RATE Study: Questions Regarding Accelerated Nuclear Decay and Radiometric Dating

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Abstract

Secular arguments supporting the use of radiometric dating in defining natural history have been rebuffed by many creationist critiques. However, recently, several young-earth creationists have suggested that radiometric dating can be accepted with one or more episodes of accelerated nuclear decay having occurred during Earth's past. A number of theoretical and practical problems face this hypothesis, such as excessive heat generation, variability in the rate of nuclear decay among radioisotopes, and, perhaps most important, the lack of any radiometric age-date conversion factor that would allow the use of secular dating results in creationist field work.

Introduction

The old-age results from various methods of radiometric dating have been and remain one of the most serious challenges to biblical earth history, and so young-earth creationists have examined the science and, to a lesser extent, the philosophy behind radiometric dating. They have come to varying conclusions: (1) some have accepted the age-dates without question, and abandoned literal biblical history, (2) some accept the results, but propose mechanisms to bring them into line with literal biblical history (e.g., accelerated radiometric decay), and (3) some remain skeptical of radiometric dating methods/results, reject the assumptions that they require, and hold to a literal biblical history.

Any evaluation of radiometric dating must include an examination of its links to the naturalistic view of earth history. Therefore, any use of radiometric dating methods or results in creation science should be cautious and lean heavily on empirical evidence. An analysis of various radiometric methods has been done by young-earth creationists, dating back several decades. The results demonstrate sufficient leeway that naturalistic geologists can often "cherry-pick" dates they deem appropriate to their particular studies, and if results do not agree with expected dates, the "error" is attributed to any number of possible problems (Froede, 2010). Although radiometric dates are used to defend the evolutionary geologic column, it is important to remember that the column preceded dating methods, and does not require them for validation.

The largest and best-known study by young-earth creationists to date was the Radioisotopes and the Age of The Earth, or RATE, Project (Vardiman et al, 2000, 2005). This group investigated potential problems with using standard radiometric age-dating methods, as well as possible adjustments to results necessary to defend a young earth. One interesting conclusion from the RATE scientists was that some form of accelerated nuclear decay occurred in the past. However, many questions remain regarding the potential to verify and then use results based on the concept of a period of faster decay. These challenges

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Accepted for publication October 19, 2011

are both theoretical and practical. For example, how would one derive a "conversion factor" to correct conventional results to younger ages, and what is the role of the geologic timescale? Many opportunities exist for expanding this interesting area of research, but providing a defensible conversion factor for each of the age-dating methods should be a top priority. Until we can do so, the use of radiometric results in young-earth creation studies appears to be limited.

Radiometric Age-Dating in Creation Science—A Brief History

Beginning with the publication of *The Genesis Flood* (Whitcomb and Morris, 1961), radiometric age-dating was deemed incompatible with biblical history. Over the years, many young-earth creationists have documented the problems and unbiblical assumptions of various dating methods (Acrey, 1965; Armstrong, 1966; Clementson, 1970; Cook, 1968; Lammerts, 1964; Whitelaw 1968, 1969a, 1969b; Woodmorappe, 1979, 1999).

In 1968, Gentry proposed a bold idea based on his work on radioactively damaged zircons. He stated, "While there might be other alternatives, one possible explanation of these 'fractures' or 'blasting' halos is that *the rate of radioactive decay was at one time greater than that observed today*" (Gentry, 1968, p. 85; italics added). The idea that decay constants possibly varied in earth's past was also deemed possible by DeYoung (1976). Talbot (1977) supported varying constants, claiming that current physical laws may not have been constant in the past. Based on his examination of the Oklo natural uranium reactor, Chaffin (1982, 1985) suggested that accelerated radiometric decay had likely occurred during the Flood. But no one could offer a mechanism for decay acceleration. The possibility of "variable constants" (including variable rates of radiometric decay) was reviewed in a minisymposium in the *Creation Research Society Quarterly* (Baumgardner, 1990; Brown, 1990; Byl, 1990; Chaffin, 1987, 1990; Gentry, 1990; Heinze, 1992; Morton, 1990; Williams, 1990). These authors accepted the idea that "constants" may have varied in the past (most likely during the Flood), but none proposed a viable and quantifiable mechanism. Chaffin (2000) proposed that a variation in the fifth dimension of our universe early in the Creation Week might have led to accelerated nuclear decay.

RATE Project

As a joint project between the Institute for Creation Research and the Creation Research Society, the RATE group convened in 1997 to discuss issues with radiometric dating within the framework of a young earth. Vardiman (2000, p. 7) summarized their goals: "Radioisotopes and the age of the earth were significant problems which must be addressed if young-earth creationism was to continue to have significant impact on the issue of origins both within and outside the Christian community."

Research seemed predicated on the belief that

> at some time in the past much higher rates of radioisotope decay may have occurred, leading to the production of large quantities of daughter products in a short period of time. It has been suggested that these increased decay rates may have been part of the rock-forming process on the early earth and/or one of the results of God's judgment upon man following the Creation, that is, the Curse or during the Flood (Vardiman, 2000, p. 4).

The results of the eight-year study were published in 2005 (Vardiman et al, 2005), and the RATE scientists determined that

> accelerated nuclear decay was the most promising explanation for the large amount of daughter products. Initially, the concept of accelerated decay was only a hypothesis, but evidence from several different sources resulted in *accelerated decay becoming the primary explanation for the findings of RATE* (Vardiman, 2005, p. 7).

However, not all creationists accept accelerated decay as the best explanation for the data. In spite of the overall helpfulness of the study in many areas, such as empirical tests of various methods and the documentation of detectible Carbon-14 in coal and diamond samples purported to be billions of years old, several issues remain problems for accelerated decay theory. These include: (1) excessive heat generation, (2) the variability in the rate of nuclear decay among radioisotopes, and (3) the lack of any defined use for the theory.

Problem of Massive Heat Generation

Any episode of rapid nuclear decay should result in the release of large amounts of heat (Humphreys, 2005; Snelling, 2005; Vardiman, 2005). This heat would profoundly affect the planet, whether it happened during the Creation Week, following the Curse, or during the Flood. It is strange that there was limited discussion of the problem. Humphreys (2005, p. 68) stated,

> The RATE initiative has found several lines of evidence implying that rapid cooling occurred along with accelerated nuclear decay, resulting in a smaller rise of temperature than would have occurred without such cooling. Andrew Snelling's successful model for the formation of Po radiohalos requires *rapid cooling*.... John Baumgardner solved a long-standing geothermal mystery by assuming a burst of heat from accelerated decay accompanied by rapid cooling. In both these cases, most of the cooling could not be by the normal processes of conduction,

> convection, or radiation. Instead, the process would have to cool the entire volume of material simultaneously ("volume" cooling) and abnormally fast.

But what is the source of this "rapid cooling," and how would it offset the heat produced by rapid decay? Also, if Snelling's model requires rapid cooling, then he must be able to demonstrate the cooling independently of his model, or the two do not reinforce each other, and rapid decay and rapid cooling remain in the realm of speculation. If a new type of cooling ("volume cooling") is proposed, then this is certainly an area that requires extensive investigation.

> The heat carried by the water [acting as a cooling agent] has to go somewhere else on earth, and that heat would be more than enough to melt the earth's crust globally. Thus, we require significant volume cooling to compensate for the otherwise large amount of heat from accelerated nuclear decay…. In my feasibility study, I pointed out a little-known and less-understood phenomenon in standard General Relativity theory that seems quite relevant. The mechanism causes photons and moving material particles in an expanding cosmos to lose energy. The equations clearly show the loss of energy but where and how the energy goes is less clear…. This mechanism offers good potential for removing heat on a large scale. We do not need to resolve the experts' confusion about where the energy goes in order to utilize this mechanism (Humphreys, 2005, pp. 69–70).
>
> The real problem is how to keep non-radioactive materials from getting *too cold* at the same time (Humphreys, 2005, p. 73).

But if volume cooling is to be believed, then data should be supplied in defense of this mechanism. If the phenomenon cannot be empirically demonstrated, then it remains speculation. We look forward to future creationist research in resolving this interesting hypothetical proposal. Another area of research should address the accelerated decay of isotopes in apparent parallel stability with other physical phenomena. At a minimum, we should expect to find empirical evidence of rapid-to-instantaneous crustal cooling.

Variability in the Rates of Nuclear Decay

K-Ar, Rb-Sr, Sm-Nd, and Pb-Pb Isochron Discordance

Other questions warrant further investigation. For example, in his analysis of the parent/daughter radioisotopes for the Beartooth amphibolite (Wyoming) and the Bass Rapids diabase sill (Grand Canyon, Arizona), Austin determined that changing decay rates created discordances in the K-Ar, Rb-Sr, Sm-Nd, and Pb-Pb radioisotope age-dates. He noted,

> Furthermore, our data are consistent with the possibilities that, at some time or times in the past, decay of the α-emitters (^{238}U, ^{235}U, and ^{147}Sm) was accelerated more than decay of the β-emitters (^{87}Rb and ^{40}K). (Austin, 2005, p. 386)

Snelling and others reached this same conclusion in their investigation of the Bass Rapids diabase sill:

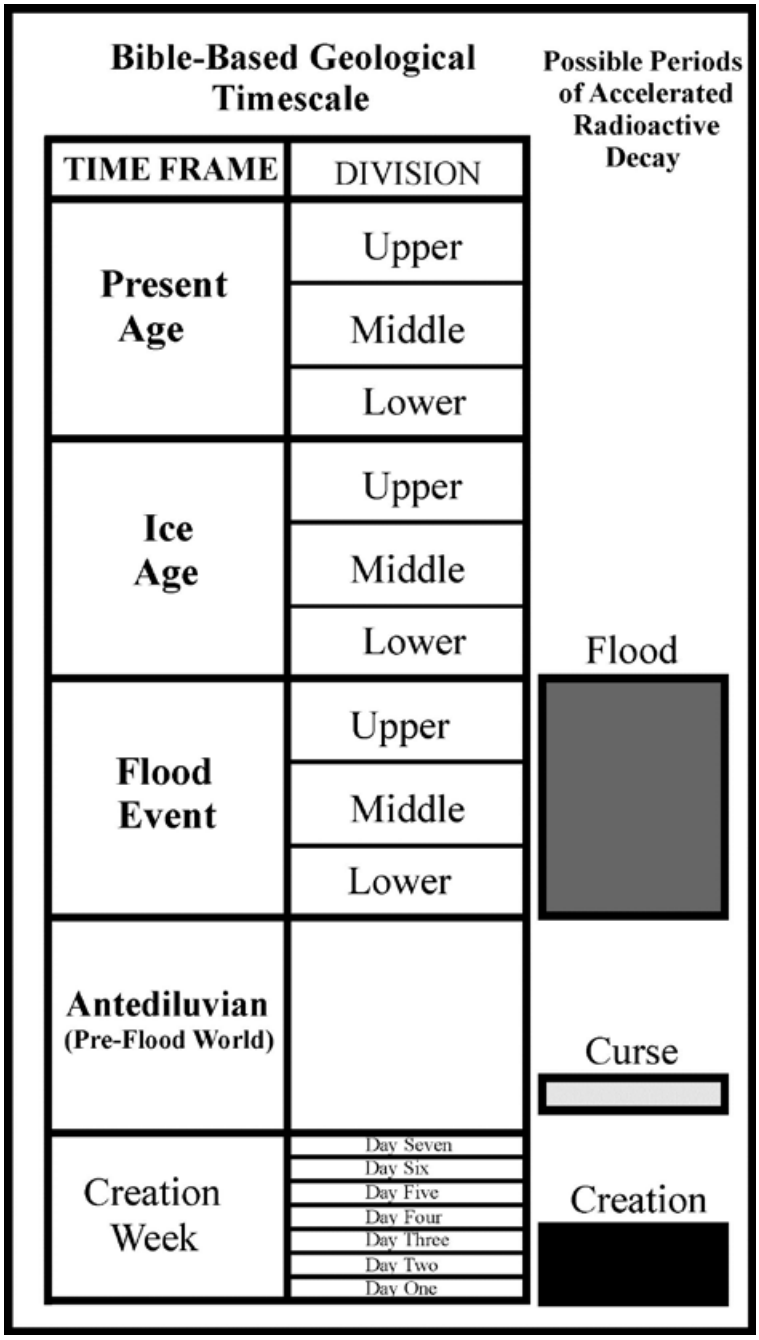
> Changing decay rates in the past could account for the demonstrated discordances between the resultant isochron "ages." Furthermore, our data are consistent with the possibilities that, at some time or times in the past, decay of the alpha emitters (^{238}U, ^{235}U, and ^{147}Sm) was accelerated more than decay of the beta emitters (^{87}Rb and ^{40}K), and the longer the present half-life of the alpha or beta emitter the more its decay was accelerated relative to the other alpha and beta emitters. (Snelling et al, 2003, p. 283)

Both projects concluded that there was decay-dependent variability in the rate of nuclear decay that should show consistent differences between *different* radiometric dating methods, yet some level of consistency in the *same* method. For the two sites studied, the Beartooth amphibolite had a reported radiometric age ranging between 2.52 billion years (Ga) ±110 million years (Ma) and 2.89 Ga ±190 Ma, and the Grand Canyon diabase sill returned ages between 0.842 Ma ±164 thousand years and 1.38 Ga ±140 Ma. These differences are reportedly a function of the different radiometric dating methods (Austin, 2005). No specific relationship between the results and period(s) when accelerated nuclear decay occurred were provided. In other words, what radiometric age-dates would indicate Creation Week rocks, post-Curse antediluvian rocks, or Flood rocks and sediments? (Figure 1) If the results (using accelerated decay) are to be useful, the ability to link rocks/sediments to biblical history is essential. This also raises the question of a quantifiable conversion factor for each radiometric method; such numerical factors would be invaluable for creationist analyses of radiometric age-dates (Figure 2).

Inconsistency between Carbon 14 and Long-Lived Nuclides

Baumgardner (2005) presented an interesting study on detectable carbon 14 (^{14}C) in various "old" coal deposits and diamonds. But the study raises questions for creationists too. If accelerated decay occurred, why were short-lived isotopes such as ^{14}C not eliminated altogether? Baumgardner addressed this issue:

> Evidence from this research suggests that several billions of years' worth of cumulative decay at today's rates occurred for isotopes such as ^{238}U during the creation of the physical earth and that a significant amount of such decay likewise took place during the Flood cataclysm. An important issue then arises as to how an episode of accelerated decay dur-



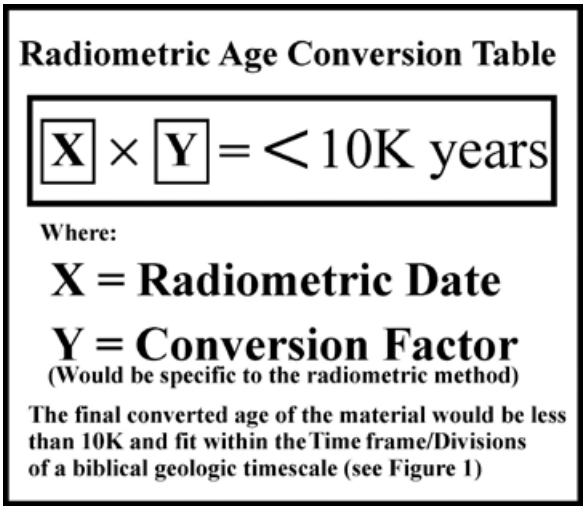


Figure 1 *(left)*. This diagram shows a biblical geologic timescale with three shaded boxes corresponding to the three periods of time when accelerated radiometric decay purportedly occurred. The darker the box, the greater the level of accelerated radiometric decay based on the findings of the RATE project team.

Figure 2 *(above)*. This diagram presents a hypothetical mathematical formula necessary to convert naturalistic radiometric dates to accelerated and acceptable values in the Creation/Flood geologic framework of earth history. Missing are the conversion factors for each of the secular radiometric age-dating methods. These factors will need to be provided in order to demonstrate that accelerated nuclear decay occurred within the anticipated time frame of the biblical record (see Figure 1).

ing the Flood might have affected a short half-life isotope like ^{14}C. The surprising levels of ^{14}C in fossil material from organisms that were alive before the cataclysm suggests that perhaps only a modest amount of accelerated ^{14}C decay took place during the cataclysm itself, an amount insufficient to eliminate the ^{14}C that existed in these organisms prior to the cataclysm. Accordingly, we here offer the tentative hypothesis that, whatever the physics was describing the decay acceleration, it did not operate in so simple a manner as to reduce temporarily the effective half-lives of all radioisotopes by the same factor. (Baumgardner, 2005, p. 620)

Hence this scaling, speculative as it may be suggests only about 2000 years' worth of accelerated ^{14}C decay occurred during the Flood. This amount of decay represents …~20% reduction in ^{14}C as a result of accelerated decay. (Baumgardner, 2005, p. 621)

At present, it is not clear how accelerated nuclear decay could have occurred at very high rates for the K-Ar, Rb-Sr, Sm-Nd, and Pb-Pb systems but at very low rates for short-lived isotopes such as ^{14}C. It would be of interest to all scientists who might use any of these

methods to have quantifiable conversions, based on sound science, which would demonstrate predictable results in the field. Of course, as with any forensic investigation, retrodiction of theoretical or presently observed events renders all historical applications less certain and open to revision.

Certainty and the RATE Results

The results of the Radioisotopes and the Age of the Earth (RATE) initiative are summarized in the last chapter of the second volume:

> The major result of the project is that nuclear decay processes appear to have been accelerated during brief periods in earth history (Vardiman et al, 2005, p. 735).

However, as noted above, the specifics of this process remain unknown, yet of intense interest, since radiometric dating remains a popular argument against biblical history. Thus, it is useful that some of the results of the RATE research appear to be critiques of radiometric dating from both theoretical and experimental perspectives (Snelling et al, 2003; Snelling, 2004).

One of the questions to be answered would be the timing of any accelerated nuclear decay event(s).

> Accelerated decay during several periods of earth history became the primary hypothesis because of the strong physical evidence the RATE group had accumulated that a large amount of nuclear decay had indeed occurred in the rocks themselves after their initial creation. This evidence suggested that most of the decay occurred during Creation week events, but also that a large amount must have taken place during the Genesis Flood. (Vardiman et al, 2005, p. 737)

These speculations remain uncertain because we do not know the original levels of radioisotopes in the various earth materials. Unfortunately, the same circularity that afflicts modern secular stratigraphers seems likely to also plague creationists that take this route. Quantifying accelerated decay for each dating method would go a long way toward reducing those uncertainties. Thus, while RATE has shown many problems with the secular use of radiometric dating, it has not yet generated a way to use results to help constrain actual field studies, and the resulting stratigraphic uncertainty remains.

Discussion and Conclusions

The RATE Project would have been stronger had it included the enumeration of clearly defined objectives at the outset, although their absence may simply reflect the inherent uncertainty in the historical application of any of these methods. We applaud and appreciate the valuable work that was done, but the apparent lack of empirical data necessary for understanding accelerated nuclear decay seems to provide no practical use for young-earth creationists. It also has a number of theoretical problems to solve before it can be accepted on even a theoretical basis. Right now, it might best be described as an interesting hypothesis. One issue is the timing, although the RATE group recognized that during certain periods accelerated nuclear decay would be less likely than others.

> The RATE group considered the possibility that a substantial amount of decay might have occurred during the Judgment in the Garden of Eden, but then it was concluded that the implied levels of radiation and heating would have been so highly destructive to biology at that point in earth history as to render this possibility unlikely (Vardiman et al, 2005, p. 737).

Humphreys (2005) addressed this problem in his summary chapter. He speculated that heat produced by rapid decay would be removed by "volume cooling" so quickly that it would not be a problem. The associated issue of excessive radiation generated during accelerated nuclear decay was briefly mentioned, but no clear solution seems possible, given the unknowns at present.

Snelling et al (2003) and Austin (2005) suggested that "older" rocks experienced greater levels of accelerated nuclear decay than younger rocks. If true, then some evidence is possible, such as gradational metamorphism (i.e., the older rocks being of higher metamorphic grade than the younger). However, it may be difficult to tie this kind of evidence to accelerated decay, since metamorphism may have been caused by other factors. Their proposal also raises the inherent problem of knowing the relative ages of rocks in the first place. Some creationists resolve this problem by accepting a compressed version of the standard geologic timescale, although one reason for doing so is the presumption of accelerated radiometric dating (Dickens and Snelling, 2008a, 2008b). However, Reed (2008a, 2008b, 2008c, 2008d) and others (Froede, 2008; Reed and Oard, 2008) have questioned this approach. It is not clear if the RATE results support this conclusion.

An important issue that must be resolved by proponents of accelerated decay is how any field application of their theory can be squared with earlier research that demonstrated a lack of accuracy and precision of radiometric results, and their inconsistency with other field evidence. Some of these studies showed results that were definitively wrong (Austin, 1988, 1992, 1994, 1996, 2000; Snelling, 1995, 1999a, 1999b, 2000a, 2000b). It will be interesting to see if any of these systematic problems can be resolved by accelerated radiometric decay theory.

A competing theory was proposed by Woodmorappe (1999). He asserted that radiometric dating is inherently unreliable and that secular scientists select desired results from a reservoir of

inconsistent results, based on their needs at the time. Future research would be enhanced if creationists used the accelerated decay theory and Woodmorappe's statistical noise theory as competing hypotheses. This would provide a more comprehensive focus on the problem and force the proponents of accelerated decay to address issues that might not have been clear before. It would require researchers to find a quantitative basis for eliciting consistency from apparently inconsistent results. This might provide the basis for conversion factors or equations that would ultimately allow the theory to become useful in field studies. If they cannot, then the skepticism of Woodmorappe (1999) and the earlier creationists who wrote against radiometric age-dating might be vindicated.

But even then, a good result will have been achieved. If creationists can demonstrate the inherent inconsistency of secular results, the argument for a young earth is greatly strengthened. This would force acknowledgment that chronology must ultimately rest on the divinely inspired historical documents provided in the Bible. Similarly, the demonstration of the unreliability of radiometric dating would reinforce the inherent weakness of the geological timescale (Reed, 2008c).

Many opportunities exist for expanding further study and research into this interesting area, but providing a scientifically defensible conversion factor for each of the age-dating methods should become a research priority for those who wish to demonstrate the reality for episodic events of accelerated decay in the past. Such a result would not only validate their theory, but also would provide a useful field tool for geologists. However, in our opinion, too many questions remain unanswered for creationists to adopt this hypothesis at this time. Therefore, at present, it would seem best not to assume that accelerated nuclear decay provides an acceptable pathway for the adoption of naturalistically derived radiometric age-dates, as it currently lacks functionality or application.

Acknowledgments

We are grateful for the assistance we have received from a number of individuals, including Dr. John Reed, Dr. Don DeYoung, and Dr. Kevin Anderson. Gratitude is expressed to the anonymous peer reviewers for their helpful comments. We thank Mr. Jon Richards, who provided a valuable technical review. We also appreciate the support of our spouses (Prov. 12:4). Any mistakes that may remain are our own. Glory to God in the highest (Prov. 3:5–6)!

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JoC: Journal of Creation
CenTJ: Creation ex nihilo Technical Journal

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