CORRELATION OF C-14 AGE WITH REAL TIME

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Abstract

A quantitative relationship is derived by which a C-14 age may be translated into a real-time equivalent that is consistent with the chronological data given in the Bible and also with C-14 age data for historic events. Two applications of this conversion formula are given that remove anomalies in the C-14 age estimates for the lifespan of a frozen musk ox carcass from Alaska, and dung accumulation rates in a Grand Canyon cave that served as a ground sloth den.

Introduction

The full spectrum of C-14 age data must be taken into account in the development of a model for Earth history that gives proper recognition to the data in the first chapters of Genesis. Appropriate use of biblical data and C-14 data in the development of such a model requires a quantitative conversion between C-14 age and real-time age. Noteworthy contributions to the need for this conversion have been made by Whitelaw (1970), Hefferlin (1972), and Hanson (1976). The following treatment develops an expression for radiocarbon age as a function of real-time in a mathematical equation that can be readily adjusted to meet the user's preferences concerning the real-time date for the Flood and the biosphere C-14 level at the time of the Flood.

The quantitative development presented here is limited to the period of Earth history following the refashioning of Earth's geography, climate, and ecosystems that resulted from the universal catastrophe described in the seventh and eighth chapters of Genesis (the Genesis Flood). There is no C-14 data on which to base a similar treatment for the pre-Flood era.

Mathematical Development

We can begin the quantitative development with Equation 1,

$$A = A_1[1 - (1\text{-}f)\, e^{-at}] \qquad (1)$$

In which A represents C-14 activity, either as the ratio of C-14 to C-12, or as the number of C-14 spontaneous transformations per unit of time per unit mass of carbon. A_1 represents the equilibrium value of A that would be reached after an infinite amount of time. The A without a subscript represents the activity t years after the Flood. The value of A immediately after, or during, the Flood, t = 0, is represented by fA_1. The exponential rate at which A changes after a disturbance from its equilibrium value is represented by a.

Equation 1 assumes that all factors influencing the level of C-14 in the biosphere after the Flood can be satisfactorily represented by a first-order exponential function. If this assumption is inadequate, and there was a fluctuation of A from a smooth simple exponential trend, there will be uncertainty in a real-time equivalent age based on Equation 1.

Variations in the exponential constant a of Equation 1 could result from variation in the rate at which CO_2 was taken out of the atmosphere by the reestablishment of vegetation after the Flood. Other variables include the volubility of atmospheric CO_2 in the surface water of the ocean (CO_2 volubility increases with lower water temperature), the cosmic radiation level, and the geomagnetic field (a decrease in geomagnetic field allows more cosmic radiation to interact with the atmosphere and produce C-14). The constant a is an equilibration constant, not a nuclear decay constant. This can be illustrated by the changes in biosphere C-14 levels associated with nuclear weapon testing. By 1965 the atmosphere and fresh-growth C-14 levels in the Northern Hemisphere had increased 90% (nearly doubled) due to C-14 produced by nuclear explosions. After the testing of nuclear weapons in the atmosphere was discontinued, the excess C-14 level dropped exponentially, reaching 20% by 1986 (Kozak, et al., 1989).

Equation 1 is easier to use if time is measured backward from the present. Using T to represent time in years before present (BP), according to the radiocarbon age convention of zero time at AD 1950, and F to represent the date of the Flood in years BP, Equation 1 becomes

$$A = A_1[1 - (1\text{-}f)\, e^{-a(F-T)}] \qquad (2)$$

Essential agreement of C-14 age with real-time historical age can readily be established as far back as the middle of the second millennium BC (3500 BP) [Libby, 1955]. Correlation beyond 4000 BP must be based on models that involve assumptions, due to lack of objects which can be precisely dated from historical records. To meet the requirement that A has been approximately equal to A_1 (equilibrium of C-14 in the upper biosphere) over the past 3500 years, we can use a trial setting of $A = 0.95A_1$ at T = 4000, from which

$$a = \{\ln[20(1\text{-}f)]\}/(F\text{-}4000)$$

$$= [2.996 + \ln(1\text{-}f)]/(F\text{-}4000).$$

With this expression for a Equation 2 becomes

$$A = A_1\{1 - (1\text{-}f)e^{-[2.996 + \ln(1\text{-}f)](F-T)/(F-4000)}\}. \qquad (3)$$

Since we are not making observations at time T, but at the present (T = 0), we need an expression for the activity at zero BP, A_n, of a specimen that had activity A at T years, BP. Over the time since T years ago the C-14 activity will decrease exponentially at the rate corresponding to the mean life of a C-14 atom. For simplification 8300 years can be used for the mean radiocarbon life (half-life 5730 years). Accordingly $A_n = Ae^{-T/8300}$, with A given by Equation 3. Consequently

$$A_n = A_1\{1 - (1\text{-}f)e^{-[2.996 + \ln(1\text{-}f)](F-T)/(F-4000)}\}e^{-T/8300}. \qquad (4)$$

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The present activity A_n is interpreted to indicate a C-14 age R by the relationship $A_n = A_1 e^{-R/8300}$. With this expression for A_n we can proceed from Equation 4 to a relationship between radiocarbon age R and real-time age T for specified values of F and f.

$$e^{-R/8300} = e^{-T/8300}\{1 - (1-f)e^{-[2.996 + \ln(1-f)](F-T)/(f-4000)}\}. \quad (5)$$

In my judgment the most suitable value for F is 5350. The reasons for this choice (Brown, 1990) are bolstered by the observation that amino acid racemization/epimerization rate constants for C-14 dated material are more consistent when computed with real-time age equivalents based on 5350 than on values a few hundred years less or greater (Brown and Webster, in press).

A value for f can be estimated from the evidence that fossils which are a consequence of the Flood (coal, e.g.) have C-14 ages in the 40,000 year range, and likely centering around 43,000 (Brown, 1988). Material deposited 5350 years ago and having a present C-14 age of 43,000 would have had an initial C-14 "age" of 43,000 minus 5350 (37,650 BP). The fraction of equilibrium activity represented by age 37,650 is 0.011. The range between 40 and 46 thousand years for a C-14 age placement of the Flood represents a range of 0.015-0.007 for f, so a suitable estimate for f would be 0.011 ± 0.004. Neither the precision of C-14 age data nor the strictness of the relationship in Equation 5 justifies carrying the ± terms related to the uncertainty in f, so a working relationship from Equation 5 is

$$e^{-R/8300} = e^{-T/8300}\{1 - 0.989e^{-2.985(5350-T)/1350}\}. \quad (6)$$

The relationship of Equation 6 is easier to work with if ages are expressed in thousands of years, R_k and T_k,

$$e^{-R_k/8.3} = e^{-T_k/8.3}\{1 - 0.989e^{-2.11(5.35-T_k)}\}. \quad (7)$$

A more convenient form of this relationship is obtained by taking the natural logarithm of Equation 7,

$$R_k = T_k + 8.3\{\ln[1 - 0.989e^{-2.211(5.35-T_k)}]^{-1}\} \quad (8)$$

Application

Values of C-14 age R for corresponding real-time age T, as calculated from Equation 8, are listed in Table I. A plot of these values is given in Figure 1. For a corresponding table and plot based on placement of the Flood at 5000 BP with negligible initial C-14 see Brown, 1990.

The buildup of C-14 in the biosphere from a level on the order of 1/100th the level that has been maintained closely over the past 3500 years probably did not proceed with monotonous uniformity. Some anomalies are to be expected in real-time ages derived from C-14 ages by use of a simple mathematical relationship such as given by Equation 8. Use of Equation 8 for C-14 ages greater than 34,000 is highly questionable. For C-14 ages in the range between zero and 30,000 C-14 years the associated real-time age probably may be significantly placed within a range of less than ± 100 years.

A test of the Equation 8 relationship can be made with C-14 data for a musk ox carcass frozen in Alaskan muck (Stuckenrath and Mielke, 1970). The C-14 ages of scalp muscle tissue and hair are 24,140 ± 2200 and 17,210 ± 500, respectively. The difference between the age of hair and the age of underlying tissue should be a minimum value for the life span of the supporting animal. The conversions given by Equation 8 place this difference approximately in the 48-92 year range. A fully satisfactory determination of life span would require better than 0.2% precision in the real-time age equivalents. Such precision is beyond the capabilities of C-14 age determination techniques, and less than the confidence range for a conversion with Equation 8.

Table I. Tabulation of Representative Real-time Ages, T, versus Associated Radiocarbon Age, R, in years.

T	R	T	R	T	R
0	0	3800	4070	5000	10,060
1000	1000	3900	4240	5050	10,960
2000	2000	4000	4430	5100	12,090
2500	2510	4100	4630	5150	13,530
3000	3050	4200	4870	5200	15,470
3100	3160	4300	5150	5250	18,320
3200	3270	4400	5470	5300	23,290
3300	3390	4500	5860	5310	24,880
3400	3510	4600	6330	5320	26,880
3500	3640	4700	6920	5330	29,590
3600	3770	4800	7680	5340	33,750
3700	3920	4900	8680	5350	42,780

Another test can be made with data for the ground sloth dung deposit in Rampart Cave (Long and Martin, 1974). Approximately 39,000 dung pellets accumulated in the main area of this cave between 40 and 20 thousand C-14 years BP. An average of 1.9 pellets per year (39,000 divided by 20,000 C-14 years) is unrealistic for a viable population of sloths in the vicinity of the cave. Converting 40,000 and 20,000 to 5348 and 5271 years real-time gives a 77 year interval and about 1.4 dung pellets per day. The upper 50 cm of cave floor deposit accumulated between 12,000 and 10,800 C-14 years BP, and represents about 215 pellets per C-14 year in the main area of the cave. Conversion to real-time equivalents yields 13 pellets per day over a real time interval of 54 years. [These comparisons should be taken in place of the incorrect treatment I gave at the First International Conference on Creationism (Brown, 1986; specifically page 48, paragraph 3).]

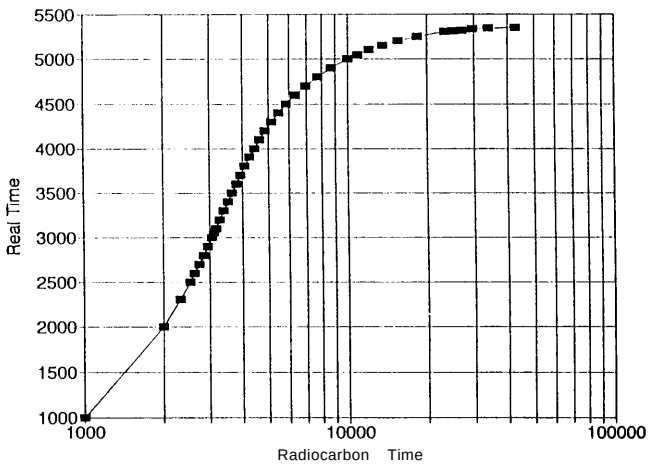

Figure 1. Plot of real-time (T) vs. radiocarbon time (R) from data in Table I.

Conclusion

There appears to be a sound basis for quantitative correlation of C-14 ages over the range between zero and the vicinity of 35,000 years BP with real time ages that are in conformity with biblical guidelines. It is the hope of the author that the treatment in this paper will increase the effectiveness with which C-14 measurements may be used in scientific research, as well as contribute to confidence in the biblical chronological data.

Acknowledgments

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CARBON-14 QUARTERLY BIBLIOGRAPHY

Many readers who enjoyed Dr. Brown's fine article may find other articles, sections of articles and notes on carbon-14 dating of interest. A selected bibliography is given below for those who wish to do an in-depth study of creationist articles on the subject.

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BOOK REVIEWS

Darwin On Trial by Phillip E. Johnson. 1991. Regnery Gateway. Washington, DC, 195 pages. $19.95.

Reviewed by Wilbert Rusch, Sr.*

This latest critique of Darwinism is written by Phillip E. Johnson, a law professor at Berkeley.** He underlines what every reader of the works of Darwinism proponents usually encounters, namely, that they accept Darwinism as fact and then seek evidence to support it. I have always found this type of approach to be irritating and unscholarly. Such writers usually fail to heed the admonition of one of their mentors, Thomas H. Huxley, when he said:

> . . . there is not a single belief that it is not a bounden (sic) duty with them to hold with a light hand and to part with cheerfully, the moment it is really proved contrary to any fact, great or small (Huxley, p. 469).

In this work, Professor Johnson combines a broad knowledge of biology with the incisive logic of a leading legal scholar to underline the validity of Huxley's admonition. Michael Denton refers to *Darwin On Trial* as "the best critique of Darwinism he has ever seen." He then adds "there is no doubt that this book will prove a severe embarrassment to the Darwinian establishment" (back cover).

Johnson discusses in turn the following topics;

The Legal Setting
Natural Selection
Both Micro- and Macromutations
The Fossil Problem
The Vertebrate Sequence
The Molecular Evidence
Pre-biological Evolution
The Rules of Science
Darwinist Religion
Darwinist Education
Science and Pseudoscience
Research Notes

I found the last section particularly useful. It served as an excellent study guide to the sources used in the production of this work.

In his concluding chapter, "Science and Pseudoscience," Johnson makes the point:

> that if the purpose of Darwinism is to persuade the public to believe that there is no purposeful intelligence that transcends the natural world, then this purpose implies two important limitations upon scientific inquiry.
>
> First, scientists may not consider all the possibilities, but must restrict themselves to those which are consistent with a strict philosophical naturalism. Secondly, scientists may not falsify an element of Darwinism, such as the creative power of natural selection, until and unless they can provide an acceptable substitute. This rule is necessary because advocates of naturalism must at all times have a complete theory at their disposal to prevent any rival philosophy from establishing a foothold" (p. 154).

I have long noted this characteristic in many evolutionist writings.

I appreciated that Johnson was ready to discuss Dawkins' *The Blind Watchmaker* (1985) as well as Edey and Johanson's *Blueprints: Solving the Mystery of Evolution* (1989). Further, he also contends with the works of both S. J. Gould and Douglas Futuyma. Creationists would be interested in his answers to these works.

In general, *Darwin On Trial* is scholarly and well-written. I can heartily recommend its purchase by those interested in the creation approach to the matter of origins. It will serve as a valuable reference work for individuals who propose to write or speak on the subject of origins. I recommend Johnson's work as a valuable and necessary addition to the library of any Christian college. It also has its place in the library of the concerned pastor.

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A Scientific Approach to Christianity by Robert W. Faid. 1991. New Leaf Press, P.O. Box 311, Green Forest, AR 72638.196 pages $15.

Reviewed by Clifford L. Lillo*

The book jacket describes the author as a nuclear scientist and consultant to the nuclear power industry and claims:

Science proves these amazing facts:
Jesus was a historical person.
There is actual evidence for the Resurrection.
The Bible was dictated by the Holy Spirit and contains mathematical proof of this.
There is an afterlife, a heaven, a hell, and coming judgment.
Scientific evidence refutes the theory of evolution.

However, a look within the covers reveals that Faid falls woefully short of such grandiose proofs. The author has used no footnotes but does quote from the

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**Another review of this book may be seen in *CRSQ* 28:171.
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