RADIOMETRIC DATING

By Ashby L. Camp

I. Introduction[1]

A. Imagine you walk into a friend's house and see water dripping from the ceiling. Under the drip spot is a fish tank filled with 10 gallons of water. You time the leak and see that it's dripping at the rate of 1 gallon per hour. So you conclude that the leak has been dripping into the tank for 10 hours -- it drips at 1 gallon per hour and you've got 10 gallons.

B. When you think about it more, however, you realize that the correctness of your conclusion depends on certain unproven assumptions. You assumed that there was no water in the tank when it was placed under the leak, you assumed that no water entered the tank from another source or exited the tank after it was placed under the leak, and you assumed that the leak always was dripping at the rate of 1 gallon per hour.

C. If your friend left a note saying "I put the tank under the leak at 1:00 p.m. on Saturday" and you arrived at 2:00 p.m., you could either believe your friend, which would mean rejecting one or more of those assumptions, or continue to accept the assumptions, which would mean disbelieving your friend.

D. This is the like the situation we face with the Bible and radiometric dating. We can believe the Bible and reject certain assumptions or continue to accept those assumptions and disbelieve the Bible. (A third alternative is to claim that the Bible does not affirm anything about the age of creation – about when the tank was put under the leak. I explain in "A View of Creation" some of why I find this unacceptable.)

II. General Principle

A. There are a number of radioactive elements in nature. These elements are unstable, meaning they spontaneously decay or give off particles over time, which results in their being transformed into other elements. For example, C-14 (a radioactive form of carbon) transforms into N-14 over time; potassium-40 (a radioactive form of potassium) transforms into argon-40 over time; rubidium-87 decays into strontium-87; thorium-232

[1] These are notes from a class I taught at church in 2005. That is why the sources are not carefully documented. The facts asserted can be confirmed from the articles in my online list of articles of interest to creationists at http://trueorigin.org/camplist.asp and in the following books: Steven A. Austin, ed., *Grand Canyon: Monument to a Catastrophe* (Santee, CA: Institute for Creation Research, 1994); Don Batten, ed., *The Revised and Expanded Answers Book* (Green Forest, AR: Master Books, 2000); Larry Vardiman, Andrew A. Snelling, and Eugene F. Chaffin, eds., *Radioisotopes and the Age of the Earth* (El Cajon, CA: Institute for Creation Research, 2000); Jonathan Sarfati, *Refuting Compromise* (Green Forest, AR: Master Books, 2004); Don DeYoung, *Thousands Not Billions* (Green Forest, AR: Master Books, 2005).

decays into lead-208; uranium-235 decays into lead-207; uranium-238 decays into lead-206.

B. The rates at which these various elements decay have been measured, and these rates are referenced by their "half-lives." The half-life of a radioactive element is the time it takes for half of a given number of atoms of that element to turn into the element it finally turns into. To use uranium-235 as an example, the half-life is how long it takes half of the uranium-235 atoms to turn into lead-207. The original radioactive isotope (here U-235) is called the parent element and the stable element into which it finally turns (here Pb-207) is called the daughter element.

C. If a scientist measures the elements in a rock sample and finds there is the same amount of U-235 as Pb-207, he may well conclude that 1/2 of the U-235 has decayed into Pb-207, that is, that the U-235 has gone through one half-life of decay. The half-life of U-235 is 704 million years, and thus the conclusion would be that the rock was 704 million years old.

D. The assumptions behind this conclusion would be (1) that there was no Pb-207 present at the start (initial conditions), (2) that no U-235 or Pb-207 has seeped into the sample or leached out of the sample (a closed system), and (3) that the rate at which U-235 transforms into Pb-207 has always been the same.

E. This is the "model age method." The "isochron method," applied either to whole rocks or to one or more of the minerals that make up the rocks (e.g., biotite, feldspar, olivine, quartz), looks at a group of rocks (or minerals within a rock) formed from the same source and assumes (because of indications of mixing) that the stable daughter element was evenly distributed when the rocks were formed. If the ratios of parent to daughter elements measured today plot in a straight line, the assumption of mixing is deemed confirmed and the initial amount of the daughter element can be determined. (See addendum re isochron dating.) With this, it is thought the absolute date can be determined securely (assuming constancy of decay). But even this method is acknowledged to yield false dates (those unacceptable to evolutionists).

III. Dating assumptions highlighted when radiometric dating yields unacceptable results

A. With very few exceptions, radiometric dating is available only for igneous and metamorphic rocks, not for sedimentary rocks, which are the types of rocks that contain fossils. The reason is that sedimentary rocks are made up of sediments gathered together from different places; they're a mishmash of eroded particles. (Even metamorphic rocks are less useful for radiometric dating because they're preexisting rocks that have been reworked or transformed.) So to get radiometric dates that are relevant to fossils scientists date igneous or, to a lesser extent, metamorphic rocks near the fossils.

B. To choose one example, when they dated by the argon-argon method samples of basalt (an igneous rock) that were nearest to the strata in which the fossil hominid *Australopithecus ramidus* was found, most of the samples yielded dates of around 23

million years. Because the authors believed that date was too old for this creature to have already evolved, they figured the assumption of a closed system must have been wrong in that case, that the date was untrustworthy. They looked at some basalt further removed and selected 17 of 26 samples to get an acceptable date of 4.4 million years.

C. Five lava flows that happened in New Zealand in 1949, 1954, and 1975 yielded K-Ar dates that ranged from less than 270,000 years to 3.5 million years. Of course, scientists concluded that "excess" argon had been retained in the rock when it solidified, but if excess argon can cause exaggerated dates for rocks of known age, then why trust the method for rocks of unknown age?

D. Basaltic rocks from the top of the Grand Canyon, rocks that most geologists accept are only thousands of years old, yielded different results depending on which radiometric technique was used:

Six potassium-argon ages	10,000 yrs. - 117 million
Five rubidium-strontium ages	1.27 - 1.39 billion
Lead-lead isochron	2.6 billion

E. Wood found in some basalt in Australia, meaning it was buried in the lava flow that formed the basalt, was C-14 dated to 45,000 years, but the basalt was dated by the potassium-argon method to 45 million years.

F. Various radiometric methods for dating uraninite crystals in Australia produced dates of 0 (three times), 61 million, 275 million, 841 million, and 1.6 billion.

G. The forms used by radioisotope labs for submission of samples to be dated commonly ask how old the sample *is expected* to be. Why? If the techniques were objective and reliable, this information would not be necessary. Presumably the labs know that anomalous dates are common, so they need some check on whether they have obtained a "good" date.

IV. C-14 dating undercuts long ages

A. Carbon is common throughout the biosphere. A tiny fraction of this carbon is C-14, which is radioactive. C-14 is constantly decaying into N-14 but it is also constantly being created in the atmosphere.

B. Every living thing has C-14 in it. It picks this up in the "great cycle of life." When the living thing dies, it ceases to interact with the environment and thus ceases to take in any more carbon, including any more C-14. So the amount of C-14 in every living thing begins to decrease at death as the C-14 decays or is transformed into N-14. This means the ratio of C-14 to C-12 gets smaller (since the amount of C-12 remains constant).

C. The half-life of C-14 is 5,730 years. So after about 250,000 years, no C-14 should be remaining in a specimen. Between about 90,000 and 250,000 years, some C-14 would remain, but the amount would be too small to detect even with the extremely sensitive accelerator mass spectrometer.

D. Almost invariably, when they check for C-14 in samples that allegedly are a hundred thousand to hundreds of millions of years old they find detectable C-14 at levels far above the lower limits of detectability. In 2001, Dr. Paul Giem listed more than 70 examples culled from the scientific literature. In the following year or two, scientists from the ICR found many additional examples.

E. Over the last 20+ years, many papers were written attempting to understand this phenomenon, what was labeled a "contamination problem." Many admit that the C-14 appears to be intrinsic to the samples themselves, meaning it was not contamination from preparation or analysis of the sample.

F. The ICR scientists on the RATE project obtained 10 coal samples from Penn State University dating from the Eocene epoch (3), Cretaceous period (3), and Pennsylvanian epoch (4) (meaning from about 45 million, 100 million, 300 million) and sent them to leading C-14 labs. It was determined that all the samples had detectable levels of C-14, which should not be the case if they were anywhere near as old as believed. It was also determined that the amounts of C-14 were all less than 1/2 of 1% (0.1 to 0.46) of the modern C-14 level. This clustering is consistent with the organisms all dying around the same time.

G. The scientists from RATE also submitted 12 diamond samples for C-14 dating. As far as they were able to determine, they were the first to attempt C-14 dating of diamonds. Though diamonds are thought to be millions if not billions of years old, they all had detectable levels of C-14.

H. Lest you think the RATE scientists are a bunch of scientific ignoramuses, they all have Ph.D.s from major universities in relevant scientific disciplines. They include a physicist, a theoretical nuclear physicist, a geophysicist, and two geologists. The geophysicist, John Baumgardner, who was in charge of the C-14 research, was described in the 6/16/97 issue of *U. S. News and World Report* as "the world's pre-eminent expert in the design of computer models for geophysical convection."

I. Since contamination from preparation and analysis can be ruled out, the only option for old-agers is to argue that the material somehow was contaminated with C-14 from the environment before it was extracted. But no mechanism of contamination has yet been proposed that can explain the results.

1. Some have suggested that the atmosphere or groundwater somehow was supplying new C-14 atoms, but if that were the case, the measured traces of C-14 would vary wildly throughout the rock strata. The fact is that the measured traces are fairly uniform. So that won't work.

2. Some have suggested that neutrons were entering the samples and converting some N-14 into C-14. But calculations show that the amount of C-14 that can be produced this way are several thousand times below the range actually measured (not to mention the problem with the uniformity of the measured amounts).

3. Some have suggested that radioactive decay of nearby radium, thorium, or uranium could have produced some C-14 that found its way into the samples, but the production of C-14 is so rare from that type of decay that it could at most generate 100,000 times less than the measured amounts of C-14 (not to mention the problem with the uniformity of the measured amounts).

J. The C-14 content of coal, diamonds, and many other earth materials that should be "carbon dead" varies between 0.1 and 0.5 percent modern carbon (pMC). These measured numbers translate into C-14 ages of between 44,000 and 57,000 years, which is a far cry from the alleged ages of millions and hundreds of millions of years. Does that then prove that the earth is at least 44,000 years old? Not at all. It may well be that the ratio of C-14 to C-12 in the pre-Flood world was significantly less than it is today. If so, samples from before the Flood would be interpreted as being older than they actually are because the lower C-14 would be attributed to decay that never happened. In other words, the C-14 in pre-Flood samples is not so low because so much decayed away; rather, it's so low because there was less of it to begin with than is assumed.

K. The claim of a lower C-14 to C-12 ratio in the pre-Flood world is supported by:

1. The fossil record, including the great reservoirs of fossil fuels, shows that the Flood removed from the biosphere (by burial) vast amounts of carbon (in the biospheric ratio), so that the amount of C-14 that has accumulated subsequently is a greater percentage of the total carbon in the biosphere. Imagine that once per year a drop of red dye falls into a container holding a million drops of water. After 5 years, the ratio of dye to water would be five parts per million. If you suddenly removed 1/2 the dyed water from the container, the ratio of dye to water in the remaining 1/2 still would be five parts per million. But the next drop of red dye would increase the ratio of dye to water more than the previous drops had increased it. Instead of being one part per million, it would be two parts per million (or one part per 500,000 parts). The water represents to total carbon in the biosphere, the red dye represents the accumulation of C-14 over time, and the removal of 1/2 the dyed water represents the removal of vast amounts of carbon in the biosphere.

2. There is good reason for believing that the earth's magnetic field was stronger in the past. This stronger magnetic field would deflect cosmic rays away from the earth more efficiently than today which would decrease the rate at which C-14 is produced in the atmosphere.

V. Helium retention in zircons

A. In the 1970's, geoscientists from Los Alamos National Laboratory took core samples from some Precambrian basement granite thought to be in excess of 1 billion years old. The granite contained microscopic crystals called zircons, which as often happens, contained uranium and thorium. Based on the amounts of uranium, thorium, and radiogenic lead measured in these zircons and the presence of other elements in the uranium-lead decay chain, the granite had an age of 1.5 billion years.

B. Here's what the October 2005 issue of *Scientific American* says about zircons and dating:

> Once extracted from their source rock, individual crystals could be dated because zircons make ideal timekeepers. In addition to their longevity, they contain trace amounts of radioactive uranium, which decays at a known rate to lead. When a zircon forms from a solidifying magma, atoms of zirconium, silicon and oxygen combine in exact proportions ($ZrSiO_4$) to create a crystal structure unique to zircon; uranium occasionally substitutes as a trace impurity. Atoms of lead, on the other hand, are too large to comfortably replace any of the elements in the lattice, so zircons start out virtually lead-free. The uranium-lead clock starts ticking as soon as the zircon crystallizes. Thus, the ratio of lead to uranium increases with the age of the crystal.

C. A number of creation scientists, like physicist Russ Humphreys, agree that zircons are a closed system, that the elements in them were indeed produced through radioactive decay. Humphreys writes, "It is difficult to conceive of non-nuclear scenarios which would, all over the world, insert the necessary isotopes into all the microscopic radiocenters and zircons in approximately the right proportions" (RATE, 336). Instead of challenging the assumption of a closed system, they are challenging the notion that the rate of radioactive decay has always been constant. In terms of the water leak analogy, instead of challenging that all the water in the fish tank came from the leak, they're saying there were one or two brief periods of accelerated leaking, times when the water leaked much faster than when you measured it.

D. Is there any evidence for such a wild idea? Yes. When uranium decays into lead, it produces helium as a byproduct. The amount of helium produced is a function of the amount of decay that has occurred, so if you know the amount of decay you can know the amount of helium that was produced. It's as if for every gallon of water that came through the leak, you knew that ten flakes of pipe corrosion get broken loose. If 10 gallons of water came through the leak, 100 flakes of corrosion would have been produced.

E. Given the amount of radioactive decay necessary to produce the amount of radiogenic lead measured in these zircons, "X" amount of helium was produced inside the zircons. But helium is a very "slippery" gas. Helium atoms can diffuse through solids,

meaning they wiggle through the spaces between atoms in a crystal lattice. In other words, it leaks out of the zircon.

F. As part of the original analysis in the 1970's, physicist Robert Gentry heated the Los Alamos zircons to 1000° C in a mass spectrometer and measured the amount of helium liberated. He found that the various zircon samples still had 58%, 27%, 17%, 1.2%, and 0.1% of "X", the amount of helium that would have been produced. The differences corresponded to differences in depth, which corresponded to differences in temperature of the rocks. The deeper rocks were hotter, which means the helium would be more active and thus likely to escape.

G. The ICR scientists on the RATE project wanted to measure the rate at which helium leaks out of zircons, specifically the Los Alamos zircons. So they collected more samples from *the same bore hole*, and submitted them anonymously for testing to a professor at Cal. Tech., one of the world's leading experts on helium diffusion measurements in minerals. According to the leak rate he found, if the Los Alamos zircons were older than 5680 (+/- 2000) years, they would not have as much helium in them as they were measured to have. In other words, if you start with the "X" amount of helium that would have been produced in the zircons by turning that much uranium into that much lead, after more than 7,680 years you would have less helium than was found.

H. The hypothesis that explains both the amount of radioactive decay (as determined by the distribution of elements) and the remaining amount of helium is that the decay all happened within the last 3,680 to 7,680 years. Since that is far faster than the decay rate we measure today, the rate must have been much faster at some point in the past.

VI. More on accelerated decay

A. Other data seem to support the hypothesis. For example, geologists Steve Austin and Andrew Snelling recently examined a formation in the upper Precambrian that is considered ideal for isochron dating. For 20 years the whole-rock, rubidium-strontium isochron date of 1.07 billion years has been regarded as an excellent example of radioisotopic dating. Austin and Snelling got whole-rock and mineral isochron dates for four different isotope systems: potassium-argon, rubidium-strontium, samarium-neodymium, and lead-lead. The isochron dates for each isotopic system were consistent with each other, which indicates that the elements being measured were products of radioactive decay. But the ages given by the four isotope systems differed significantly from each other, ranging from 841 million to 1.375 billion. They conclude:

> Our data indicate that the alpha emitters (^{238}U, ^{235}U, and ^{147}Sm) have yielded older ages than the beta emitters (^{87}Rb and ^{40}K) when used to date the same geologic event, that is, the intrusion of the Bass Rapids diabase sill. A logical explanation of these data is that the radioisotope decay of the various parent isotopes has not always proceeded at the rates described by modern decay "constants", the discordances being due to the different

parent radioisotopes decaying at different rates over the *same* time period since the formation of the sill. In other words, the decay of these parent radioisotopes was accelerated by different amounts. Thus are data are consistent with the possibility that alpha decay accelerated more than beta decay at some time or times in the past.

Furthermore, our data also show that there is a correlation between the present radioactive decay constants for these alpha and beta emitters and the "ages" they have yielded for this same geologic event. Of the alpha emitters, ^{147}Sm has the smallest decay constant (and thus the longest half-life) and it yielded the oldest "age", a mineral isochron "age" of 1375$\pm$170 Ma (Figure 9), compared to the Pb-Pb whole-rock isochron "age" of 1249$\pm$140 Ma (Figure 7). Similarly, of the beta emitters, ^{87}Rb has the smaller decay constant (and thus the longer half-life) and it yielded older "ages", a whole-rock isochron "age" of 1055$\pm$46 Ma (Figure 5) and a mineral isochron "age" of 1059$\pm$48 Ma (Figure 8), compared to the K-Ar whole-rock isochron "age" of 841.5$\pm$164 Ma (Figure 3). Thus our data are also consistent with the possibility that the longer the half-life of the alpha or beta emitter the more its decay has been accelerated, relative to the other alpha or beta emitters, at some time or times in the past.

B. Similar discordance in isochron dates from different isotope systems have been found at Beartooth Mountains in Wyoming, the Great Dike rock formation in Zimbabwe, the Stuart Dike swarm (multiple, simultaneous eruptions of magma) and the Somerset Dam in Australia, Mt. Ngauruhoe in New Zealand, a dike swarm in Uruguay, four other sites in the Grand Canyon, and two sites in central Arizona.

C. Geologist Andrew Snelling remarks:

Because the different radioisotopes are dating the same geologic event, to have produced different 'dates' has to mean that the parent radioisotopes have decayed at different rates over the same time period. In other words, the decay of the parent radioisotopes was accelerated by different amounts, the decay of those yielding older 'ages' (the alpha-decayers) having been accelerated more. Obviously, if radioisotope decay was accelerated, say during the Genesis Flood, then the radioisotope decay 'clocks' could never be relied upon to 'date' rocks as many millions of years old. To the contrary, the rocks could still only be a few thousand years old.

VII. Questions raised by accelerated nuclear decay

A. If nuclear decay was so accelerated in the past that 1.5 billion years of uranium decay occurred in less than 8,000 years, why is there any C-14 to detect? If 1.5 billion years of C-14 decay occurred, there would be no C-14 left. It is theoretically possible, according to nuclear physicist Eugene Chaffin, for nuclear decay to be accelerated in a

way that affects decay rates differently, depending on their half-lives and depending on whether they decay by alpha or beta decay.

B. How could the massive amounts of heat that would be generated by such accelerated decay be dissipated? The short answer is "miraculously."

1. As for how the miracle was *executed*, perhaps as physicist Russ Humphreys speculates, God rapidly expanded the cosmos at the time or times of accelerated decay. The effect would be that the heat energy would go into the expansion of the fabric of space itself. For accelerated decay at the time of the Flood, geophysicist Baumgardner believes supersonic steam jets that are part of his theory of catastrophic plate tectonics during the Flood would suffice to dissipate the heat.

2. But maybe God simply removed the heat without employing any natural process. You ask, why would God use an intermediate process to generate the heat (radioactive decay) and then not use an intermediate process to dissipate it? One could well ask, Why not?

C. Wouldn't such a massively accelerated decay rate kill every living thing? Not necessarily.

1. God could have miraculously protected living things. But even if he did not, the rate could have been very high in the first days of creation, before the creation of plants or animals.

2. Radioactive decay generates heat, and heat controls the viscosity and buoyancy of various rock layers in the earth. So God may have used an abrupt increase in radioactivity in connection with the massive tectonic events that preceded the creation of life. And if the Flood was accompanied by major tectonic events, as hinted at in Gen. 7:11 (the breaking open of the fountains of the deep) and modeled by geophysicist Baumgardner, God also may have used increased radiation at that time.

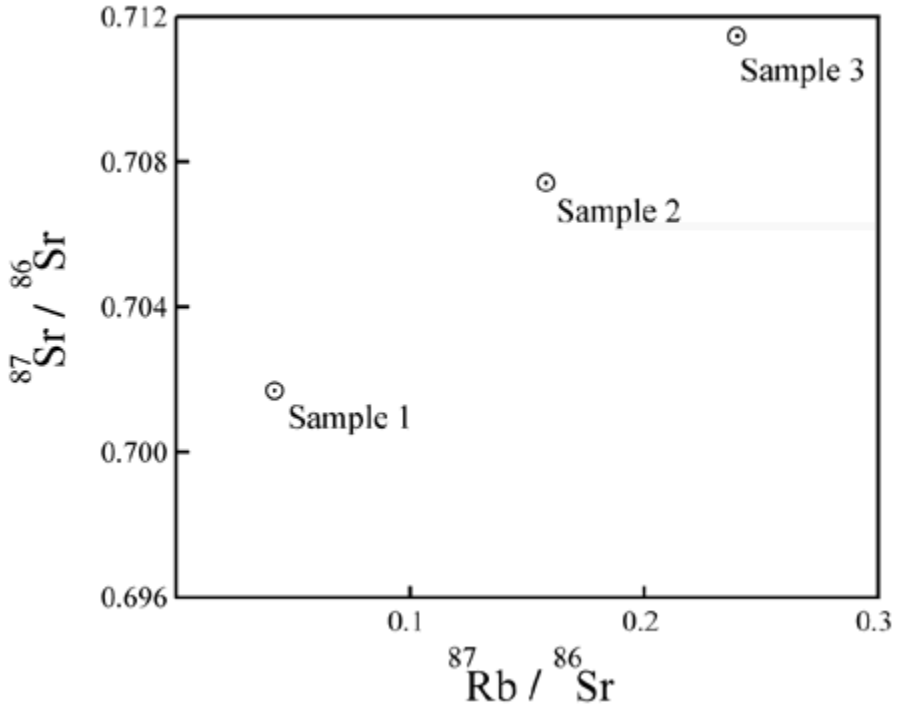
3. During the year of the Genesis flood, deep water would have shielded the ark from radioactive rocks below and the thick walls of the ark would have shielded the creatures within from any radioactive elements that leached from the rocks into the water.

D. Accelerated decay of C-14 and potassium-40, which elements are present in our bodies today, need not have been a problem because it's possible their levels were much lower at the time of the flood. The lower level of C-14 already was mentioned. The K-40 in living things today comes from soil formed by erosion of continental granites *during* the Genesis flood, not from pre-flood soil. As Humphreys says:

> The food that the creatures aboard the ark ate apparently came from soil that God created on the third day of creation, for the use of unfallen Adam and Eve. I can think of no reason for God to have added the radioactive

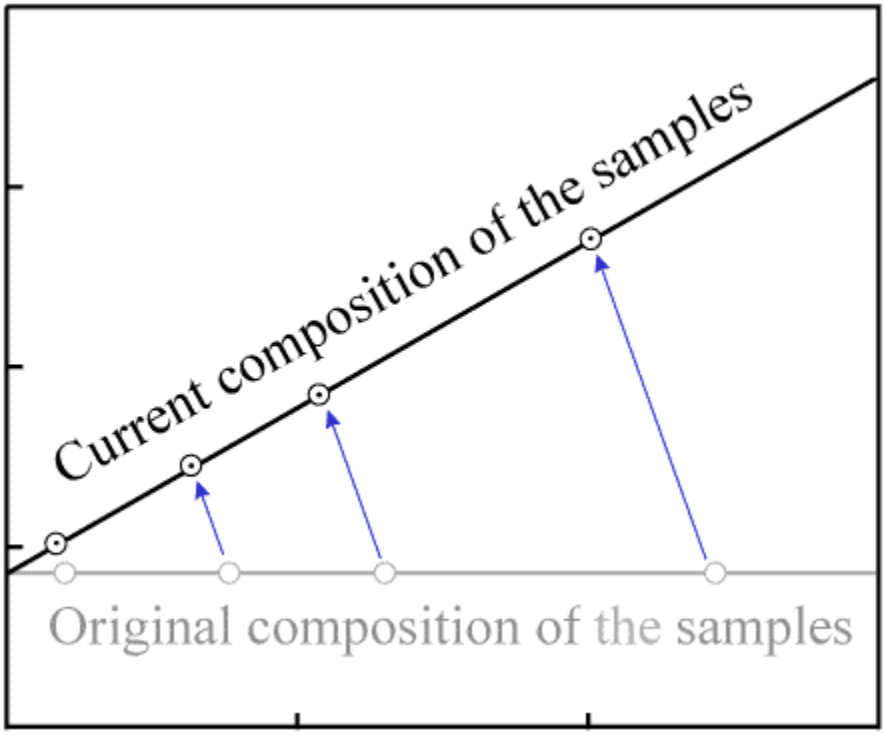
isotope of potassium (K-40) to that primeval soil; non-radioactive potassium 39 would have met every biological need.

ADDENDUM RE ISOCHRON DATING



Rb-87 decays into Sr-87. The assumption is that, for each sample, the *initial ratio* of Sr-87/Sr-86 will be the same because the chemistry of rock formation does not discriminate between Sr-87 and Sr-86 (hence, the line at that time would be horizontal). Over time, the ratio of Rb-87/Sr-86 will decrease in each sample (as Rb-87 decays) and the ratio of Sr-87/Sr-86 will increase proportionately (as Sr-87 is created) in each sample, thereby increasing the slope of the line (see diagram on following page).

If the initial ratio of Sr87/Sr-86 was indeed the same in each sample at the time of formation and if the system remained closed, the line formed by plotting the ratios of Rb-87/Sr 86 against the ratios of Sr-87/Sr-86 for each sample will remain straight while the slope increases over time. If plotting these ratios in fact yields a straight line, the assumption is deemed confirmed, and one can then determine the initial amount of Sr-87 in each sample by swinging the line down to horizontal. The age of the sample can be determined from the slope of the line, assuming a constant decay rate.


Current composition of the samples
Original composition of the samples