there have been episodes of accelerated nuclear decay, possibly during Creation Week and at the time of Noah's Global Flood, when huge tectonic movements took place and mountains were pushed up and when the "fountains of the deep" were broken open and deep oceans were formed.

One notable feature of U-238 decay is that 8 α particle are ejected from U-238, and these acquire electrons to form helium atoms. Helium is an inert gas, that is, it forms no chemical compounds.

Uranium atoms occur in granite, which is the solidified magma from the mantle of the earth and often forms outcrops at the surface. In 1974 a 2.6 mile deep core was drilled out at Fenton Hill, New Mexico, and this granite
is considered to be very old.

Granite is highly crystalline, and one of the main constituents is the mineral *biotite* or mica. It occurs in "sheets." Embedded in mica are tiny crystals of *zirconium silicate* called *zircons*, formula $ZrSiO_4$. Zircons contain tiny inclusions of U-238. If these were really billions of years old, all the helium would have diffused away long ago.

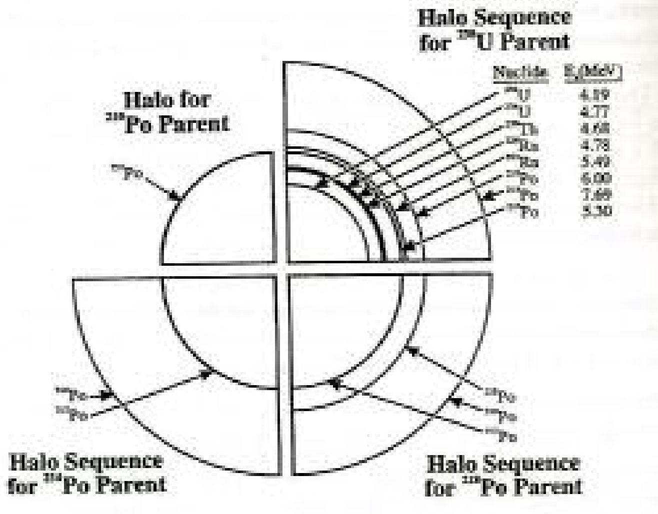
Uranium in Zircons: Accelerated Nuclear Decay

But surprisingly, much helium remains. From 1000 meters down, 58% of the total helium generated by past nuclear decay is retained, and the remaining 42%has gone no further than the surrounding biotite.
From deeper depths, where the temperature was higher, less was retained.

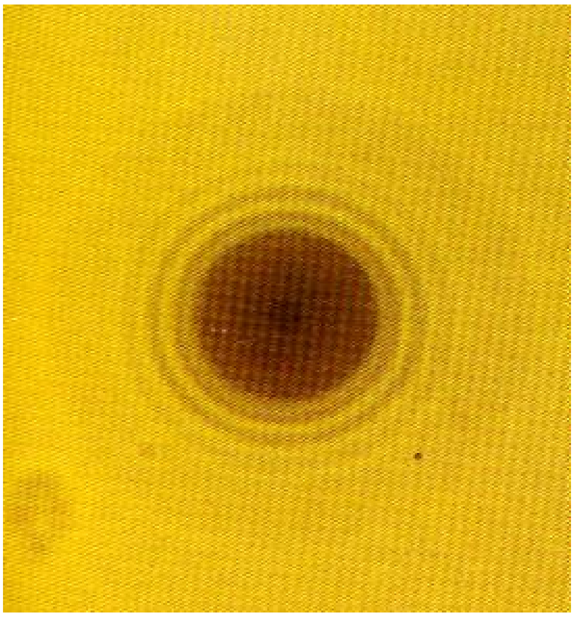
Accelerated Nuclear Decay

The large amount of helium retained in the zircons might have been due to *accelerated nuclear decay,* which occurred just thousands of years ago. Then, because it took place recently, much of it remains because it has had insufficient time to leak out. Such high concentrations of Helium cannot be sustained for more than a few thousand years. Biotite has not been found to be a barrier to diffusion of Helium.

Radiohaloes



Characteristic ring configurations for different parent elements.



When granite cools, tiny specks of Uranium- 238 may be embedded in zircon crystals (zirconium silicate or $ZrSiO_4$) or in biotite. There are 15 stages of Uranium decay, and eight of these stages produce α-particles. These travel varying distances in the crystals according to their energy of ejection. They cause damage to the crystalline structure causing a darkening of the biotite, seen as a radio halo. It needs 500 million α–particles to make a visible halo, and this amounts to about 100 million years of α decay. Typically these haloes are 10 to 40 microns in diameter (one micron is one-thousandth of a millimetre.) They only form in solid crystalline material, and are destroyed when this is heated to about 150^0 C

Notice, however, that three of the last α−emitting stages in the disintegration of U-238 involve three isotopes of the element POLPONIUM, each of which has a very short half-life:

Polonium – 210	138 days
Polonium – 214	0.000164 seconds
Polonium – 218	3.1 minutes

Notice that the inert, radio-active gas Radon-222 precedes the formation of the Polonium isotopes. How is it that such short-lived Polonium isotopes, although derived from U=238, produce separate haloes? It is reckoned that Radon gas, together with hot hydrothermal liquids running between the layers of mica (biotite), carry these Polonium isotopes sufficiently far from the "parent" uranium (up to 1 mm distant) to produce these specks of Polonium, which then start to decay and produce their own separate haloes.

These amazing short-lived Polonium isotope haloes occur in granites from all over the world, both in the Precambrian, the "oldest" rocks, and the "youngest" Cenozoic rocks. Samples were taken from:
Cenozoic, late and post-Flood deposits
Mezozoic, mid and late Flood deposits
Paleozoic, early Flood deposits
Precambrian, creation week and pre-Flood deposits.

If we refer back to the table of U-238 disintegration, it is seen that Radon-222 precedes the formation of the Polonium isotopes and other short-lived isotopes. Radon is a radioactive inert gas, and would carry the Polonium isotopes along with hot hydrothermal liquids, between the layers of mica. When the Polonium granules came to rest, separate from the "parent" Uranium, they would start to decay and produce their own independent haloes.

Polonium haloes show

(1) that granites cool rapidly, not over long ages as is often assumed
(2) the existence of so many Polonium haloes in rocks of Flood age points to an extreme amount of accelerated nuclear decay during this period, and this points to a young age of the earth.

Fission Tracks

About one in two million U-238 atoms undergo spontaneous fission into two Palladium-119 atoms (and in other ways of fission too):

U-238 gives Pd-119 + Pd-119

It is this sort of fission that occurs in an atom bomb. The resulting atoms fly apart and make visible tracks 10 to 15 microns long in minerals. These fission tracks disappear if the mineral is subjected to temperatures from 50 to 400 degrees C.

The number of tracks over a known surface area is counted, and the number of undecayed U-238 atoms is measured by bombarding with neutrons in a nuclear reactor. The new fission tracks are captured in a target material placed closely adjacent to the original sample. These are counted and give the original number of U-238 atoms.

From these data, the age is calculated. However, this does not give the true age of the sample, but the time since heating events set the time to zero. It is difficult to imagine rock formations remaining cool over vast periods of time with accompanying episodes of volcanic and tectonic activity. In the Young Earth view, the fission tracks occurred after the Flood, and give evidence of accelerated nuclear decay.

Discordant Dates

Accurate dating requires three assumptions:

(1) Known initial conditions for the rock
(2) A closed system
(3) Constant rate of nuclear decay

A glaring example of wrong dating is that of magma around Hawaii, which is known to have erupted about 200 years ago, was "dated" 22 about million years old by the Potassium/Argon method. The reason is because of the assumption of no argon in the erupted magma, but argon can be "inherited" from the magma.

General discordance is observed when samples are taken from the same rock:

(1) α–Decay isotopes give older ages than β-decay isotopes
(2) Elements with longer half-lives give older age

This may suggest that, during a past period of accelerated decay, the α-decay process underwent more overall decay than the β process.

A sample of fossilized wood was found embedded in solid Hawkesbury Sandstone around Sydney. The evolutionary 'age' of this Middle Triassic sandstone is 224-230 million years, whereas the Carbon age dated with the AMS technique was only 33,720 years. Checks to eliminate contamination were made. (*Creation Magazine, 21-3, 39 (1999).*

Bones of a dinosaur and amber samples gave similar C-14 dates vastly discordant with evolutionary 'dates'. (CRSQ 43-2, 84 (2006)). But these C-14 dates are too old because of the greater protective magnetic field of the earth pre-Flood, and the C-14/C ratio was less than 1% of that today.

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