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"POTASSIUM/ARGON DERIVED ^{238}U FISSION DECAY CONSTANTS AND CONSEQUENCES FOR THE RECENT-CREATION MODEL"

ARNOLD J. GUIKEMA

KEYWORDS
uranium, spontaneous fission decay constant, fission track dating

ABSTRACT
The uniformitarian model predicts an age of the earth consistent with the results of the value of the uranium 238 fission constant. The widespread acceptance of this value stems from several factors, one of the foremost being the acceptance by the uniformitarian community that there was no change in the decay constant at any time in the earth's history. Furthermore, the value for the uranium 238 fission constant derived from the results of potassium/argon dating methods also gives a value fairly consistent with the uniformitarian model (old earth) view [1].

The recent creationist community holds the Biblical account of the Genesis Flood as a literal event in the earth's history and expects to observe its consequences in the experiments performed today. Did such a worldwide catastrophic event alter the normal process of mineral formation in such a way that present uranium dating methods make a faulty assumption when supposing that there is no correction necessary for a change in the fission constant? An emerging theory in recent-creationism is the possibility of accelerated nuclear decay. Toward this objective, this study will focus on the discrepancy between uranium 238 decay constants obtained from potassium/argon studies (about 7×10^{-17}/yr) and the directly obtained value of 8.5×10^{-17} / yr.

Determination of the λ_f value is important for nuclear physics, with one of the major applications being the calculation of the fission track age in geochronology. The determination of this constant has been an active area of research since 1940. This study will compare the directly obtained λ_f value derived from a fission track experiment to values from the method of potassium/argon dating. The objective is to determine whether there are problems with K/Ar dating, uranium-based dating methods, or with both as the recent-creationist community would tend to believe.

INTRODUCTION

Background

In 1940, Flerov and Petrzhak found the spontaneous fission of uranium using an ionization chamber and estimated its partial decay constant was between 1×10^{-16} and 1×10^{-17} a^{-1} [2]. Since then, there has been much activity toward the determination of the λ_f constant. In 1959, using an electron microscope it was found that the fission fragments of heavy elements could produce radiation damage tracks in the insulating solid materials (such as for example, mica). In the early 1960s, using chemical etching means, R.L. Fleischer and P.B. Price successfully enlarged this kind of radiation damage tracks of fission fragments to such size that they could be observed with an optic microscope and established the fission track dating method on this basis. With the vigorous development of fission track dating, the accurate measurement of a λ_f value has still been a problem [3].

In the SSTD method, the first step is preparation of fission sources of natural uranium. Natural uranium is deposited on disks and the contents then analyzed. Next, the sample is irradiated. Natural uranium fission sources are covered with SSTD made up of polycarbonate Lexon or pure muscovite, for example.

Two different methods, the comparison method of fission track dating and other dating of international standard age samples and the SSTD method for natural uranium fission sources have different factors influencing reliability of data: (i) the fading of spontaneous fission tracks (fossil tracks), (ii) the influence of parameters of reactor on measurements of thermal neutron fluence during irradiation of samples. With regard to the first factor, the samples to be analysed in these experiments are of known age.

Since the 1940s, the decay constant value has become of great importance for geochronologists. Some new techniques strongly tied to fission tracks were added to the techniques used until that juncture. Methods used to measure λ_f values have been grouped as follows:

(1) direct determinations
(2) radiochemical or mass spectrochemical analysis
(3) solid-state track detectors (SSTD) and photographic emulsions

(4) fission track, K/Ar and or Rb/Sr dating comparisons, or dating of samples of well-known ages

Recent-creationism

Radioisotope data published in mainstream science journals seem to fit the age of the earth dictated by the uniformitarian model. Do the data fit old ages naturally or can the data fit the recent-creation model better by assuming an accelerated nuclear decay event before or after the Flood? To answer this question, the spontaneous fission track densities (SFTD, fission tracks per surface area) is the focus of this study.

Natural fission is a radioactive decay process which occurs for ^{238}U. Trace amounts of uranium are found in natural glasses and minerals. These materials store tracks of the fission event. The recoiling product nuclides produce tracks by disrupting the lattice structure in their trajectory. These fission tracks are on the order of tens of angstroms in width, but can be etched on a cross-section of the specimen to microns.

Using the principles of radioactivity, the number of fission tracks per surface area is related to the time since the rock or material solidified. Non-radiogenic and radiogenic sources for fission tracks other than ^{238}U are insignificant. It is not necessary to assume an initial radiogenic daughter amount because unsolidified rock does not retain fission tracks. Contamination is minimized by selecting a material characterized by homogeneous uranium content. Furthermore, SFTD between individual shards will be monitored for any surface count density variation.

The recent-creationist community has made attempts to theoretically explain the puzzling processes of creation and its origin. These creationist theories make fruitful avenues for experiment. Many recent-creationists claim that there was a time of increased nuclear decay. This means that decay constants of radioisotopes were not constant for a time during the past. These recent-creationists place an accelerated nuclear decay event during the Flood and/or Creation event.

In a recent study [4], the SFTD of a Miocene obsidian in Resting Spring Range interpreted to be post-Flood was analyzed in 1994. A SFTD of 2.0 +/- 10^4 cm^{-3} for a recent creation was predicted beforehand knowing the uranium content of the sample and assuming a constant fission rate in post-Flood times.

Recent-creationists continue to grapple with the true significance of radioisotopic dating methods. Many results of these methods published in standard journals in this century seem naturally to fit an old-earth view (i.e. an age of the earth of 4.5 billion years). In contrast, the Bible connects Creation, the Flood, and the time of Christ by chronological data which, with a straightforward reading account for only a few thousand years.

There are recent creationists who have postulated that mainstream published conclusions based on radioisotope data may not be as deductive as claimed. The data themselves have not been called into question; most recent creationists believe that the conclusions published in mainstream journals are consistent with a naturalistic world view. However, recent-creationists reject this naturalistic world-view reflected by the mainstream journals. This difference in world-view can influence the theoretical prediction, data interpretation, and research topic focus.

Recent-creationists are devising models for radioisotope dating based upon their foundational assumptions (for example Grand Canyon strata and Rb/Sr mixing models for isochrons). Most recent-creationist studies thus far have been theoretical, or have used published data. This seems to reflect limited resources rather than a predisposition for theory above experiment. However, a few recent-creationists have profitably used experimental aspects in their investigation of radiogenic dating. It is hoped that the work of this study will add to the recent-creationist database of experiment al radioisotope data and assist in refining the recent-creationist explanation of this information.

The sciences were built upon the idea that the universe was created by a rational Being. Early scientists, therefore, concluded that His works could be understood by rational investigation. These early scientists

were confident that correct results in science could only confirm Scripture. This led many of them to believe in a six-day creation and a world-wide Flood event in the earth's past. This meant that the rock strata could be categorized by these two major events in the world's history. This view of the catastrophic production of most strata is predominant today in most recent-creationist circles. Any given strata can be classified as creation, pre-flood or post-flood.

Today, there are many positions regarding the history of the earth in between the traditional recent creationist view and that of modern secular geology. This spectrum includes recent creation, progressive creation, theistic evolution, and purely atheistic or naturalistic evolution. It should be understood that there is considerable variation within these classifications. The recent-creationist views the geological age of the strata differently than the other groups. The rest of the origin spectrum tend to incorporate the claims of today's conventionally accepted geological column.

The most well-known Biblical chronology for the history of the earth is Bishop Ussher's. His chronology dates creation to the year 4004 B.C. Ussher's chronology is often mistakenly claimed to be the "creationist's view". Actually many creationists do not follow Ussher's work. Notable recent creationists would not deny that Scripture does not restrict the age of the earth to 4004 B.C.[5].

It does appear possible that there may be gaps in the Biblical genealogical data used by Ussher. However, it is believed that proposed gaps in these genealogies could not be extended to millions of years and the genealogies still be taken seriously. Thus, from the recent-creationist catastrophic perspective, all rocks are seen to be younger in age than millions of years.

The concept that most of the sedimentary layers of the earth are products of very slow but continuously occurring processes became appealing to some scientists around 1750 A.D. This became the common understanding of geologists by the 19th century.

Many isotopic dating methods have been developed in the past hundred years. Many of the ranges of application go beyond thousands of years. A lot of radioisotopic data seems to support the idea that the earth is much older than thousands of years, as claimed by the recent-creationists.

Some recent-creationists have suggested that the old ages given by radioisotopic dating methods are due to an event of accelerated nuclear decay which occurred during the flood, the fall, or even during Creation week. On the basis of these accelerated decay theories, Flood and pre-Flood rocks would be expected to possess large amounts of radioactive decay products, but post-flood rocks should not. A growing community of recent-creationists place the flood/post-flood boundary before the Cenozoic strata.

Theory

Radioisotope dating methods are based on the radioactive decay of the nucleus by either beta, alpha, a chain combination of the two, or spontaneous fission. Beta decay occurs when the nucleus of the stable isotope emits an electron, thus increasing the charge of the nucleus by one unit of charge. This can be regarded as a neutron transforming or decaying into a proton and an expelled electron. Similar processes occur in positron decay, but change in the opposite direction. One other method of decay involving electrons is the capture of an extranuclear electron into the nucleus causing a net decrease in positive charge of the nucleus; this is called an electron capture. Unstable nuclides of atomic number greater than 58 are prone to another mode of decay called alpha decay. Alpha particles are nuclides of two protons and two neutrons thus having a +2 charge. When an alpha particle is ejected from the nucleus during alpha decay, the atomic and neutron numbers are each reduced by two. The result is a daughter isotope of a different element with mass number 4 less than the parent.

For nuclides of Z greater than 100, another mode of decay, known as fission has been observed. Fission decay can occur both spontaneously and induced. Indeed fission was first observed in 1938 by Hahn and Straussman. Spontaneous nuclear fission of uranium was reported Flerov and Petrzhak in 1940. The nuclide fissions because the binding energy of the products is greater than that of the parents [6].

In this case, the atomic masses of the products of the fission average near 96 and 140 with energies ranging between 0.4 and 1 MeV per nucleon. Some of the total available decay energy is also given to freed neutrons and gamma emission. If ^{238}U are contained in certain materials, fission tracks are formed whenever these atoms decay by spontaneous fission. Glasses and glassy minerals preserve fission tracks. The first observation of fission tracks was in 1959 in mica by Silke and Barnes using a transmission electron microscope. Assuming a constant decay rate, a physical dating technique can be derived known

as fission track dating. The atom number of (D_s) of spontaneous fission of ^{238}U is

$$D_s = N_{238}(1 - e^{\lambda Dt})\frac{\lambda_f}{\lambda_t} \tag{1}$$

where N_{238} is the atom number of ^{238}U at the beginning moment t=0; λ_p total decay constant of ^{238}U; λ_f spontaneous decay constant of ^{238}U; t spontaneous fission decay time.

The number of spontaneous fission tracks (N_s) recorded on SSTD is:

$$N_s = N_{238}(1 - e^{-\lambda_D t})\frac{\lambda_f}{\lambda_D}\epsilon \tag{2}$$

where ϵ is the detection coefficient. If the time of spontaneous fission decay is not too long, a simplified form of Eq. (2) is used:

$$N_s = N_{238}\lambda_f t\epsilon \tag{3}$$

$$\lambda_f = \frac{N_s}{N_{238}t\epsilon} \tag{4}$$

Rutherford and Soddy suggested that for all time the rate of radioactive decay of an unstable isotope is directly proportional to the number of parent atoms remaining at any time, t.

$$\frac{dN}{dt} \propto N \tag{5}$$

dN is the differential change in the parent isotope atoms in some differential change in time. There is a minus sign because the rate decreases with respect to time. The proportionality can be converted to an equality by the introduction of the so-called decay constant, λ. This coefficient is assumed to be constant for all time. The decay constant can be regarded as the probability that an atom will decay within a unit of time. The equation then becomes:

$$\frac{dN}{dt} = (N - \lambda)N \tag{6}$$

By separating variables and integrating this relation, we can obtain a mathematical equation for time, t, required for a certain number of parent atoms to decay.

$$-\int \frac{dN}{dt} = \lambda \int dt \tag{7}$$

resulting in,

$$-\ln(N)\ \lambda t + C \tag{8}$$

where C is the constant of integration. The value of C can be found from initial conditions. When N = N_o and t = 0

$$C = -\ln(N_0) \tag{9}$$

Combining equations 8 and 9 gives

$$t = \frac{\ln(N_0) - \ln(N)}{\lambda} \tag{10}$$

or

$$t = \frac{1}{\lambda}\ln(\frac{N}{N_0}) \tag{11}$$

This relation is more commonly presented as

$$N = N_0 e^{-\lambda t} \tag{12}$$

describing all radioactive decay processes.

Two important parameters commonly related to the decay constant should be introduced for completeness. The first is called the half-life ($T_{1/2}$). This is the time elapsed for half of the parent isotope atoms of a system to decay. If $t = T_{1/2}$ and $N = 1/2\ N_o$ are substituted into equation 12 and solved for $T_{1/2}$ then

$$T_{1/2} = \frac{\ln(2)}{\lambda} \tag{13}$$

The second parameter, mean life (τ) is defined as the average life expectancy of an individual unstable nuclide. It is the time interval No of a system to reduce by a factor 1/e (where e = 2.718).

$$\tau = -\frac{1}{N_0} \int_{t=0}^{t=\infty} t\,dN \tag{14}$$

Knowing that $dN = -\lambda N dt$ and integrating results in:

$$t = -\frac{1}{\lambda} \tag{15}$$

Thus there is a simple relation between the decay constant and the half-life or the mean life. The number of radiogenic daughter atoms that are produced after an elapsed time t is:

$$D^* = N_0 - N \tag{16}$$

By substituting in the relation for N above D* becomes

$$D^* = N_0(1 - e^{-\lambda t}) \tag{17}$$

This amount is the total daughter product present at time t, assuming no atoms have been added or lost and that initially the system had zero daughter product. The relation which is normally used for radioisotope age determination is:

$$D = D_0 + N(e^{-\lambda t} - 1) \tag{18}$$

where D_o is the initial daughter, the second term on the right side is D* (knowing $N_o = Ne^{\lambda t}$), and D is the total amount of daughter product at time t. D and N are measurable quantities as opposed to D_o which much usually be assumed.

The development of a spontaneous fission track density equation is easily derived from general radioisotope dating principles. Fossil fission tracks observed in glassy material are a dosimeter of spontaneous fission of parent atoms into daughter products. Knowing the time since the rock or material solidified and the amount of fissionable parent nuclide at present (N) is, in practice, enough information to calculate a SFTD (similar to D) according to the principles described earlier. For this case, equation 18 looks like:

$$D = {}^{238}U(e^{-\lambda_\alpha t} - 1) \tag{19}$$

where D is now the number of alpha decay events and ^{238}U is the number of uranium atoms of mass number 238 per cubic centimeter.

Alpha decay of ^{238}U is the dominant decay ($\lambda = 1.55125 \times 10^{-10}\ yr^{-1}$). Loss of ^{238}U atoms from the sample with time can be approximated as entirely due to alpha emission, because the spontaneous fission constant (λ_f) is about 10^{-7} times smaller than λ_α. The fraction of decays given to spontaneous fission can be represented as

$$F_s = \frac{\lambda_f^{238}}{\lambda_\alpha} U(e^{-\lambda_\alpha t} - 1) \tag{20}$$

It is useful to note that $e^{\lambda\alpha t}$-1 approximately equals $\lambda_\alpha t$ for t < 500 Ma. Thus, F_s can be rewritten as

$$F_s = \lambda_f^{238} U t \tag{21}$$

The uranium content of the sample is usually determined in parts per million (ppm) and can be converted to appropriate units by,

$$^{238}U = \frac{U \rho N_A}{U_{\alpha w}} (1 - I) \tag{22}$$

where U is the total uranium content in ppm, r is the sample's mass density, NA = 6.023 x 10^{23} atoms/mole, U_{aw} is the atomic weight of uranium (=238.0289 amu), and I is the natural abundance of ^{235}U atoms to ^{238}U atoms (=1/137.88).
Thus,

$$F_s = \frac{\lambda_f U \rho N_A}{U_{\alpha w}} (1 - I) t \tag{23}$$

Given the value of λ_f, this equation can be used to predict a volume SFTD (F_s) for a sample of age t using the measured r and U content. The remainder of this chapter applies this equation in this way to our chosen rock sample.

Isotope dilution will be used to determine the uranium content of the sample. This technique uses a mass spectrometer to separate charged atoms and record the amounts of each mass on the basis of their responses to electrical and magnetic fields. Isotope dilution is more sensitive than neutron irradiation because the amount of the sample can be increased as the as the concentration of the desired element decreases.

The physics of fission track formation is similar in many respects to processes that occur in the more familiar case of alpha decay. Because of Newton's third law a recoil energy is given to both alpha and daughter nuclides. From the conservation of momentum in an alpha decay event,

$$M_a v_\alpha = M_p v_p \tag{24}$$

where M is mass and v is velocity of the labeled alpha and product nuclide. The total alpha decay energy is said to be the sum of the kinetic energy of the products created in the event.

$$E_\alpha = \frac{1}{2} M_\alpha v_\alpha^2 + \frac{1}{2} M_p v_p^2 \tag{25}$$

Using these relations and knowing the stopping power of the material the products travel through, a distance traveled can be determined for both the a particle and the recoiling daughter. Tracks with lengths of about 10^{-2} μm are produced. These have been observed in materials and utilized for age determinations. Note that the tracks in the material occur from the heavy product not the alpha particle.

The measured volume track density due to spontaneous fission, F_{sm}, can be related to the measured areal (or surface) track density, ρ_{sm}, as follows.

$$\rho_{sm} = F_{sm} q \tag{26}$$

The factor q represents that conversion factor and m signifies that the parameter is obtained from a track count. This transformation can be represented as,

$$d\rho_{sm} = {}^{238}U g(t) A f(x) dx \tag{27}$$

where $d\rho_{sm}$ is the area track density of tracks with the same track midpoint distance which cross the revealed surface, ^{238}U is the uranium-238 content of the sample g(t) is the separated time dependence of the equation, A is the area of the count, and f(x) is the fraction of track orientations with the same track midpoint displacement form the surface that actually cross the surface at x. This fraction is obtained by viewing the total track orientation as a sphere with radius L/2, where L is the length of the track. The fraction of track orientations that cross the surface at x in the figure is given by,

$$f(x) = \frac{surfacearea(cap)}{Surfacearea(hemisphere)} = 2\pi(L/2)\frac{(L/2 - x)}{2\pi(L/2)^2} \quad (28)$$

Integrating will give the total area track density of a surface cross-section for all possible track orientations and midpoint positions. Thus, the integration of f(X)dx gives,

$$\int_{-L/2}^{L/2} \frac{(L/2 - x)}{L/2} dx = (x - \frac{x^2}{L})_{-L/2}^{L/2} = L/2 \quad (29)$$

which is equal to q. Therefore the equation to relate an area fission track density to a volume fission track density is

$$F_{sm} = \frac{2\rho_{sm}}{L} \quad (30)$$

In practice it is necessary to include one other parameter to this equation. The determination of F_{sm} by a surface track count also depends on the track revealing efficiency (ϵ) of the fission track revealing technique. The more practical equation of F_{sm} is:

$$F_{sm} = \frac{2\rho_{sm}}{\epsilon L} \quad (31)$$

Interlaboratory Calibration

In the last fifteen years the range where λ_f could be comprised has been reduced, and two values are commonly accepted by fission track workers:

(1) about 7×10^{-17} yr^{-1}
(2) about 8.5×10^{-17} yr^{-1}

Ages calculated by using these two values differ by about 20%. However, measurements performed on the same samples in different laboratories, using the two λ_f values do not necessarily differ by 20% from one another, for researchers have not yet found a complete agreement on other parameters which are fundamental to fission track dating. In each laboratory where fission track dating has been developed for dating, a local calibration has been endeavored, especially during the early 1960s. Different methods have been used for the measurement of the neutron dose, for the counting, and for the age correction of samples which had undergone fossil-track fading. Thus, an evaluation of ages obtained by different laboratories is very difficult, especially if the age determinations date back to the very early determinations after 1962. It is known for certain that, in each laboratory, age measurements obtained by the fission track method have been compared to those obtained by other radiometric methods (prevalently K/Ar, Rb/Sr and U/Pb) and/or to the stratigraphic ages. Every calibration has been obviously directed toward the obtaining of data that are most concordant with those obtained in some other way.

It is possible that different laboratories with different λ_f values in use could have derived similar ages on identical samples using different dating methods. Some examples of ways this could have been done include: correcting or not correcting for the thermally lowered gas; using different neutron-dose standards, etc.

The first interlaboratory comparison was done on a sample distributed by C.W. Naeser of the U.S. Geological Survey (namely, apatite and zircon from the previously mentioned Fish Canyon tuff from the San Juan Mountains in Colorado). The results obtained using the decay constant of 7×10^{-17} yr^{-1} for the calculation have an average value higher than the results obtained by the labs where the constant 8.5×10^{-17} yr^{-1} was used; the difference was nearly 20%.

The analysis of the techniques connected with fission tracks - viz, the SSTD measurements, the measurements by best fit between FT and other ages and the measurements by dating well-known samples, clearly reveals that the uncertainty in λ_f strictly tied to the focal points of every fission track dating approach:

(1) neutron dosimetry
(2) dating technique and age correction

In the SSTD technique, λ_f is normally obtained by using a detector-uranium sandwich and counting the number of tracks produced on the detector in a known time, by the fissions occurring in the uranium

source next to it. The irradiation of the sandwich with thermal neutrons is used in order to solve two problems: the determination of the efficiency, and the determination of the number of ^{238}U atoms per unit volume in the uranium source. By efficiency one means the ratio between the number of revealable tracks by chemical etching on the detector surface and the number of fissions which occur in the uranium per unit volume. But the use of irradiation involves the dose measurement: λ_f determinations by SSTD were obtained by different laboratories using different dose calibrations. For this reason, such measurements, even if they predominantly agree with 7×10^{-17} yr^{-1}, are not easily comparable either with each other or with the data obtained by other techniques.

The hypothesis that SSTD values are lower than the real one because of a counting loss due to the track densities being low is not well-supported; in fact, this would assume the same counting loss for every laboratory.

When λ_f is obtained by the comparison between FT and K/Ar and/or Rb/Sr ages, the neutron-dose calibration and the much-discussed problem of apparent age correction are focal points. To show this the curves obtained by Fleischer and Price, Gentner, and Naeser are displayed.

The best fit between the fission track ages and K/Ar-Rb/Sr ages has been obtained by using samples, amongst others of tektites, obsidians, and muscovites. Whoever has analysed such kind of samples knows that thermally-lowered fission track ages are relatively frequent in them. Owing to the fact that in 1964 age corrections were not yet being used, the value of 6.9×10^{-17} yr^{-1} obtained should be regarded as lower than the real one, as some of the samples examined are likely to have had a fission-track age lowered by thermal phenomena, i.e. the observed fossil-track density to have been reduced. The above authors observed excessively young ages on some samples, but these were samples with extremely clear fading, which points were significantly distant from the line along which the points relating to the other samples were aligned [7].

In agreement with the results of Gentner, etal. the fossil track fading cannot be neglected when comparing FT ages and K/Ar ages, or Rb/Sr or other well-accepted ages for that matter. The above authors used, for the best fit of the data, only the unaffected fission-track ages. The corrected values of the ages on the graph agree perfectly with those obtained by other methods when using the best-fit value: 8.4×10^{-17} yr^{-1}. It must be noticed that in both Figs. 1 and 2, ages of identical materials, namely tektites and obsidians are shown.

Unfortunately, as stated before, the two λ_f measurements are not entirely comparable, owing to the lack of standardization of the neutron dosimetry. Naeser, et al., have built the same kind of curve using samples of zircons. Zircon is very resistant to fading phenomena; the last- named authors write: " ages are all from volcanic rocks in which annealing should be either absent or minimal."

Although Naeser, et al., do not explain in that paper their dating technique, it is very probable that they used the external-detector method, normally applied by Naeser in zircon samples. In this method, the fossil tracks are revealed on polished surfaces of the zircons themselves, whereas the induced tracks are observed in an external detector (which could be a muscovite mica or a plastic detector), which is placed in contact with the sample during the irradiation. In this way, the fossil tracks are registered with 4π geometry, whereas the induced tracks are registered with 2π geometry and in a different material [8].

In addition, ages by the external detector method are not susceptible of being corrected for fossil track fading. To calculate the age, a factor has to be introduced to correct for the induced track density. This factor should take into account the different geometry as well as the possible differences in etching efficiency, along with the possible discrepancies in optical counting of the two samples. Further work is needed to establish the effect of etching efficiency with crystallographic orientation in zircons and in other minerals. It means that when using the external-detector method, if for some of the polished surfaces of the zircons an etching efficiency is applicable which is lower than the one corresponding to the probable best orientation, a lower fission track age could be obtained.

In the field of λ_f determination by the dating of samples of well-known age, Wagner, etal, and Thiel and Herr have performed two very important measurements, as they analyzed samples whose age was historically known. The results agree with those obtained with the "rotating bubble chamber" (around 8.5 $\times 10^{-17}$ yr^{-1}). The neutron dose has been measured with great care by Wagner, etal. Nevertheless the results show that the neutron dosimetry is among the main sources of error. The authors emphasize the possibility of obtaining differences in the decay constant value which are not easily explainable if different

reactors and different irradiations are employed. This means that the determination of the neutron dose is one of the main problems in the λ_f measurement by the fission track method, even if the differences that Wagner, et al., observed are far from the percentage (20%) that separates the values clustered around 7×10^{-17} yr^{-1} and 8.5×10^{-17} yr^{-1}. Equally important is the fading of fossil tracks. as a proof the higher value of λ_f (about 8.5×10^{-17} yr^{-1}) supported by the fission track work by Storzer, Gentner, Wagner, Mark, Thiel and Herr is only used in laboratories where thermal fading corrections are applied easily and routinely. One could conclude that the lower value of λ_f could compensate for the lack of correction that is exhibited in thermally-lowered ages [9].

As shown in the above discussion, it is very difficult to say what the true value of the ^{238}U fission decay constant is. Many apparently good measurements can be found in the literature, which sometimes agree with one and sometimes agree with the other of the two values that are used by fission track workers today. A good calibration, accepted everywhere is the main aim of geochronoligists, so that age measurements performed in different laboratories may be compared with each other and with those obtained with other techniques. The analysis of the λ_f measurements made by the fission track method has shown that they are not easy to evaluate; this is because of the problems associated with the method that are still under discussion in connection with this geochronological technique. There are two possibilities in obtaining an interlaboratory calculation:

(1) the choice of a standard for neutron dose measurement which is acceptable to all; or
(2) the choice of one or more standard age samples

In the first case, the λ_f value is needed; the value obtained by the best fit between the fission track ages and ages obtained by other radiometric methods would be recommended. This comparison should be limited to easily controllable samples, for which any of the fading phenomena of the fossil tracks can be reasonably excluded. Not all researchers, in fact, agree with the correction of apparent ages and on which technique to use. It appears reasonable, for example to use a value of around 7×10^{-17} yr^{-1} for λ_f when for the neutron dose determination the standard glasses SRM 963 of the National Bureau of Standards, U.S.A., are used. But we must take into account the fact that this λ_f value must be considered a conventional value referring to the chosen standard [10].

If, on the other hand, an agreement on the choice of one or more of the age-standards is reached, then problems connected with both the neutron dose measurement and with the λ_f value can be overcome; as the age measured by the fission-track method would refer to the known ages. The age would be determined by a comparison between the ratios of (fossil/induced) track densities of both the sample with a known age and the ample under investigation. In any case, the standard-age samples must be chosen with great care as regards the presence of fading phenomena of the fossil tracks. However, there is an arbitrariness in the initial choice when it is maintained that in the standard sample, the age measured by the fission track method is equal to the age measured by other radiometric techniques.

A calibration obtained in these two ways does not give an absolute guarantee of the numerical values of the age, but it allows that, at least, a comparison can be made amongst measurements done at different laboratories. These points, in relation to the calibration of the fission-track method are widely discussed discussed in other papers in this special issue. In fact, as we have observed several times in this discussion, the value of the decay constant, the neutron dosimetry and the dating techniques are problems which are strictly tied to each other.

Finally, we must not forget the problem of the real value of the ^{238}U fission decay constant- that is even if an interlaboratory calibration is obtained and convincing age measurements can be performed. In fact, scientists cannot be satisfied with merely accepting a conventional value for a physical quantity which should be capable of being directly measured.

The Experiment

The irradiation by slow thermal neutrons of a sample will be accomplished at the University of Michigan's Phoenix Memorial reactor facility. The experiment will be performed to establish a direct measurement of the spontaneous fission constant in the glass. The glass will be obtained from the National Bureau of Standards and will be of a known age and known composition of uranium. The above equations have explained in detail how the fission constant can be calculated with the given information. The time of this experiment will be taken as 0.5 yrs.; previous calculations have determined that a uranium enriched sample of 5% uranium will be necessary, due to the constraints of the size of sample which can be accommodated at the Phoenix experimental reactor.

Microscopic analysis of the ample will be performed to determine a number of fission tracks to be obtained by direct evaluation (optically). This has been calculated to be approximately a ten hour experiment and should be performed in 2 days in December 1997. The resultant value of λ_f derived from the fission track density will be discussed in the light of the controversy outlined regarding recent-creationism and the naturalistic view of the universe. The values will be compared and discussed, and the consequences analysed insofar as they regard K/Ar derived fission constants, and the possibility of accelerated nuclear decay.

Implications about the possibilities of making consistent and accurate interlaboratory calculations will also be discussed as was outlined in the previous section. It is hoped that these results will contribute to the understanding of these three problems and add to the database available to creation science in radioisotopic dating.

CONCLUSION

The ^{238}U fission decay constant value is of prime importance for geochronologists, as it is one of the components of the formula for the age calculation by the fission track method. Since the discovery of ^{238}U spontaneous fission, many measurements have been performed to determine the fission rate constant, One of the reasons for the difficulty in measuring λ_f is the fact that the probability of the occurrence of fission is very much lower than that of competing radioactive decays: for uranium, for instance, the a decay constant is about 2×10^6 times the fission decay constant ($\lambda_\alpha = (^{238}U) = 1.551 \times 10^{-10}\ yr^{-1}$ [11].

More than 40 measurements of the ^{238}U fission decay constant have been performed since 1940 until now. Sometimes the results disagree with each other; most workers in fission track dating have used one of the two possible values: about $7 \times 10^{-17}\ yr^{-1}$ and about $8.5 \times 10^{-17}\ yr^{-1}$. Most of the SSTD measurements by solid state track detector in 2π geometry agree with the first value while most of the direct measurements agree with the second one. Measurements by radiochemical or mass-spectrometric analyses give a scatter over a large range [12].

Upon analysing the measurements obtained by the fission track method, it is clear that the two focal points are:

(1) neutron dosimetry ,and
(2) dating technique and age corrections.

The problem of λ_f values can then be solved only together with other open problems in fission track dating, when a standardization of the method can be accepted by all fission track workers.

The experiment discussed above will be a stepping stone in the development of a model for radioisotopic dating that will hopefully contribute to an understanding of the recent-creationist model and its validity. It is also hoped that these results will be a contribution toward interlaboratory analysis consistency among creation science researchers.

REFERENCES

[1] Westagate, J.A., **Isothermal Plateau-Fission-Track Ages of Hydrated Glass Shards form Silicic Tephra Beds.**, Earth and Planetary Science Letters V. 95 [1989] pp. 226-234

[2] Flerov and Petrzhak, **Spontaneous Fission of Uranium**, Journal of Physics V.3 [1940] pp.275-280

[3] Fleischer, R.L. and Price, P.B., Nuclear Tracks in Solids: Principles and Applications. [1975] University of California, Los Angeles, CA p. 605

[4] Bielecki, J.W., **A Study of the Spontaneous Fission Track Densities in Resting Spring Obsidian (Miocene) near Shoshone,CA** [1994] I.C.R. Master thesis p.17

[5] Humphreys, R., Starlight and Time, [1994], Master Books, Green Forest, AR, pp. 53-55

[6] Carpenter and Reimer, G.M., **Calibrated Glass Standards for Fission Track Use**, NBS Special Publication, [1974] pp. 249-260

[7] Gentner, W. and Storzer, D., **Calibration of the Decay Constant of 238U Spontaneous Fission**, Transactions of the American Nuclear Society, ANS [1972] V. 15 pp. 125-126

[8] Gleadow, A.J.W. and Lovering, J.F., **Geometry Factor for External Detectors in Fission Track Testing**, Nuclear Track Detection, [1977] V. 1 pp.99-106

[9] Green, P.F., **On the Cause of Shortening of Spontaneous Fission Tracks in Certain Minerals**, Nuclear Tracks [1980] V. 4 pp. 91-100

[10] Bertel, E., Mark, T.D. and Pahl,M., **A New Method for the Measurement of the Mean Etchable Fission Track Length and of Extremely High Fission Track Densities in Minerals**, Nuclear Track Detection V. 1 [1977] pp. 123-126

[11] Steven, T.A., United States Geological Survey Professional Paper, [1976] 575-D pp. D47-D55

[12] Emma, V. and LoNigro, S., **Decay Constant for Spontaneous Fission of 238U and 232Th**. Nuclear Instrumental Methods, V. 128 [1975] pp. 355-357