APPENDIX B - CRITIQUE OF RADIOMETRIC DATING

I. GENERAL PRINCIPLES OF RADIOACTIVITY.

A. STRUCTURE OF THE ATOM.

Visual # B-1

An atom has a *nucleus* composed of *protons* and *neutrons*, with *electrons* moving somewhere around the outside in regions called *orbitals*. Despite the fact that there is a repulsive force between the positively charged protons in the nucleus, most nuclei that have more than one proton do not fly apart. Scientists do not know why, so they use the term "strong nuclear force" to describe whatever keeps the nuclei together. However, some nuclei *do* break down. As they do, they release various types of radiation - hence the name radioactivity.

The number of protons in the nucleus, the *atomic number,* determines which element the atom is. The total number of protons plus neutrons is called the *mass number* or *isotope number*.

Most elements have atoms of more than one *isotope:* the number of protons is the same, but the number of neutrons is different. For instance, Carbon exists as either Carbon-12 with six protons and six neutrons, C-13 with six protons and seven neutrons, or C-14 with six protons and eight neutrons. In some way that is not clearly understood, the ratio of protons to neutrons is related to the stability of the atom.

B. TYPES OF RADIOACTIVE DECAY.

Visual # B-2

Two types of radioactivity, *alpha* and *beta* decay, change the number of protons and thus turn the atom into a different element. The third type, *gamma*, only rearranges the protons and neutrons and thus does not produce new elements.

- Alpha radiation releases an alpha particle composed of two protons and two neutrons. As the particle leaves the nucleus, it lowers the atom's atomic number by two and its mass number by four.
- Beta decay occurs when a neutron in the nucleus breaks down, releasing a high-energy electron or beta particle and leaving behind a proton where the neutron was. Since neutrons do not count in determining the atomic number but protons do, beta decay actually increases the atom's atomic number by one. However, since an electron has only about 1/1800th the mass of a neutron, beta decay leaves the mass number unchanged.

Nobody is quite sure why radioactive decay occurs; it just does. The process may occur in one step (e.g. Carbon-14 changes to Nitrogen-14 by beta decay), or it may go through many intermediate stages, as in the case of Uranium-238. This isotope goes through 14 steps (both alpha and beta decay) on its way to becoming Lead-206.

II. USE OF RADIOACTIVITY IN DATING.

Scientists use radioactivity to try to determine how old things are. They measure the ratio between an unstable radioactive "parent" element whose atoms release various types of decay particles and a *radiogenic* (radioactively produced) "daughter" which they eventually turn into.

Since we are not sure why an individual atom undergoes radioactive decay, we cannot predict when it will happen. However, large numbers of radioactive atoms (trillions or more, which may be only a tiny fraction of a gram) have been found to behave in a statistically predictable way. If we take any given sample of a radioactive element, the amount of time it takes for half of it to decay is known as its *half-life*. For instance, suppose we have a 100 kilogram sample of uranium. After one half-life, half (50 kg) will still be uranium but the other half will have decayed into lead. After another half-life, half of what was left will have decayed so that only one-fourth of the uranium (25 kg) remains, while three-fourths (75 kg) has decayed into lead. After another half-life, only one-eighth of the original uranium (12.5 kg) remains

Visual # B-3

while seven-eights (87.5 kg) has decayed into lead, and so on.

Each radioactive isotope has a different half-life. By calculating the ratio of parent-to-daughter of the isotopes in a rock sample and making several major assumptions (see below), we can estimate how many half-lives the sample has gone through and thus estimate its age.

The most commonly used radiometric dating methods, along with the currently accepted half-lives of the parent elements, are as follows.

Visual
B-4

PARENT	DAUGHTER	HALF-LIFE
Carbon-14 decays to	Nitrogen-14	5730 years
Potassium-40 decays to	Argon-40	1.3 billion years
Uranium-235 decays to	Lead-207	713 million years
Uranium-238 decays to	Lead-206	4.51 billion years
Rubidium-87 decays to	Strontium-87	47 billion years

(Slusher, 1981, 12-45)

Since almost all the parent would be gone within about ten half-lives, the ages detectable by any of these methods are limited to a few half-lives.

III. UNCERTAINTIES OF RADIOMETRIC DATING.

Though Carbon-14 is the best-known radiometric dating technique, its short half-life limits its usefulness to ages of a few thousand years. If we want to determine the age of an object believed to be extremely old such as a volcanic (igneous) rock, we must use one of the methods that depend upon long half-lives.

Visual
B-5

A reliable clock must meet three criteria: (1) Initial conditions must be known, (2) the rate of change must be known, and (3) the clock must not have been tampered with at any time. Radiometric dating fails on all three points.

A. INITIAL RATIO OF PARENT TO DAUGHTER.

Visual
B-6

Most rocks contain multiple elements. In cases of radioactive decay, some of the parent is present along with some of the daughter as well as a great many other minerals. In order to date a rock, we ignore the other minerals and compare the present ratio of parent to daughter to the ratio at the time the rock was formed. Thus, we must know what the ratio of parent to daughter was at the beginning. But since no human observer was present to record this ratio in the distant past, we have no way to know this.

1. ORIGIN OF RADIOACTIVE ELEMENTS.

Visual
B-7

Many radiometric methods start with the assumption that any given sample started with 100% parent and 0% daughter. However, since no one was there to observe how heavy elements were formed (refer to Chapter Two, Section III-B), we cannot exclude the possibility that some of the elements thought to be daughters were present as building blocks in manufacturing the parent. Since the most common scenario for the origin of the earth says that it cooled from molten rock, some of each isotope considered to be a radiogenic daughter could have been present from the beginning.

2. IMPERFECT MIXING.

Magma, the molten rock that spews out of volcanoes, contains many imperfectly mixed elements from inside the earth. Because of this imperfect mixing, there is no way to know if the ratio of parent-to-daughter in the magma at the site of the volcano is the same as the ratio anywhere else. Thus, the parent-to-daughter ratio in any given rock may not accurately represent the overall ratio in the earth's interior. This makes it even harder to determine how much of the daughter was present when the rock came out of the volcano and how much has been produced by decay since that time. Since the initial conditions are unknown and unknowable, we cannot legitimately use the parent-to-daughter ratio to determine the rock's age.

3. THE EARLY ENVIRONMENT.

In the young-earth model of Initial Complexity, (young-earth creation) the earth was capable of supporting modern organisms within a very short time. If so, conditions would have been similar to those in the present. There would probably have been a mixture of parent and daughter from the beginning.

Our assumptions about the initial parent-to-daughter ratio are nothing more than guesses. If we are wrong, the ages we obtain may be wrong by billions of years.

B. CONSTANT RATE OF DECAY.

Visual # B-8

Radioactivity was discovered around the end of the nineteenth century. Radioactive decay rates were first determined several decades later by measuring clicks on a Geiger counter over a few days (Taylor, 1987, 296-297). Many scientists through the years repeated the counting process, yielding the published half-lives which are the averages of the values obtained.

Visual # B-9

The fact that we use an average implies that not all values are exactly the same. This calls into question the accuracy and precision of the whole process. But even if we had been constantly observing the rate of decay for a hundred years, it takes an extraordinary amount of *extrapolation* (going beyond the data) to insist that the rate has remained absolutely constant for the earth's supposed age of 4.6 billion years.

Imagine you observe a jet flying past for one second. Could you tell how fast it had been traveling for the last 522 days? Of course not. Yet this is the same amount of extrapolation - 45,000,000 times the available data - as applying 100 years of observation to our planet's supposed age of 4.5 billion years.

We do not know why individual atoms decay. Within any given sample of radioactive material, some atoms decay immediately, while others may not change for millions of years. Many scientists believe the process is completely random, but others think an atom decays when it is struck by some subatomic particle such as a neutrino. If the former group is right, the decay rate may be constant. However, if the latter is correct, an event that increased the neutrino density (such as a supernova, which occurs about every 25 years in our galaxy) would greatly speed up the decay rate.

A number of experiments have shown that decay rates are not so constant as we thought. Between 1949 and 1972 scientists were able to induce changes in the decay rates of 14 different isotopes by using changes in pressure, temperature, chemical state, electric potential, and stress of monomolecular layers. Some of the elements that show a definite difference in decay rate are Beryllium-7, Nobelium-90, Cesium-133 and -137, Carbon-14, and Uranium (Slusher, 1981, 20-22; White, 1985, 69-71).

More recent studies show that under *plasma* conditions, extremely high temperatures where electrons are completely removed from nuclei, beta decay rates can be up to a billion times faster than normal (Woodmorappe, 2001). Though we cannot be certain why the decay speeds up so much, we can make a logical guess. Suppose the decay of a radioactive nucleus is not purely random but has some as yet unknown cause. Under normal circumstances, the electrons in orbit around the nucleus seem to have a shielding effect. Removing those electrons would remove this effect, allowing the decay rate to increase drastically.

Such a scenario ties in with Humphreys' (1994) and Boudreaux's (2003) ideas about the origin of the chemical elements referred to in Chapter Two, Section III-B. They believe in a Biblical scenario: rather than starting with only hydrogen, the universe began as an enormous ball of water perhaps two light-years in diameter. The internal gravity of the water ball would have been sufficient to start the process of nuclear fusion and produce the known naturally-occurring elements.

What kind of conditions would have existed inside the ball of water? Plasma. Thus, as new radioactive isotopes were coming into existence by fusion, others would be forming by accelerated decay. What would seem to be millions or billions of years of decay products could have formed in a matter of hours.

This causes a serious problem in using radioactive decay rates to show that the earth is old. The standard scenario of elements being produced in stars and supernovae also requires plasma conditions. (See Chapter 2, Section III B 3 b and c.) Thus, decay rates would have been far faster at the beginning than at present so that as the earth cooled, it would have already had a large volume of radioactive decay products. This would destroy the reliability of radiometric dating methods.

Visual # B-10

More recent studies (Sturrock *et al*., 2010; Stober, 2010; Walg et al., 2021) reveal the fact that not only are radioactive decay rates *not* constant, they vary predictably according to the earth's position with respect to the sun. Researchers at Purdue and Stanford Universities have detected several anomalies in radioactive decay rates.

(1) They go through a cycle of fastest to slowest every 33 days, believed to be the rotation rate of the sun's core.
(2) In the wintertime when we are slightly closer to the sun the decay rates accelerate a tiny bit; in the summertime when we are farther away, they slow down slightly.
(3) Decay rates seem to drop slightly just before solar flares.

Scientists have long thought that radioactive decay was a completely random, uncaused process. However, this study has forced some of them to consider the possibility that there may be processes going on inside the sun that release unknown particles or forces that reach the earth and affect decay rates. If so, there would be no way to be sure that radioactive decay rates have always been absolutely constant.

Regardless what the cause of decay might be, decay rates can be increased. We have no way to be sure that they have always been the same as they are today. Thus, the past rate of change in radiometric systems cannot be known. All we can legitimately use radiometric dating for is to set upper limits on the age of any object.

C. NO PARENT OR DAUGHTER ADDED OR REMOVED.

Visual # B-11

If there was any disturbance to the system while the decay process was going on, the age estimates are not reliable. Consider the fact that the earth's crust is constantly changing due to erosion, earthquakes, floods, and many other such disruptions. In order to furnish trustworthy radiometric ages, samples of radioactive elements found in the crust would have had to remain undisturbed throughout hundreds of millions of years, while entire continents eroded around them many times over.

Some radioactive parents and decay products are water soluble, e.g., uranium salts and lead salts. If the rock gets wet even one time, the radioactive age is unreliable. Is there any rock on earth we can be sure has never gotten wet a single time in 4.5 billion years? Of course not.

Radioactive dating is not reliable because there is no way to know that we are correct about any of these factors. All we can do is assume. We can set upper limits on the age of a rock, but their accuracy depends on the accuracy of our assumptions. If we are wrong in any of them, we may obtain an age which is incorrect by thousands or even billions of years.

D. PROBLEMS WITH COMMONLY USED DATING METHODS.

1. POTASSIUM-ARGON DATING.

One of the common radiometric methods used to indicate great ages is potassium-argon. Despite the confidence some place in it, the technique is full of uncertainties.

Visual # B-12

Potassium is abundant in rocks throughout the world. It occurs in three isotopes: K-39 and K-41, which are stable and account for over 99.9% of the known potassium, and K-40, which is unstable and accounts for just over 0.01%. The half-life of K-40 is calculated at about 1.26 billion years. This is the isotope used for potassium dating.

Researchers have noticed a "branching" phenomenon that affects the reliability of K-40 dating: about 89.5% of the time it decays, its nucleus ejects an electron (beta decay) and turns into Calcium-40, but about 10.5% of the time it turns into Argon-40 (Kelley, 2002, 786) by exotic processes involving electron capture or positron decay. Since Ca-40 could either be radiogenic or primordial, it is not taken into account in the dating method. The other product, Ar-40, is used because it is much rarer and is a noble gas that does not react with other elements.

Potassium-Argon dating depends upon three main assumptions.

a. The earth's rocks began in a molten state and cooled over hundreds of millions of years.

b. Any K-40 that decayed while the rocks were still molten would have left no traces because the Ar-40 would have leaked out into the atmosphere.

c. Once the rock hardened, no Ar-40 could escape. The ratio of the remaining K-40 to Ar-40 allows us to tell the age of the rock.

There are several problems. First, we cannot be sure that branching ratio has always been 89% to 11%. Second, if any of the Ar-40 inside a rock ever leaked into the atmosphere, the K-Ar ratio would no longer give reliable results. This could happen if a rock did something as simple as heat up. It would not need to melt all the way, just soften a little so so that some of the gas could escape.

Even skeptics have to admit that there have been many volcanic events in the earth's history. If any of these affected a rock that contained K-40 and Ar-40, the radiometric ages could be off by billions of years.

2. ISOCHRON DATING.

In an attempt to get around some of the uncertainties of radiometric dating, scientists have devised several dating methods known as *isochrons*. These attempt to eliminate the need to know the initial ratio of parent to daughter.

Visual # B-13

Most rocks are a mixture of many elements and isotopes. In order to perform isochron dating, we need to focus on just two at a time, e.g., Rubidium and Strontium. We first gather a number of rock samples that contain a radioactive isotope (e.g., Rb-87) and a radiogenic daughter (e.g., Sr-87) into which it decays, plus at least one other isotope of the second element (e.g., Sr-86) which is non-radiogenic and occurs naturally. The non-radiogenic isotope is used as a reference. In our example of Rubidium and Strontium, the amounts of Rb-87 and Sr-87 should change through time but the amount of Sr-86 should not. If we compare the two substances involved in the decay process to the one that is not, we should ideally see that the ratio of Rb-87 to Sr-86 decreases while the Sr-87 to Sr-86 ratio increases.

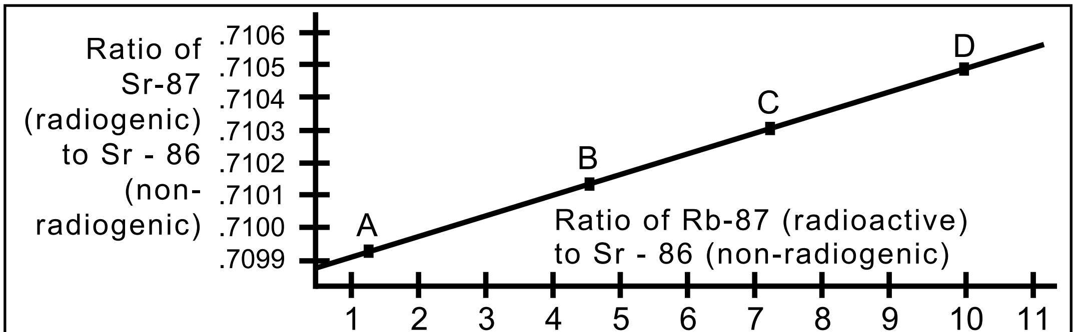
Shown on the next page are some of the combinations used in isochron dating. The left column shows the radiogenic daughter as compared to the original parent isotope, while the right column shows the radiogenic daughter as compared to the non-radiogenic isotope.

Parent/ Non-Radiogenic Isotope		Radiogenic Daughter/ Non-Radiogenic Isotope
Rb-87/Sr-86	vs.	Sr-87/Sr-86
K-40/Ar-36	vs.	Ar-40/Ar-36
U-232/Pb-204	vs.	Pb-208/Pb-204
U-235/Pb-204	vs.	Pb-207/Pb-204
U-238/Pb-204	vs.	Pb-206/Pb-204
Sm-143/Nd-144	vs.	Nd-143/Nd-144

(Arndts *et al.*, 1990, 20).

Samples are taken from several places throughout a rock. If any of the combinations shown above are present, the parent/non-radiogenic and radiogenic/non-radiogenic ratios are plotted against each other. If everything goes well, the result looks something like the graph below.

Visual
B-14



After Arndts, Overn, Bartz, & Kramer

a. Rationale of Isochron dating.

The technique assumes that when a rock sample formed it contained a mixture of the radioactive parent, the radiogenic daughter, and the non-radiogenic isotope. As time went on, some of the parent decayed into the radiogenic daughter. This made the ratio of parent to non-radiogenic isotope decrease and the ratio of radiogenic daughter to non-radiogenic isotope increase. Since individual atoms decay at different times we compare samples taken from different places in the rock to see how the ratios have changed in different places.

As an example: suppose we find a ratio of 0.7100 radiogenic-to-non-radiogenic in one sample and 0.7105 in another, as in the graph above. Since the amount of parent should decrease as the radiogenic daughter increases, we look for a smaller ratio of parent-to-non-radiogenic in the first sample and a larger one in the second. If we find it, we consider that the parent has decreased and the daughter has increased relative to the non-radiogenic reference isotope. We graph these two ratios and use the slope of the resulting line to come up with an age estimate that is supposed to be independent of the initial parent-to-daughter ratio.

b. Fatal flaws in the method.

Despite bold claims for isochron dating, at least four major flaws render the results meaningless.

i. Imperfect Mixing.

Isochron dating relies on the assumption that the rocks contained a perfectly uniform mixture of elements at the beginning. Direct observation shows us that this assumption is not valid. Even today, we can see that rocks are far from perfectly mixed as they come out of a volcano.

ii. Arbitrary meaning of slope.

The line on the graph only gives us a slope. We decide what it means. If the slope is 1.09, why should that mean 1.09 billion years instead of 1.09 million, 1.09 thousand, or 1.09 of anything else?

iii. Negative Ages.

In some cases, the slope of the line is negative, indicating a negative age (Arndts *et al.*, 1990, 16 & 24) - a physical impossibility. We can either *discard the data* or recognize that imperfect mixing is a perfectly valid explanation for this phenomenon.

iv. Need for a closed system.

If any of the non-radiogenic element was ever added or removed the isochron is useless. We have no way to be sure this didn't happen.

Visual # B-15

The unreliability of the Rb-Sr isochron method is obvious in the dating of two Grand Canyon lava flows: the Cardeñas Basalt at the bottom of the canyon, believed to be about a billion years old, and the Uinkaret Plateau basalt at the top of the canyon, believed to be only about a million. Rubidium-Strontium showed an age of about 1.07 billion years for the Cardeñas rocks. No surprises here. Exactly the same technique was then applied to the Uinkaret, which showed an age of about 1.34 billion years - over a thousand times too old, and 270 million years older than the rocks at the bottom (Austin, 1992). Either the isochron method is unreliable or else the Grand Canyon is upside down.

Geochrons are merely isochrons on a wider geographic scale. They, too, must assume a perfect mixture of elements at the beginning. This assumption is clearly wrong. We have no way to be sure how much parent and daughter were present in any ancient rock at the time it formed, much less in many rocks spread over a wide area.

3. CARBON-14 DATING.

Many people have at least heard of Carbon-14 and are are under the mistaken impression that it is used to date fossils. It is not.

Visual # B-16

All known life is based on carbon, of which the most common isotope is C-12, with six protons and six neutrons. The form used in carbon dating is C-14, which comes from Nitrogen-14, the most abundant gas in the atmosphere. Nitrogen normally has seven protons and seven neutrons. Scientists believe that some nitrogen atoms are struck by cosmic radiation as they circulate in the upper atmosphere. The most commonly accepted model says that the radiation alters the atom by knocking one of its inner electrons into the nucleus, where it combines with a proton to produce an unstable neutron. The result is C-14, an unstable atom with six protons and eight neutrons. The unstable neutron eventually decays back into a proton, changing the atom back into N-14.

Carbon gets into living things through photosynthesis at the bottom of the food chain. Throughout their life spans, photosynthetic organisms put together atoms into cell structures. They use a mixture of C-14 and C-12 in the same ratio as that in the atmosphere. After they die, they stop taking in either form of carbon. The unstable C-14 in their cells begins to decay back into Nitrogen-14, but the stable C-12 does not change.

The carbon moves up the food chain as animals eat the plants or other animals that ate the plants. As long as an animal lives it should have the same C-14/C-12 ratio as its food, which should be that same ratio as that in the atmosphere. When it dies, it stops taking in either form of carbon. Since the C-14 is unstable, the ratio of C-14 to C-12 in its carcass will begin to change too.

We measure the ratio of the two isotopes in the object being dated, expecting that if it were alive it would contain the same ratio as the atmosphere. The ratio is commonly estimated at about a trillion to one. If the ratio is lower – e.g., two trillion to one, or one half the expected amount – we estimate that the organism stopped taking in C-14 one half-life ago, or about 5700 years.

There are several reasons this technique is not used to date any but the most recent fossils.

a. Loss of Carbon content.

Visual # B-17

The carbon in most fossils has been replaced by other minerals. You can't carbon date something that doesn't contain carbon.

Even in cases where there is enough carbon to allow carbon dating, several other factors limit the accuracy of the technique.

b. Environment.

If an animal or plant lives in an environment unusually low in C-14, it will not absorb much C-14 and thus will show an artificially high age. This can easily happen in sea creatures living in an area rich in sea shells. The shells consist mostly of calcium carbonate formed from the carbon available in the water. Since relatively little C-14 from the atmosphere reaches them, they use mostly C-12. The shells, the organisms that live in them, and the animals that eat those organisms will all show exaggerated C-14 ages.

c. Atmospheric C-12/C-14 ratio.

C-14 dating assumes that the ratio of C-12 to C-14 in the atmosphere has not changed in the last several thousand years. This is not true. Scientists have measured both the rate at which C-14 is produced and the rate at which it decays. The rate of production is about 24% faster than the rate of decay (Slusher, 1981). This means that the farther back in time we go, the less C-14 was available. An object older than a few thousand years would have started with a low amount of C-14, making it show an excessively old age. The farther back we try to go, the less reliable carbon dating is.

d. Short half-life.

Since Carbon-14 has a half-life calculated at just over 5700 years, it is only used to date objects believed to be less than a few tens of thousand of years old. The fact that most fossils are dated at millions of years tells us immediately that they were not carbon dated.

e. External factors.

Like any radiometric method, C-14 dating requires that the system be free from outside interference. If anything (e.g., a fire) adds or removes carbon or nitrogen from the system, the technique is no longer reliable.

f. Initial concentration of C-14 in the organism.

Some of the plants that build up their cell structures by taking carbon from the atmosphere seem to be able to distinguish between the isotopes of carbon, and reject all but C-12 (Folger, 1994, 28). Since their cells start with a low amount of

C-14, they would show excessive ages if carbon dated. Likewise, any animal that ate them might also show an erroneous age, since it uses the carbon in the plant cells to build its body cells.

4. RECENT CARBON DATING RESULTS.

Visual # B-18

Recent work in carbon dating by Baumgardner and others (Baumgardner *et al.*, 2003, 127-142) shows just how poorly it fits with the idea of a great age. In the past, researchers had to count clicks on a detector such as a Geiger counter to estimate how much C-14 was present in a given sample. Because normal background radiation also caused clicks, this technique was uncertain enough that it could not be used beyond about ten half-lives (corresponding to perhaps 57,000 years under perfect circumstances, which don't exist). Anything older should register no C-14 at all and show up as an infinite age.

Baumgardner's team reports that C-14 dating has been refined by means of an updated technology called *accelerator mass spectrometry* (AMS). The previous technique was limited because the percentage of C-14 is very low to begin with. Only about a thousandth of that amount – extremely difficult to detect – would be left after ten half-lives. However, AMS allows us to detect the presence of C-14 with about 100,000 times more sensitivity. With it, we should be able to identify samples up to about 43 half-lives old, or 250,000 years.

The team reexamined the carbon-dating literature in light of AMS and also did some carbon dating on their own. Out of hundreds of samples of objects such as dinosaur bones and oil thought to be hundreds of millions of years old, only two failed to yield a detectable amount of C-14. For all the rest, the calculated ages were significantly less than 250,000 years! In fact, many supposed to be 300,000,000 years old instead point to a maximum age of about 90,000 years. (And of course, the true age could be anything less.)

We can only conclude that, rather than showing that the fossils are hundreds of millions of years old, carbon dating shows that they are considerably less than a hundred thousand years old, maybe just a few thousand.

5. OTHER REASONS FOSSILS ARE NOT RADIOMETRICALLY DATED.

Visual # B-19

Even if radiometric dating were reliable, there are at least two other reasons why it is of very limited usefulness in dating fossils.

a. Sediment too finely divided to date.

In order to be datable, a piece of rock must be large enough to give a good sized sample of the elements involved. However, the sedimentary rocks that contain fossils are composed of finely divided particles of dirt, sand, and other minerals, each of which contains too little radioactive material to date.

b. Only volcanic rocks directly datable.

Only igneous (volcanic) rocks contain enough radioactive material to be radiometrically dated. These originated as molten rock. Any living thing in their path would have been destroyed, not preserved as a fossil.

E. EXAMPLES OF ERRONEOUS RADIOMETRIC DATES.

Visual # B-20

Radiometric dating is nowhere near as reliable as most people think it is. The commonly used methods such as C-14, Rubidium-Strontium, and Uranium-Lead often give wildly erroneous "ages" because of the uncertainties inherent in any radiometric dating technique. A few examples:

- The hair of a frozen mammoth found at Checkurovka, Siberia was carbon dated at 26,000 years. However, the peaty soil in which it was preserved was dated only 5,600 years (Fairhall *et al.*, 1966).

- "The Carbon-14 contents of the shells of the snails of *Melanoides tuberculatus* living today in artesian springs in southern Nevada indicate an apparent age of 27,000 years." (Riggs, 1984, 58-61).
- Tissue from a living mollusk was dated by the carbon-14 method at over 2,300 years (Keith & Anderson, 1963, 634). The water in which it lived was rich in carbon-12 from dissolved limestone, producing an abnormally high ratio of C-12 to C-14.
- Two different C-14 ages 15,000 years apart were obtained from the same block of peat in New Zealand (Goh *et al.*, 1978, 463-466).
- Dried seal carcasses less than 30 years old have been carbon dated as old as 4,600 years. Likewise, the blood of a seal freshly killed at McMurdo Sound in the Antarctic was tested by Carbon-14. The test said that the seal had died 1,300 years ago (Dort, 1971, 210).
- The rocks containing Louis Leakey's "Nutcracker Man" were dated by the potassium-argon method at 1.75 million years. However, bones found below that stratum, which should be older, were dated at only 10,000 years by the C-14 method (Berger & Libby, 1969, 194-209).
- Lava rocks in Hawaii were dated by the potassium-argon method at almost 3 billion years. However, the rocks were not formed until the volcano erupted in 1801, less than 200 years before (Funkhouser & Naughton, 1968, 4601).
- Moon rocks have been dated by various radiometric techniques. The results of the tests have not been consistent with each other, but varied from 700 million to 28 billion years (Whitcomb & DeYoung, 1978, 98-102).
- Rocks from one of the lava domes at Mt. St. Helens yielded potassium-argon ages ranging from 350,000 to 900,000 years. The radiometric age of several samples of the mineral pyroxene at the same location ranged from 1,700,000 to 2,800,000 years. The actual age of the rocks at the time was a mere ten years (Austin, 1996, 335-343).

These ages were wildly incorrect because they depended upon the assumptions described above, at least one of which was wrong in each case. The uncertainty in the assumptions means we cannot be sure that *any* radiometrically dated object is really the age the tests say. All we can realistically do is set an upper limit on the object's age. It could be anything less.

Most people think radioactivity proves the earth is old. It does not do any such thing. All it can legitimately do is put an upper limit on the age of the earth. It could be as old as 4.5 billion years, or it could be anything less.