RADIOCARBON DATING AFTER FORTY YEARS: DO CREATIONISTS SEE IT AS SUPPORTING THE BIBLICAL CREATION AND FLOOD?

A Review and Critique of Pertinent Creationist Writing, 1950-1990

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Abstract

Some 30 papers by creationists on various aspects of radiocarbon dating have appeared since the definitive work by Willard F. Libby appeared 40 years ago. During that time over 50,000 published dates, using the Libby Method have appeared in the annual journal Radiocarbon. *This paper surveys and compares the views expressed by creationist in these papers, mostly in* CRSQ, *and summarizes the points on which they agree and differ. The objective is two fold, (1) to show that a substantial body of creationists perceive that the radiocarbon dating method, properly screened and corrected, dramatically supports both the biblical Creation and Flood, and (2) to establish a basis for harmony among creationists in asserting such support so as to confront evolutionists with this biblical witness and evoke a response.*

By biblical creation is meant a sudden appearance of the entire natural universe by divine fiat within six Earth days; and by the biblical Flood is meant worldwide catastrophic inundation and destruction of all terrestrial life as described in Genesis 6-8.

Introduction

The radiocarbon dating method was conceived about 1950 and published by Willard F. Libby in 1952. It provided a completely new tool by which to measure the age (i.e. death-date) of ancient wooden artifacts, carbon-bearing fossils, and buried vegetation of all kinds. Here was a tool totally unlike the earlier methods attempted for radiometric dating of rock strata, a tool that goes to the heart of the creation vs. evolution question "When did life begin?". Furthermore, Libby verified that the method, applied to specimens of known age (cathedral arches, old barges, etc.) gave consistent answers within a probable error smaller than many prior methods used in archeology.

In the 40 years that have elapsed since Libby's initial work, it has generated three kinds of response in the world of science, as follows:

(1) Over 50,000 radiocarbon dates of specimens of all kinds from all parts of the earth, determined by over 100 leading laboratories worldwide, have been published, first in *Science* until 1958, and since then in the annual journal *Radiocarbon*.

(2) The body of scientist and publications generally committed to acceptance and defense of evolution and the geological ages proposed by Lyell in 1830, have used the dates sparingly. None appear to question their first amazing result, namely that every valid specimen, whether of human, animal, or vegetable origin, yields a death-date compatible with fiat creation some 7,000 years ago (as will be shown), whereas Lyellian geology, if true, should have resulted in 99 percent of all primeval specimens being "too old to date" since radiocarbon cannot detect reliable death-dates older than about 35,000 years.

(3) A significant number of scientists committed to the trustworthiness of Scripture, have reported that C-14 dating gives us a tool which can verify (and vindicate) Scripture at the two critical points in ancient history which leave no room for the presuppositions of evolution, namely, (a) the first appearance of all biological life some 7,000 years ago, beginning with vegetation on the third day of God's creative work, and (b) the total destruction of all animal life (except for eight humans and representative pairs of animals preserved in a small ship), and worldwide inundation of the land mass in a span of a few months some 5,000 years ago, based on biblical chronology.

It is fitting therefore that we choose the fortieth anniversary of the radiocarbon dating method to survey the scientific publications of creationists pertinent to radiocarbon dating, and to show how remarkably they support the historical truth of both the biblical Creation and Flood.

Some Facts about Dating Prehistoric Events, Artifacts, Life, and Strata

Archeological papers describing events and artifacts before the Christian era use such phrases as "These are dated at XXX B.C. . . .," or "These belong to the XXX Dynasty of Egypt in the reign of YYY . . ."; or pertaining to a new geological or fossil discovery, "This has been dated XXX million years ago . . ."

If such a paper pertains to an artifact or event in ancient history reported in a prestigious scientific journal, or engraved upon a plaque at a famous museum, one assumes that the investigator who assigned such dates employed a proven chronology, such as a sequence of regnal years linked to a known date in the modern calendar. If it pertains to a prehistoric fossil or rock strata, one assumes that the reporting scientist likewise employed a reliable means of dating the fossil or rock capable of spanning many thousands (or millions) of years with fair accuracy. It is unthinkable to most readers that such statements would originate from assumptions never proved, and become "scientifically accepted" largely by constant repetition. Even more amazing is it to find geologists and paleontologists adhering to Lyell's table of geological ages which was invented over 150 years ago and never yet substantiated.

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In approaching all such literature, the Bible-believer therefore needs to know three important facts about "dating" any event, fossil, or artifact that existed before the Christian era, i.e. before events were reliably recorded using the western calendar (or in parts of the world whose calendars can be synchronized with ours). These three facts are:

(1) It is not possible to establish the date of any event in human history prior to Christ apart from biblical chronology. Following Anstey et al, one begins with Daniel 9:23-27 to establish the first regnal year of Cyrus at the Fall of Babylon 486.5 years before Christ's crucifixion. To date an event prior to that, one must be able to tie it to some event in Hebrew history linked to biblical chronology. The dates for OT events printed in some Bibles (usually from Ussher) are based on Ptolemy's spurious canon of Assyrian and Persian kings, or on supposed dates of Olympiads or solar eclipses, never fully verified. The more ancient dates of Egyptian dynasties based on Manetho et al, or of paleo-Babylonian dynasties based on Berosus, etc., are even less reliable by as much as thousands of years.

(2) No fossil, organic residue, or ancient artifact can be dated reliably unless it contains carbon uncontaminated by its environment. Radiocarbon dating in that case is best provided one measures its present specific decay rate, SDR, *and calculates its SDR when it died* by knowing the specific production rate of radiocarbon in the world carbon cycle (Note 1).

(3) The date of origin or formation of rock-strata of any kind, igneous, metamorphic or sedimentary, cannot be established by any method proposed to date without knowledge of conditions or events (atmospheric, magnetic, or geological) when it was formed. Hence such "clocks" require "pre-setting the hands" in order to read them.

Since Libby's definitive work of 1952, some 30 papers by creationists on radiocarbon dating have appeared. Beginning with Libby, these writings are numbered and reviewed below.

Terms and Definitions

Author: The word "author" always refers to the author of the paper being surveyed.

Reviewer: The writer of this review.

SPR: Specific Production Rate of C-14 atoms in the earth's atmosphere by cosmic radiation, in atoms per minute per gram of total carbon in the earth's active carbon inventory. This inventory is defined as all carbon in the cycle from atmospheric CO, to living things and back again, i.e. carbon that passes from the air to anything in the biosphere while living, and then after death restores that same carbon to the atmosphere while decaying. The only carbon on earth excluded from this cycle is that so buried in strata or the ocean floor as to be inaccessible to oxidation by the atmosphere. See Paper #l for one estimate of this inventory today.

SDR: Specific Decay Rate of C-14 atoms in any specimen of a living or once-living thing, in atoms per minute per gm of total carbon in the specimen. For living things on earth today SDR is approximately 16 disintegrations/min per gm of total carbon, which corresponds to approximately 1.4 atoms of C-14 per trillion atoms of total carbon.

BP: Before Present, on a radiocarbon date, where "Present" has been chosen as 1950, in order to correct for abnormally "old" atmospheric CO_2 in the modern era. See Paper #5.

Review of Creationist Papers on Radiocarbon Dating, 1950-1990

The papers are numbered and reviewed in chronological order, beginning with the definitive work of Willard Libby. Though Libby was not a creationist, he himself perceived that here was a clock that indicated a "recent turning-on" of C-14 in the earth's atmospheric carbon dioxide, a fact he promptly dismissed because of its creationist implications.

Paper 1. Libby, W. F. *Radiocarbon Dating.* 1952, 1955. University of Chicago Press. Chicago.

Libby begins by describing his method step-by-step as follows:

(1) Cosmic radiation bombards the earth's atmosphere with energetic particles of 1 to 2 billion electron-volts;

(2) These generate neutrons of 5 to 10 million electron-volts (mev) at all altitudes, with maximum at about 40,000 feet.

(3) This flux of free neutrons, most of it slowed to lower energy (below 1 mev) by scattering, collides with atmospheric nitrogen in two concurrent nuclear reactions:

With neutrons of 0.4-1.6 mev,

$$N^{14} + n = C^{14} + H^{1}, \text{ 98\% of the reactions.}$$

With high energy neutrons

$$N^{14} + n = C^{12} + H^{3}, \text{ remaining reactions.}$$

(4) The C^{14} atoms produced in the first reaction oxidize to radioactive carbon dioxide and diffuse to produce a fairly uniform C^{14}/C^{12} oxide ratio throughout the world atmosphere.

(5) The average neutron intensity at which the first reaction occurs is 2.6 n/cm^2-sec.

(6) Knowing the "carbon inventory" of the earth in gm/cm^2, (given as 7.25 in ocean carbonates. 0.59 in dissolved ocean organics, 0.33 in the biosphere, 0.12 in the atmosphere; total = 8.3 gm/cm^2), this yields a value for Specific Production Rate (SPR) of C-14 = 2.6 x 60/8.3 = 18.8 atoms/gm-min.

(7) But the Specific Decay Rate (SDR) of C-14 in living matter was measured to be 16.1 ± 0.5 disintegrations/gm-min based on the 1950 half-life of 5568 yrs for C-14. This puzzled Libby because if Lyellian geology were true, and the world millions of years old, the SDR should have long since come to equilibrium with the SPR, the half-life of C-14 being short compared to such great age. He decided that 18.8 and 16.1 were "sufficiently within the experimental errors involved" because if not it would bring into question the "constancy in intensity of cosmic radiation over the past several thousand years." Libby then makes the following astounding statement, evidently unaware how exactly it agrees with the biblical record of a recent creation by divine fiat (p. 7):

> *If one were to imagine that the cosmic radiation had been turned off until a short while ago, the enormous amount of radiocarbon necessary to the equilibrium state would not have been manufactured and the specific radioactivity (SDR) of*

living matter would be much less than the rate of production (SPR) calculated from the neutron intensity.

(8) Ignoring the above disparity between the SPR and SDR of C-14 (which the biblical record would lead one to expect), Libby assumed the two numbers equal, and assumed that the specific activity (SDR) of C-14 in the earth's biosphere, at least for the last 20,000 to 30,000 years, had an SDR the same as found today. Libby computed this SDR in the biosphere today as 15.3 dis/gm-min, after correcting the earlier figure of 16.1 for the ratio of C-13/C-12 in inorganic carbon (seashells, etc) which dominates the earth's carbon inventory (Libby's Table 1, p. 6).

Because of the two unwarranted assumptions, Libby's method is referred to hereafter as the Uncorrected Libby Method. The Corrected Radiocarbon Dating Method, described in Paper #10 and agreed to by other creationist papers reviewed, derives the value of SDR at the death of a specimen from the SDR/SPR ratio measured today, using the exponential build-up curve.

(9) Libby then showed that living specimens of all kinds, over a wide range of latitude and longitude, have the same SDR = 15.3 dis/gm-min. This was expected since all plant life acquires the atmospheric ratio of C-14/C-12 by photosynthesis and underlies the food chains of all animals.

(10) The Libby Method then follows from the fact that, from the moment of death, anything in the biosphere would cease to "take up" C-14 from the atmosphere (or the CO_2 in water) and would decay to half the value of SDR in its tissue every 5568 yrs *(now 5730 yrs) if uncontaminated by living matter or atmospheric carbon dioxide.* thus a simple measure of the SDR (in dis/gm of total carbon) in an *uncontaminated* specimen of ancient life should yield its death date, *assuming one knows the SDR in its tissue at the moment of death.*

(11) In order to vindicate his dating method, Libby selected a large number of uncontaminated carbon samples of known historical ages and compared them with their "radiocarbon age" determined by his method. The results dramatically supported his C-14 dating method within reasonable error for specimens dying within the last 4500 years. Five examples from Libby follow (Fig. 1, p. 9):

Tree ring (1370 BP) dated at 1260 BP = Before 1950)

Egyptian specimen of Ptolemy's era (2150 ± 150 BP) dated at 2200 BP

Redwood specimen (2930 ± 50 BP) dated at 2880 BP

Egyptian specimen, tomb of Sesostris (3750 BP) dated at 3650 BP

Egyptian specimen, tomb of Sneferu (4525 ± 75 BP) dated at 4475 BP

2. Morris, H. M. and J. C. Whitcomb. 1961. *The Genesis Flood.* Presbyterian and Reformed. Philadelphia pp. 43-44, 370-378.

On pp. 42-44 Morris and Whitcomb contend against objections by Bernard Ramm to a universal Flood. While Morris and Whitcomb adhere to the biblical six-day Creation and world-wide Flood, they do not see the genealogies of Genesis 5 and 11 as father-son relationships, and allow a much longer period from Creation to Flood to Abraham if necessary.

The authors also dismiss radiocarbon dating as unreliable, based on some cases presented at the 1959 C-14 Symposium at Groningen. On p. 44 they make the categorical statement, ". . . the radiocarbon method cannot be applied to periods in the remote past, because the biblical doctrine of a universal deluge calls for a non-uniformitarian history of the earth's atmosphere and thus of cosmic-ray activity and radiocarbon concentrations." No grounds are supplied for this latter statement.

On pp. 370-374 Morris and Whitcomb address "Radiocarbon Dating of Recent Deposits." On p. 371-372 they list some seven assumptions in the method, of which they state "every one of these assumptions is highly questionable in the context of the events of Creation and the Deluge." The seventh assumption they list as faulty is "that the rate of formation (SPR) and the rate of decay (SDR) of radiocarbon atoms have been in equilibrium throughout the period of applicability." They fail to note however that Libby discovered that the SDR and SPR were not in equilibrium, and that he merely assumed they were to avoid the implications of a "recent beginning."

The authors then cite further authorities to discredit the validity of radiocarbon dating, stating that "any genuine correlation of the radiocarbon method with definite historical chronologies is limited only to some time after the Flood and Dispersion."

Finally, on pp. 374-377 under "Carbon-14 and the Deluge" Morris and Whitcomb disclose the basis for their rejection of any validity in radiocarbon dating prior to (and for some time after) the Flood, this being their attachment to the canopy theory. On p. 377 Morris and Whitcomb do however cite the pivotal statement by Libby (quoted earlier) about cosmic radiation being "turned off until a short while ago." Here they agree that this would automatically reduce the published radiocarbon dates.

3a. Armstrong, H. L. 1966. An attempt to correct C-14 dating. *CRSQ* 2(4):31-32.

b. Wiant, H. V. and Lester Harris. 1966. How reliable is carbon 14 dating. *CRSQ* 2(4):31-32

a. The paper examines the possible errors, especially in dating specimens buried at or before the Flood resulting from (a) contamination by admixture with fossil fuel, or with younger carbon-bearing material in the sedimentary turmoil at the Flood. The author also recognizes the error of assuming constant SDR in living matter (as Libby did) rather than buildup from Creation. Armstrong supports his thesis partly by use of a biblical chronology about 100 years longer than Ussher's.

b. The article by Wiant and Harris, in the same issue of the Quarterly, contains excerpts from longer papers. Wiant points out two possible sources of error in radiocarbon dating: (1) assuming constant cosmic radiation incident on the earth (for all time past); (2) assuming constant carbon dioxide in the earth's atmosphere. The second source mentioned by Wiant senses the importance of the carbon cycle inventory before and after the Flood.

Harris looks into errors resulting from transient variations in atmospheric C-14 caused by volcanic activity, and by the great increase in fossil fuel combustion and by atomic bomb testing. He also questions the assumption of constant cosmic radiation incident on earth's atmosphere.

4. Whitelaw, R. L. 1968. Radiocarbon confirms biblical Creation. *CRSQ* 5:78-83.

This paper focuses on the significance of the disparity between Specific Production Rate (SPR) and Specific Decay Rate (SDR) of C-14 in Libby's dating method and computes the resulting date of the "recent turning on" of cosmic radiation which Libby refused to entertain. Using the Libby values of 16.1 dis/gm-min for SDR in living matter today, and 18.8 for SPR in the atmosphere, assumed constant, the resulting buildup curve leads back to a Creation date about 15,000 B.P. Whitelaw points out that W. W. Rubey in 1950 claimed a cosmic radiation 35 percent higher than Libby, and a carbon exchange inventory 6 percent less than Libby, which gives an SPR of 27 atoms/gm-min, instead of Libby's 18.8. The author then shows that values of SPR = 27 and SDR = 16.1 would give a buildup curve for SDR starting from zero at a creation date of about 7,000 B.P. This would fit biblical chronology using values in Genesis chapters 5 and 11 based upon ancient codices used in the New Testament and now available.

5. Brown, R. H. 1968. Radiocarbon dating. *CRSQ* 5:65-68.

The author begins by reviewing the radiocarbon dating method established by Libby, and adds the fact that the method is based on adhering to a half-life of 5568 yrs, rather than the more precise value of 5730 yrs agreed upon since 1970. He reminds us that all published death-dates of specimens are also by agreement based on "today" = 1950, i.e. a specimen with a Specific Decay Rate (dis/gm-min) equal to one-half the 95 percent of the SDR of the NBS oxalic acid standard which is assigned a "radiocarbon age" of 5568 years, so that its death-date assuming no contamination with "younger" C-14 since death, is published as 1950 - 5568, or 3618 B.C. This standard was adopted because 95 percent of the SDR of standard oxalic acid is considered to be equivalent to the SDR expected from living wood in 1950 growing in an 1850 atmosphere.

Even with the above, Brown points out that there remains an uncertainty of ± 100 yrs in any radiocarbon date because of local fluctuations in C-14 in the atmosphere. In addition he grants it to be a pure assumption by Libby that the SDR in an ancient specimen when it dried was the same as found in today's atmosphere. The author does not appear to recognize, however, that the disparity between SPR and SDR today points clearly to a "recent beginning" which might thereby be calculated.

Brown then compares radiocarbon dates and tree-ring dates, and discusses radiocarbon dating and Genesis. He shows that we should expect the pre-Flood atmosphere (and therefore shells, coal, vegetation, etc.) to have an SDR between .001 and .01 of today's value, and that there is a noticeable "scarcity of objects associated with human activity" having radiocarbon ages exceeding 12,000 years, suggesting that "human population has grown from a small beginning in a short period of time," the oldest dates being found in "material from the Middle East . . . and the Mediterranean basin."

The author concludes with the topic "Radiocarbon Age and Farming" in which he postulates that, to bring the SDR of the carbon reservoir up to its present level there would need to be a much *higher* value of SPR in the earth's atmosphere before the Flood, either by increased cosmic radiation or by "a reduction in the . . . nonradioactive carbon in the atmosphere." He then shows that studies of cosmic ray effects in meteorites show that cosmic radiation has been close to its present level over a period of time many orders of magnitude greater than that with which radioactive dating is concerned. He also states that even a complete disappearance of the Earth's magnetic field would no more than double the present C-14 production rate. Thus he contends that the inventory in the pre-Flood carbon cycle must have been much less than today.

6. Cook, Melvin. 1968. Do radiocarbon clocks need repair. *CRSQ* 5:69-77

The author begins by addressing the non-equilibrium between SDR and SPR which Libby discovered and discounted. He cites Libby's ratio, SDR/SPR = 15.3/18.8 = 0.81 (for the living biosphere), and compares it with that found by Lingenfelter and Suess, SDR/SPR = 13.3/18.4 = 0.72, and gives reasons to support the latter.

Cook then verifies that either of the above ratios (compared to SDR/SPR = 1.0 for an earth age of infinity) points to a recently created earth, "which is why scientists avoid it so tenaciously," says Cook. He then shows that the ratio SDR/SPR = 0.72 "telescopes all results by this (radiocarbon dating) method to about 10,000 years or less!" This he displays dramatically in his Figure 1 graph.

The author then addresses the assumptions and weaknesses of the radiological "long-time" clocks, uranium - thorium - lead, potassium/argon, and rubidium - strontium, and returns to further considerations of radiocarbon dating under the headings: (1) Radiocarbon dating of a global sea level cycle, confirmation of ancient shoreline predictions, and global extent of ancient land mass adjustments implied; (2) Radiocarbon and biblical dates associated with above sea-level changes, with The Genesis Flood, and with the (assumed) geological "division" of the earth in the days of Peleg; (3) Radiocarbon dating of ancient civilizations; and (4) Unwarranted claims of accuracy in radiocarbon dating.

7. Whitelaw, R. L. 1969. Radiocarbon and K-Ar dating in light of new discoveries in cosmic rays. *CRSQ* 6:71-73

In this short paper Whitelaw reviews again the assumptions underlying both the above dating methods, and then presents new findings regarding cosmic radiation reported by Stephen Rosen as follows:

> . . . we are still not certain where cosmic rays come from, nor precisely how they travel here . . . Until the 1930's they were thought to be electrons . . . The curve in Figure 1 (of Rosen's paper) suggests that something is happening on a galactic

> scale, the sources of the cosmic rays may be changing or . . . coming from different 'storage regions.' The highest energy of a cosmic ray observed, 10^{20} eV, *is more than a billion times* the energy obtainable at present in the most powerful accelerators on earth. . . . There is no doubt however that the great majority of *all* cosmic-ray particles are *(bundles* of) protons with nuclei about 13 times heavier than helium (i.e. alpha particles) . . . helium nuclei amount to perhaps 8 percent of the total . . .

Rosen also makes the pointed statement that spectroscopic analysis of the sun, stars, and fallen meteorites leads to the clear conclusion that "intensity of cosmic ray protons has been constant, within a factor of 2 for a thousand to a million years."

8. Howe, George F. 1970. Carbon-14 and other radioactive dating methods. *Bible-Science Newsletter.* 8(9):1-3.

Howe begins with a simple description of the Libby Method. On p. 5 Howe addresses the production of C-14 atoms from cosmic radiation which "fluctuates moment by moment, day by day, and week by week" being influenced by solar activity and other factors. He then assumes that there could have been fluctuations in past history greater than those we see today. This assumption counters prior conclusions by Libby, Brown, etc., based on meteorites, that cosmic radiation has been remarkably constant during the earth's history. It also omits the distinction between production rate of C-14 in the atmosphere, and "specific production rate" (SPR) per gm of carbon in the exchange inventory, which is the real criterion which affects buildup or decay of the "specific activity" (SDR) in the atmosphere at any time.

Howe then postulates the canopy theory and assumes it would greatly attenuate the diffusion of cosmic-ray produced neutrons and consequent production of C-14, and its oxidation to CO_2 followed by diffusion in accordance with kinetic theory of gases. How this attenuation results from the Canopy Theory is not explained.

With this postulate, the author comes to three conclusions:

> (1) a vapor canopy might have reduced the amount of radiation reaching the atmosphere, thus reducing the amount of C-14 before the Flood; (2) there might have been much more C-12 in the atmosphere before the Flood, grossly changing the C-14/C-12 ratio; and (3) there are no accurate methods of dating ancient remains by carbon 14 . . . so that there is no need to challenge the biblical young-earth view on the basis of C-14 studies.

Howe does not touch on the disparity between SPR and SDR found by Libby and others, or the creationist implications of this disparity and how it would shorten the published C-14 ages. But he does then describe the method of dendrochronology suggesting that tree-ring dating might be used to give corrections to radiocarbon dates, where a complete sequence of rings in living and nearby dead trees could be found, as in bristlecone pines and Sequoias in the mountains of California. But here he overlooks the fact, demonstrated in later papers, that a tree-ring is *not* impervious to contamination from adjacent rings or groundwater in a log which is what a valid C-14 date requires. Finally he states that ring dating by bristlecone pines goes back 4,000 years which "fits with a biblical date for the Flood."

9. Cook, Melvin. 1970. Carbon-14 and the age of the atmosphere. *CRSQ* 7:53-56

In this second paper by Cook (see Paper 6) he first gives strong support to radiocarbon dating "if due regard is taken of the *non-equilibrium* of carbon-14 in the earth as a whole" which he says "leads to a radiocarbon age of less than 10,000 years for the atmosphere itself!" He then speculates that the beginning of radiocarbon in the atmosphere "seems not to be the beginning of the earth, but rather in the Flood, perhaps only 4,500 years ago. The whole atmosphere seems to have been . . . cleansed of radiocarbon during the Flood."

His 1968 paper is then updated by discussion of Libby's attempt to reconcile the disparity between the SDR of radiocarbon in the world inventory and its SPR in the atmosphere, since the difference points to a young earth. Libby attempted to explain it by postulating that 3.4 gm/cm^2 of total carbon worldwide must be lost "by irreversible and irretrievable deposition of $CaCO_3$ every 8300 years (the mean life of a C-14 nucleus)." Cook shows the problems raised by Libby's assumption, and then offers a "generous alternate interpretation" for Libby's dilemma, but one which has three "serious implications for historical geology and uniformitarianism."

Cook's timely conclusion is that there is no solution at present in the uniformitarian view "to the discrepancy between the rate of C-14 formation (2.5 atoms/cm^2-sec) and the rate of its decay (1.9 atoms/ cm^2-sec)" but that "this discrepancy vanishes if one assumes (as the Bible indicates) that the earth and its atmosphere have both been created quite recently." On this view, he points out, "one would expect formation of C-14 to exceed its decay" as the earth's inventory would still be in the "build-up" phase for C-14.

10. Whitelaw, R. L. 1970. Time, life, and history in the light of 15,000 radiocarbon dates. *CRSQ* 7:56-71, 83.

Whitelaw begins with a review of Libby's radiocarbon dating method and of his painstaking steps to verify (1) the worldwide near-uniformity of C-14 specific production rate (SPR) in the atmosphere, (2) the similar near-uniformity of C-14 activity (SDR) in all living things, and (3) the fair accuracy with which the method yields dates of specimens of known age. Then follows a list of the 96 scientific laboratories worldwide engaged in gathering and dating radiocarbon specimens of all kinds. The wide variety of specimens dated so far are listed in Table 2 (p. 59) by geography (continent and country).

In his Table 4 (pp. 60-61) Whitelaw then displays a selection of 67 dated specimens taken from some 15,000 published to date in *Science* (1951 to 1958) and *Radiocarbon* (1959 to 1969), specimens of flora and fauna that would have been destroyed by the Genesis Flood if it were the worldwide catastrophe described in the Bible.

He then describes "ten amazing facts" pertaining to all published dates, even though all such dates are raw

or uncorrected, in that they were computed by the various laboratories ignoring the disparity between SPR and SDR which demands a correction factor. The most significant of these facts are: (1) almost every specimen of once-living matter had a date within 40,000 years, as against the evolutionary presupposition that living matter has been on earth for many millions of years, so that a major fraction of specimens, taken at random, should have been "too old to date" (the C-14 method is only able to date back to about six half-lives); (2) specimens of fossil fuel (coal, oil, and gas) were found datable within 50,000 years; (3) all supposedly prehistoric human remains and man-made artifacts were datable within the last 30,000 years, including specimens from the same strata (or older) as Leakey's *Zinjanthropus,* and the Omo Valley finds reported to be "two to four million years old"; (4) the mastodon, mylodon, sabre-tooth tiger, etc. were reported at 10,000 to 30,000 years; and (5) deep ocean deposits and cores, containing detritus of the most primeval life on earth, dated within 40,000 years.

Whitelaw then selected the 9671 "good" dates—those with small probable error—out of the 15,000 published at that time, and divided them into three major categories, (1) man and animals in the Afro-eurasian landmass, (2) man and animals in the western hemisphere, and (3) trees. All specimens of marine life, sediments, shells, peat, pollen, clay, and vegetation other than tree trunks, were excluded. In short, only such living things as would have been destroyed by the Flood were counted. To each date in these three categories he then applied the correction factor (which Libby should have applied) derived by the well-known equations for radioactive build-up and decay. This factor arises from the fact that each specimen died at a time when its C-14 activity (SDR) was less than today, being lower down on the build-up curve from zero at Creation to the present value of 15.5 dis/gm-min.

Having applied these factors which reduce every published age, all dates in each category were then accumulated in a histogram or bar-chart of 14 vertical bars, each bar 500 years wide, spanning the years from the present back to Creation. The height of each bar is proportional to the number of "good" death dates found in that 500 year span.

The purpose of the histogram was to reveal, if possible, an important consequence of the Flood, if it happened as described in Genesis 7-8. If so, we should find a 500 year period in human history when *very little life* was left on earth, preceded by one with a *great excess of deaths.* We should find this occurring in all three categories (men and animals in the eastern hemisphere, in the western hemisphere, and of trees worldwide); and we should find it at the same point in each of the three bar-charts, at the boundary between the 4th and 5th bars, approximately 3,000 B.C.

This in fact is precisely what the histogram displayed. A further examination of death-dates in each 500 year span, and their geographic location, revealed nine important additional facts in agreement with the biblical record.

It was recognized that, with only some 9700 dates distributed into 42 bars, the older dates having a probable error of ± 100 yrs or more, and with some uncertainty at the bar boundaries in which bar a date belongs, the amount of data may be statistically insufficient to draw firm conclusions. Nevertheless, the coincidence of a massive number of deaths of men, animals, and trees, followed by a great dearth of life, simultaneously on all continents at about 3000 B.C. was a conclusion that could scarcely be denied.

Having thus verified the accuracy of the biblical date of the Flood, Whitelaw than determined the unknown Specific Production Rate (SPR) of radiocarbon in the atmosphere before the Flood by the recognized procedure as follows: (a) if the build-up of Specific Decay (SDR) used to correct all dates yields a Flood-date in agreement with the Bible, which it does, then (b) we are warranted in assuming a Creation Date based on the same biblical chronology. Using that date Whitelaw derived a value of SPR = 64 dis/gm-min (rather than the present value of 18.8 found by Libby) as the value prevailing before the Flood. Using this pre-Flood value of SPR one can determine the correct build-up of SDR in living matter before the Flood, and thereby a more accurate correction factor for each date.

The mathematical procedure for doing this is given in an Appendix to the paper, along with a discussion of how and why the Flood catastrophe would greatly *increase* the inventory in the carbon cycle after the Flood, in agreement with the pre-Flood SPR of 64 as derived. It is noted that an increase in pre-Flood SPR had already been deduced by Brown in Paper 5, without deriving a numerical value for it.

11. Hefferlin, Ray. 1972. A mathematical formulation of a creationist-Flood interpretation of radiocarbon dating. *CRSQ* 9:68-71

This paper, as stated by the author, "develops a mathematical statement of the C-14/C-12 ratio under a specific, simple, Creation-Flood model." Four parameters are defined which need to be determined from empirical data before the model can be used. These are: The rate of formation of C-14 in the atmosphere before the Flood; The rate of formation of atmospheric radiocarbon during the Flood; The production rate of atmospheric radiocarbon since the Flood (assumed constant); and the number of C-12 nuclei in the biosphere after creation. Given these, the model would then need to be tested against experimental facts.

12. White, A. J. 1972. Radiocarbon dating. *CRSQ* 9: 155-158.

The author begins by reviewing Libby's radiocarbon dating method and its assumptions. He fails to mention the fact that Libby found that the SPR and the SDR of radiocarbon were *not* in equilibrium, but differ by 17 percent. Nor does he note the biblical significance of this disparity. He then evaluates each of Libby's assumptions, on which the accuracy of the method depends, but regarding SPR and SDR states that Libby "has shown that the rate of formation and the rate of decay of C-14 were in equilibrium in the late 1940's."

Under a heading "Radiocarbon Dating and the Flood" the author then attempts to support his opinion why the method has unlikely validity for dates older

than 5,000 years because of the different terrestrial and atmospheric conditions which prevailed before the Flood, the principal factor being the assumed vapor canopy which enveloped the earth and the global semi-tropical climate it produced. There are many assertions regarding this canopy citing Genesis 1:6-8 as proof of its existence, but with no examination of its physical implications, or of other possible means God might have used for the climate of the pre-Flood world.

13. Long, Ronald D. 1973. The Bible, radiocarbon dating and ancient Egypt. *CRSQ* 10:19-30

The author begins by comparing the three different dates obtained for each of over 150 ancient Egyptian materials, of which he publishes 46 (7 of them given below). The three different dates obtained in each case are based on (1) a historical date "accepted" by Egyptologists based on supposed correlations between ancient papyri, astronomical events and pharaonic dynasties, which the author shows to be doubtful or worthless; (2) a biblical date based on correlating Scripture with ancient history, using Hoeh's *Compendium of World History;* and (3) a published radiocarbon date using Libby's uncorrected method, i.e. using the modern value of SDR = 15.3 dis/gm-min as the SDR in the specimen when it died, uncorrected for C-14 buildup.

The following table compares these dates for a few of the 46 cases in the author's paper:

Specimen description	Historical Date, B.C.	Biblical Date, B.C.	Libby C-14 Date, B.C.
Acacia beam from tomb of Zoser at Sakkara	2700	1718	(avg) 2020
Wood from a brick mastaba at Sakkara	3008	2050	2150
Acacia wood from tomb at Hemaka	3008	2050	2497
Cedar from outer sarcophagus of Aha-nakht	1858	1680	1760
Wood from lid of mummiform coffin from Deir	1000-750	750	800
Linen in mastaba, Tarkhan (Petrie, 1914)	3100-2900	2254-1993	2315
Charcoal from burial, reign of Amenophis III	1408-1372	870	1137

The table (and all other cases examined by the author) shows the Libby date younger than the historical date and usually older than the biblical date. If he had corrected the Libby date for the SDR/SPR ratio, he would have found the true radiocarbon date to be younger and even closer to the biblical date.

On the basis of the 150 dates compared by Long (the above table being typical) he concludes that radiocarbon dates, even though uncorrected, corroborate the Bible and "absolutely negate the accepted or evolutionary interpretation of Egyptian history." At the same time the author is concerned about the disparity between Libby dates and biblical dates, and devotes the next five pages to dendrochronology (tree-ring dating) and the Suess curve based on the bristlecone pine in hopes of finding a way to bring the Libby dates closer to his biblical dates. He then discovers two facts about dendrochronology worldwide by comparing tree-ring dating on the bristlecone pine with results from New Zealand, Japanese, and Swiss trees, namely, (1) the Suess curve gives inconsistent results, not reconcileable with dates obtained from New Zealand and Japan, and (2) the radiocarbon (Libby) date of a tree-ring specimen always gives a younger age than counting the rings.

Long attributes the inconsistent Suess corrections to random variations of C-14 and CO_2 concentrations in the atmosphere from year to year, and at different locations. Libby had shown this to be most unlikely by the laws of neutron scattering and of diffusion of gases in air. As to the consistently younger C-14 date of a tree-ring compared to the ring-count, Long appears unaware that some diffusion of live sap from the outer cambium into rings of previous years is bound to occur, so that the decaying C-14 content of an inner ring will almost always be offset by some diffusion of fresh C-14 diffusing inwards from younger rings, depending on the porosity of the wood.

In conclusion, Long notes (1) that there are no trees in Egypt which began growth in ancient times (i.e. to permit correlation of ring patterns with bristle-cone pine or other species), and (2) biblical chronology before the Flood is not in agreement with C-14 dating, nor should it be expected because of the assumed vapor canopy.

14. Clementson, S. P. 1974. A critical examination of radiocarbon dating in the light of radiocarbon data. *CRSQ* 10:229-236

Clementson begins by describing Libby's radiocarbon dating method and the values Libby derived for SPR, 18.8 dis/gm-min, and for SDR, 16.1 dis/gm-min. He appears to accept Libby's assumption that the two values are close enough to be assumed in equilibrium, and hence does not address the possibility that the SDR in the biosphere follows the expected build-up curve from zero at Creation due to this disparity.

Clementson does reject Libby's assumption of rapid diffusion of the neutron production in the atmosphere, and equally rapid diffusion of the radioactive carbon dioxide produced by neutron collision with nitrogen atoms, which one would expect from diffusion theory.

He then postulates that wide variations are to be expected in the radiocarbon content of the outer cambium in living trees—variations with altitude, latitude and longitude—because of the poor diffusion of atmospheric C-14 claimed above. He further states that radial transfer of organic matter from ring to ring in a tree has never been observed, so that a radiocarbon dating sample taken in one ring could not be contaminated by sap from a younger outer ring.

On pp. 230-232 Clementson presents arguments and data to show that it is now "widely accepted" that the activity level (SDR) in the biosphere "has been decreasing" for some 5,000 years, based upon radiocarbon analysis of tree-rings of known age, i.e. supposedly known by a sequence of living and dead trees (or fallen logs) with overlapping ring series. His graph of Figure 2 appears to substantiate a decrease in SDR from 15.0 dis/gm-min 4500 years ago to 13.8

at present, measured in bristlecone pines in Inyo National Forest and Sequoia trees in Sequoia National Park.

He then postulates a production rate (SPR) of C-14 in the atmosphere over the same 4500 years as lower than specific activity (SDR) in the biosphere and essentially constant at about 12.4 dis/gm-min. Such a value is greatly below Libby's value of 18.8. The author attempts to explain this on p. 233 as "due to an increase of the mixing of the atmosphere." At the same time he does not seem aware that radioactive dating of tree rings whose SDR at death was greater than present could not be done by the Libby method without applying a correction for the fall-off in SDR with time. Clementson then speculates on pre-Flood conditions and the vapor canopy that might account for values of SDR higher than SPR after the Flood.

15. Brown, R. H. 1975. Can we believe radiocarbon dating? *CRSQ* 12:66-68; with further remarks by Brown regarding Rampart Cave in *CRSQ* 12:219

This short monograph describes the apparently anomalous radiocarbon dates of bat guano and sloth dung in Rampart Cave, 650 ft above the lower Colorado River near the Arizona-Nevada state line. The guano and dung layer was 4.5 ft deep and the bottom 1 ft layer gave dates between infinity and 40,000 years. The next 4 inches yielded ages from 40,000 to 18,500 years, and the upper 3 ft of the deposit dated from 18,500 to 10,500. All these dates were obtained by the uncorrected Libby method and published in *Radiocarbon*. The correction for SPR/SDR disparity of Paper 10 would put them in the pre-Flood era, which leaves further questions.

Brown finds that these anomalous dates tax the credibility of the Libby radiocarbon dating method, since it is evident that the first deposits in the cave began to accumulate a few years after the Flood, perhaps even when the Colorado was close to cave level, still draining the vast inland sea trapped upstream by the Flood. First, the large bat and bird population necessary to build the deposit to such a depth must have propagated from the few carried on the Ark. Second, how does one account for the almost zero C-14 (infinite age) in the lowest layer, since it appears impossible that the deposits in this cave, far down the canyon wall, could have survived the Flood undisturbed.

Brown also describes similar phenomena (near-infinite radiocarbon dates) in buried driftwood in Stanton's Cave some 200 miles upstream on the Colorado and 138 ft above the river. Here were found coniferous and cottonwood logs, some with as many as 150 growth rings buried in sediment.

16. Whitelaw, R. L. 1975. The testimony of radiocarbon to the Genesis Flood. Symposium on Creation V. (D. Patten, editor.) Baker. Grand Rapids. pp. 39-50

The first part of this paper (pp. 39-46) repeats the facts and data of Paper 10, the statistical analysis of terrestrial radiocarbon dates published to date.

There are minor changes in text to suit a more general audience. But in addition and for the first time, Whitelaw presents a new table and bar chart of corrected radiocarbon dates published to date in *Radiocarbon*, of oceanic marine life. the purpose of this new chart was to discover whether the numerous and vast "fossil fish-beds" found far inland and often at high altitude were a consequence of the Genesis Flood, rather than a result of frequent subsidence and rise of the land masses over geological time, as evolutionary geology postulates.

The 1,587 marine dates selected (none of them included in the 9,671 dates used in Paper 10) were divided into two categories, (1) 955 "good" dates (i.e. small probable error) of dead marine fauna taken from ocean bottoms and beaches below high tide, these constituting the "control group"; (2) 632 specimens of ocean marine life found far inland or buried in shore cliffs well above highest tides, which would therefore testify to some catastrophic inundation such as by upheaval of the ocean floor or subsidence of the continents (see Paper 26).

The results are quite dramatic. Specimens in category (1), the control group, had death dates distributed fairly uniformly (average about 70) in every 500-yr span from Creation to the present, with two minor anomalies, (a) a larger than average number in the box that included the Flood, and (b) much smaller than average (25 dates) in the 500-yr box following the Flood. Each of these anomalies are explained in the Flood scenario proposed in Paper 25.

In category (2), marine life in the inland vast fossil fish-beds of the world were all (except for a very few within reach of estuaries floodable by abnormal hurricane or tsunami) found to have died at or before the Genesis Flood. Those dying before the Flood would support the scenario of Paper 25 that the Flood was accompanied by vast upheavals (tectonic and volcanic) of the ocean-floor, transporting its detritus of once-living sea-life far inland and leaving it there.

17. Hanson, James N. 1976. Some mathematical considerations in radiocarbon dating. *CRSQ* 13(l): 50-56

Hanson's paper is in two parts. First he examines the mathematics of radioactive decay as a stochastic (probabilistic) process with random variations in effective half-life from sample to sample of a given specimen, and determines the "Sensitivity Equations" for such a case (Note 2).

In the latter half of the paper, under the heading "Global Radiocarbon," Hanson develops the equations for buildup of activity (SDR) in the biosphere where the SPR is constant. Using a value of SDR = 12.4 dis/gm-min today, from studies more recent than Libby, and Libby's SPR = 18.8 (giving a ratio R = SDR/SPR = .66), Hanson's equation gives a value of R = .42 for a Flood date of 4322 B.P. based on Ozanne's chronology. He then extrapolates back to Creation at 5978 B.P., accepting the Masoretic Text chronology of Genesis 5, and concludes that the SDR would need to exceed the SPR in the pre-Flood world, which he thinks possible by a "denser pre-Flood atmosphere," i.e. a variation of the canopy theory. In this Hanson does not address the question of what would start the world with a high value of SDR in the biosphere, other than divine fiat (Note 3).

18a. Tyler, David J. 1977. The crisis in radiocarbon calibration. *CRSQ* 14:92-99

b. Tyler, David J. 1978. Radiocarbon calibration-revised. *CRSQ* 15:16-23.

In the first of these two papers, Tyler addresses problems similar to those reviewed in Paper 13, but without tables of supporting data, namely how to calibrate radiocarbon dates against established tree-ring sequences and then how to reconcile radiocarbon dates of Egyptian archeological samples, so corrected, to the (supposedly) known historical dates. The paper would benefit from more precise definition of terms, and of procedures recommended (Note 4).

Tyler's second paper addresses the non-equilibrium between SDR and SPR in the carbon cycle, which Libby found but dismissed, and discusses various evolutionary hypotheses to account for it. In a chapter entitled "The Non-Equilibrium Model and Biblical History" he then compares creationist (biblical) views but does not appear to recognize that the SDR/SPR ratio today establishes a buildup curve giving values of SDR in the biosphere at any time in previous history (as Paper 10 shows), and thus gives a correction factor for every published Libby date.

The author then discusses again the calibration of radiocarbon dates against tree-rings, assuming an unbroken and uncontaminated ring sequence, and comparison with "accepted dates" of Egyptian specimens going back to about 500 B.C., but again using uncorrected Libby dates. A graph of such dates, calibrated by tree-rings, shows a decline in SDR which he could have calculated directly by the build-up curve corrections. From this Tyler concludes that a revised chronology of ancient Egypt is necessary. He then compares his findings with those of Courville (a creationist) and Velikovsky (a non-creationist but catastrophist).

The two papers give us no actual C-14 calibration against "good" tree-rings, nor one for archeological C-14 dates. His two general conclusions are simple: (1) "Creation and catastrophism are independent; one does not imply the other"; and (2) there is "a sequential association of events: Creation to catastrophism to variation (limited)." Other conclusions for secularists and uniformitarians are also given, but are irrelevant to our purpose here.

19. DeYoung, Donald B. 1978. Creationist predictions involving C-14 dating. *CRSQ* 15:14-16

The author begins by noting two mechanisms for the variability of cosmic ray flux through the earth's atmosphere which creationists have promoted. By this he presumably means the rate of production of C-14 atoms which has two independent variables, (1) the cosmic radiation flux itself (mostly ultra-high energy proton bundles, per Paper 7) and, (2) its rate of attenuation in the atmosphere before it produces the neutrons which initiate the neutron — N_2 — C^{14} — CO_2 sequence by which radiocarbon dating works.

The two mechanisms he lists are, (1) "the existence of a pre-Flood water vapor canopy surrounding the early earth," and (2) a "quenching" of incident cosmic radiation by the earth's magnetic field, presumed to have been much stronger at Creation and decaying ever since, as proposed by creationist Thomas Barnes (Note 5).

DeYoung then addresses the disparity between SPR and SDR discovered by Libby (calling them "formation and decay rates of C-14 in the atmosphere"), but does not note that it is precisely this disparity which Libby recognized as pointing to a recent "turning on" of radiation. The author then alludes to Kelvin's rejection of radioactivity as a spontaneous process (i.e. stochastic) holding to the idea that it was a property of the atom, rather than of the nucleus, and therefore a chemical phenomenon, subject to temperature, pressure, etc. The author is also of the opinion that natural processes can produce variable enrichment from site to site in the various isotopes of an atom, accounting for some present problems in radioactive dating (Note 6).

The paper ends with five interesting predictions re C-14 dating, and with the conclusion that "the many variables present in radiocarbon dating . . . rule out calibration of the method beyond short-term possibly absolute dendrochronology of bristlecone pines." But the author also states that "predictions concerning C-14 dating show that the future holds tremendous possibilities for evidence of a recent Creation."

20. Gladwin, H. S. 1978. Dendrochronology, radiocarbon, and bristlecones. *CRSQ* 15:24-26.

The author begins with a short history of his early studies in dendrochronology under Douglass at the Tree Ring Laboratory of the University of Arizona at Gila Pueblo, beginning in 1930. He then reviews problems in correlating a tree ring's age by ring number with its age by radiocarbon dating, as follows:

(1) Only a few species of trees are useful for a reliable ring-count; most deciduous trees are of little value because the rings are difficult to decipher, except for a few oaks. Among the conifers, junipers are often quite misleading because the trunk may be partly dead while the living part may add no ring at all or often multiple rings in the same year, and the bristle cone pine *(Pinus aristata)* is most undependable because the living cambium in a tree of 100-inch girth might only have an arc of 8 inches.

(2) Nevertheless for ring-counts to great age in a single tree (to avoid dependence on finding an overlapping sequences in adjacent dead trees or fallen logs) we are dependent today on the bristlecone pine, often living 3,000 to 4,000 years [6,000 years claimed by Renfrow in his 1974 book, *Before Civilization].* Also cited is the *Sequoia giganta* in California, and a rare species in Japan and another in New Zealand, not mentioned by Gladwin.

(3) With respect to radiocarbon dating, Gladwin describes a 1949 visit to Libby's early laboratory at the University of Chicago, and discusses the serious problems distinguishing the radiation count from a small or very old sample [often as low as 50 counts per minute (cpm)] when the background natural radioactivity may be as much as 600 cpm.

It is strange that Gladwin fails to note here that shielding and electronic discrimination techniques available since 1950 can easily make such a low sample count. In addition, counting the C-14/C-12 ratio in a sample by mass spectrometry is now well-developed, and was being done in 1976 when the above paper was written.

21. Brown, R. H. 1979. Interpretation of C-14 age data. *Proceedings, 15th Anniversary Convention of Bible Science Association,* Anaheim, CA. pp. 45-52.

Brown begins by describing the Libby radiocarbon dating method but makes no mention of the disparity between SPR and SDR which Libby found, or of its implications. Using the term "C-14 concentration level" or "radiocarbon content' for specific decay rate (SDR), he presents Figure 1 purporting to show a one-to-one correspondence between C-14 age and historical age. He does not mention the fact that his C-14 ages are derived by the Libby uncorrected method.

He then sees this correspondence as proof of "an essentially constant C-14 concentration in the upper biosphere . . . over a time span of at least 3500 years." All the data points in Figure 1 beyond 2000 years are for Egyptian specimens dated by an assumed Egyptian chronology which has been shown elsewhere to be greatly inflated when checked against tree-ring dating. Hence the author's Figure 1 shows that *correct* Egyptian dates will better fit *corrected* Libby dates, which one should expect.

The author's Figure 2 shows uncorrected C-14 dates vs. "Dendro-dates." It is offered to confirm constant SDR over the past 3500 years, but Brown does not mention that the "Dendro-dates" entail several sequence-matching regions from living tree to dead tree to logs, with serious probable errors as noted by Gladwin in Paper 20.

The author's section "Equilibrium in the Upper Biosphere: True or Quasi?" also raises questions on the definition of "upper biosphere being air, land, fresh water, ocean surface and organisms living therein" (p. 46). It is assumed that equilibrium between SDR and SPR is meant, or constancy of SDR in the biosphere. But such an arbitrary division between upper and lower ocean is dubious in view of the constant transfer between ocean strata, both of dissolved carbon dioxide and of organic. The effects of ocean currents and of the large change of CO_2 solubility with temperature are not mentioned. Nor is the fact that ocean-borne carbon dioxide is the dominant part of C-14 in the carbon-exchange cycle.

Brown's final section on "Biblical Chronology Correlation" examines four factors, cosmic ray intensity, geomagnetic field intensity, water content of the outer atmosphere, and world carbon inventory.

(1) As to cosmic ray intensity, he uses supporting references to conclude that it has been constant since the Creation.

(2) On geomagnetic field intensity, he indulges in phrases such as "it has been estimated," "it seems reasonable to presume," "one can postulate that," but gives no convincing evidence either that the earth's magnetic field has greatly changed in Bible time, or that it would significantly affect the production rate of C-14 atoms by cosmic radiation. On this point also, Brown does not mention the facts reported in Paper 7 ten years earlier, that cosmic radiation consists largely of proton bundles of atomic weight near 50 and over a billion times the energy in our most powerful accelerators, hence not easily deflected by the earth's magnetic field or by any likely increase in that field.

(3) As to the water content of the outer atmosphere, the author weighs various views regarding a pre-Flood water vapor canopy shrouding the earth and concludes that "any reasonable proposal in the pre-Flood stratosphere is ineffective" toward harmonizing C-14 dating with biblical chronology.

(4) Finally, as to the world carbon inventory, Brown estimates the inventory in his Table I, in which items 1-11 are what he calls the "total contemporary biosphere." Libby called this the "carbon exchange inventory," i.e. carbon participating in the great cycle from atmospheric C-14 to CO_2 to vegetation and ocean back to the atmosphere, this carbon being the denominator used in comparing SPR and SDR. Brown then estimates the remaining fixed or non-cyclic carbon in the world such as in fossil fuel (prior to industrial era), buried fossil vegetation (not commercially useful and sedimentary carbonates in earth's crust and ocean floor, and finds it to be some 550 times greater than the active carbon inventory. He does not address the question of how the active inventory (and therefore SDR/SPR ratio) was changed during the Flood.

Brown then lists in Table II what he calls "C-14 Time Scale Adjustment Factors" possible from each of the above four phenomena, and attempts to graph in his Figure 6 the C-14 production (SPR) and "relative concentration" changes associated with the Flood. Finally he reviews some evidence in dates of mammoths, musk-ox and mastodon taken from *Radiocarbon* indicating a post-Flood increase in SDR.

His general conclusion is that "data now available . . . provide ample assurance that the C-14 concentration (of) the biosphere over the past 3500 years could have accumulated since the Flood within a time period allowed by Biblical chronologic date."

22. Whitelaw, R. L. 1979. The biblical record of Creation, Flood and history in light of 30,000 radiocarbon dates. *Proceedings, 15th Anniversary Convention of Bible Science Association,* pp. 197-202.

This paper is an update of Paper 10, this time based on a review of over 30,000 dates published by *Radiocarbon* through 1979, of which Group I consists of 20,297 dates pertaining to man, animals and trees, and Group II, 3,090 dates pertaining to ocean creatures found in the ocean or buried on land. Analysis of dates in Group I reinforced the dramatic conclusions of the bar-charts in Paper 10, and the bar-chart distribution of the second group (marine dates) further substantiated the first report on marine dates given in Paper 16, namely that all marine life found buried on land and beyond reach of coastal waters (tides and highest waves) died either during the Flood or before the Flood and must have been transported there during the Flood, even where found at high altitudes on all five continents.

23. Whitelaw, R. L. 1982. Radiometric dating and the quest for an absolute geochronology. Baltimore Creation Convention. June 1982. GAM Printers. Sterling, VA.

In this paper Whitelaw addresses seven questions: (1) Is there an absolute geochronology available, and where is it found? (2) What is the proof that the biblical record brings us an absolute standard both for the

origin and age of the earth, and does it satisfy the accepted canons of scientific evidence? (3) What is the number of years since creation given us by the biblical record? (4) Is any known fact of history or geology in conflict with the biblical chronology, or with a sudden complete creation of a mature Earth? (5) What are the new radiometric "clocks" or techniques now available for estimating the age of the earth, and how well-proven are they? (6) Are any of these radiometric methods in conflict with the geochronology of the Bible? (7) Are any of them in agreement with the genealogies in the Bible by which the years from Creation to Christ can be determined (Note 7)?

The paper includes a Category A list of "clocks" pertaining to the biosphere (such as radiocarbon dating), and a Category B list of clocks pertaining to the geosphere, solar system or cosmic events.

24. Lee, Robert E. 1982. Radiocarbon: ages in error. *CRSQ* 19(2):117-127.

The author begins with the pessimistic assertion that "the troubles of the radiocarbon dating method are undeniably deep and serious . . . Continuing use of the method depends on a *"fix-it-as-we-go"* approach . . . and that "fully *half* of the dates are rejected."

He then reviews Libby's method and assumptions but fails to note that Libby refused to accept the evidence from the SDR/SPR ratio pointing to a recent beginning, and the obvious correction in dates this requires, as Paper 10 and others show. Author Lee then discusses various facts that have brought radiocarbon dates (meaning uncorrected Libby dates) into question: (1) calibration by dendrochronology, (2) magnetic field effects, (3) solar cycle influence, (4) atmospheric and ocean mixing effects on the local C-14 inventory, (5) fractionation between C-12 and C-14 in living things, (6) contamination of samples in the ground, (7) other contamination factors in charcoal, peat, bone, shell, and in the hands of the collector.

Lee than addresses the *statistical* uncertainty of the C-14 age of a given specimen and examples of widespread disagreement and even mis-statements by authorities. But he fails to note that they employ the uncorrected Libby method. His conclusion then begins with the statement that "radiocarbon dating has somehow avoided collapse onto its own battered foundation, and now lurches onward with feigned consistency."

25. Whitelaw, R. L. 1983. The fountains of the great deep and windows of heaven. *Proceedings, National Creation Conference,* Minneapolis. pp. 95-104

This paper, though not touching on radiocarbon dating, is pertinent here because it provides an in-depth analysis of the weaknesses of the canopy theory, which has dominated much creationist thinking on radiocarbon dating. Whitelaw first shows that the canopy theory is untenable on a number of counts, besides having no real biblical support. He then unfolds a probable scenario for the Flood catastrophe beginning with the significant phrase of Genesis 7:11 and 8:2 "the fountains of the great deep and the windows of heaven." The sequence proposed accounts for almost all the geophysical evidences of the Flood, both terrestrial and submarine, not otherwise explicable, few of which can be explained by the canopy theory. Included for the first time in this Flood scenario are such facts as the global ocean-floor maps with their abundant evidence of massive vulcanism and ocean-floor upheaval in the geologically recent past, the pre-historic maps of Antarctica by "ancient sea-kings," and evidence of massive continental shifts during the Flood, triggered by the great mid-Atlantic and Indian-Antarctic rifts, with residual motion continuing to this day.

26. Lammerts, Walter E. 1983. Are the bristlecone pine trees really so old? *CRSQ* 20:108-115

This notable paper appears to have been missed by subsequent creationist writers on dendrochronology. Lammerts reports dramatic results of actual experiments on bristlecone pine seedlings subjected to the pattern of rainfall in the White Mountains of California, where bristlecone pine tree-ring counts have been used to calibrate—and usually discredit—the C-14 date of a given ring in a sequence of living and dead trees.

The author shows conclusively that 8-month-old seedlings which received a typical (21-day) drought stress developed an extra growth ring (4 instead of 3) compared to the control group of seedlings. Also, a similar drought stress later in the season produced an extra growth ring (now making 6 instead of 4).

Lammerts concludes that

> The *San Francisco* type of spring and fall rainfall, with a relatively dry period in the summer, the young forests on the White Mountains would have grown an extra ring per year quite often. Accordingly . . . the presumed 7100 year age postulated for these trees by Ferguson would be reduced to about 5600 years, on the assumption that extra rings would be formed by stress during 50% of the years between the end of the Flood and about 1200 AD.

27. Morton, Glenn R. 1984. The carbon problem. *CRSQ* 20:212-219

This paper, though not focused on radiocarbon dating, raises an important question about the earth's total carbon inventory at Creation, evidently not considered by other creationist writers to date.

Physicist Morton shows that the quantity of carbon in the earth's known oil reservoirs is 666 times greater than the carbon found in all plants and animals on the face of the earth today; and that earth's total coal resources contain 50 times more organic carbon than the entire biosphere. Morton concludes that the usual creationist assumption that oil and coal in the earth's crust are the remains of plants and animals killed in the Genesis Flood, then requires that the pre-Flood earth must have been 716 times more lush than at present.

This last number being highly improbable, Morton goes on to consider other solutions, as (1) an abiogenic origin of much of the carbon in the earth's crust, (2) post-Flood deposition of carbon and (3) an abiogenic origin of the limestone carbonates in the ocean.

28. Vaninger, Stan F. 1985. Archeology and the antiquity of ancient civilization: a conflict with biblical chronology?—Part II *CRSQ* 22:64-67.

Author Vaninger first exposes what he calls "The Carbon 14 Coverup" in dealing with the history of ancient Egypt. In brief, prior to Libby's C-14 dating method, Egyptian chronology had been 'anchored' to several crucial dates, the earliest being 1872 B.C., the 7th year of Sesostris III. Fixing this point established the year 1786 B.C. for the end of the Middle Kingdom, a date based largely on astronomical methods. By 1960 these dates had become so crucial to 'orthodox' Egyptologists, that Velikovsky confronted a "scholastic/bureaucratic logjam" when seeking permission to test New Kingdom material by C-14 dating. He was bluntly told that "if a C-14 date supports our theories, we put it in the main text; if it does not entirely contradict them, we put it in a footnote; and if it is completely 'out of date,' we just drop it."

Vaninger shows that since those days C-14 dating, even by those using the uncorrected dates of Libby's Method, has radically reduced accepted Egyptian chronology by over 500 years, has forced a rethinking of astronomical methods previously used, and most of all has brought 'orthodox' Egyptian history into fair accord with the date of the Flood based on biblical chronology. All this is shown by Vaninger with fascinating personal details about the scientists involved.

Vaninger goes on to discuss reconciliation of C-14 dates with previous archeological (and evolutionary) estimates for the age of Mesolithic and Paleolithic Man. Here the uncorrected Libby dates give exaggerated ages, especially pre-Flood, which are compatible with the usual evolutionary bias when non-creationists write about "pre-historic man." Vaninger considers the immediate post-Flood C-14 dates to be inflated because "the Flood greatly upset the equilibrium of the C-14/C-12 ratio in the atmosphere . . ." This, of course is an assumption probably based on the canopy theory which he apparently holds. The natural buildup of the SDR/SPR ratio from the moment of Creation, and the sudden change in Carbon-cycle inventory caused by the Flood gives a better answer.

Vaninger concludes his paper by stating that "there no longer appears to be any problem . . . regarding the antiquity of human civilization conflicting with the Biblical record of the Flood and the chronology implied by Genesis 11."

In commenting on Vaninger's paper in *CRSQ* 23:37, Warren H. Johns of Andrews University lists three major problems in the C-14 dating of Egyptian materials:

(1) Contamination by "modern" carbon; e.g. reeds from Theban tombs, growing from mud bricks close to the surface could be as much as 1500 years younger.

(2) Re-use of ancient wood for funerary artifacts; e.g. a papyrus in the British Museum alleges that a piece of wood stolen from the necropolis of Rameses II (19th Dynasty) was re-used in coffins of the late 20th Dynasty, accounting for a coffin board date 1300 yrs older than the coffin joints.

(3) Damage to valuable artifacts caused by early carbon-dating sample-taking; e.g. early samples required removal of 10 to 20 grams of uncontaminated specimen to get a good date, so that few Egyptian artifacts were made available by museum curators. With the mass spectrometer method of counting C-14 and C-12 ions, used since 1985, a sample of 10 to 20 milligrams is adequate if uncontaminated.

29. Brown, R. H. 1986. Radiometric dating from the perspective of biblical chronology. Proceedings *First International Conference on Creationism.* Pittsburgh. pp. 31-56.

This paper attempts to reconcile biblical chronology with all radiometric dating methods attempted to date. Radiocarbon dating, though it alone points us to when life began, is only addressed in pp. 42-48. Brown appears to accept the uncorrected Libby method and the published dates in *Radiocarbon.* There is no mention of the need to correct their most egregious error, the SDR/SPR disparity. Instead, he focuses upon other factors that might bring C-14 dates into line with biblical chronology, these being: (1) use of dendrochronology to obtain local correction factors; (2) C-14 equilibrium in the upper atmosphere; (3) valid age limits for C-14 dates for different laboratory techniques, and probable errors due to such techniques as well as contamination of samples; (4) cosmic ray intensity effects on local values of SPR; (5) effect of geomagnetic field intensity on SPR; (6) effect of stratospheric moisture content.

The author closes with a "biblical C-14 transient model" and an estimate of the world carbon inventory (his Table 5), but proposes no satisfactory method of bringing uncorrected Libby dates into line with biblical chronology.

An Appendix lists 88 references of which some 24 pertain to radiocarbon dating, but none of the creationist papers reviewed here are listed except those by Brown himself.

30. Chaffin, Eugene F. 1987. A young earth?—A survey of dating methods. *CRSQ* 24:109-117.

The author first gives a brief survey of radiometric dating methods proposed to date. He then surveys the work done on radiocarbon dating since Libby, primarily that in the creationist papers reviewed above plus related creationist writings. The author then discusses the decay of the earth's magnetic field, indirect evidence from astronomy that implies a young age for the planet earth, and other dating procedures such as fission track dating, and stalactites and stalagmites that also point to a young earth.

Chaffin's list of 154 references is the most comprehensive seen to date. All but 22 are by creationists, most of them published in *CRSQ.* The author concludes with the statement that "there are still educated people alive today who are willing to defend biblical authority on the subject of the age of the earth and that very reasonable defenses can be made."

31. Brown, R. H. 1990. Correlation of C-14 age with the biblical time scale. *Origins.* 17:56-65.

Brown begins by supporting the Septuagint as a better basis than the Masoretic test for biblical chronology. For the date of the Flood he uses 5350 B.P. or 3360 B.C. He then considers what he calls "carbon-14 constraints," based upon results of bristlecone pine dating by Ferguson, and concludes that at the beginning of the Flood the biosphere had no more than 1 percent of the C-14/C-12 ratio "that has characterized

it over the past 3500 years." No basis is given for assuming a constant ratio since the Flood.

The author then assumes an atmospheric buildup of C-14 specific activity, A, during the Flood by the equation, $A = A_1[1 - \exp(-at)]$, and proceeds to calculate the value of the parameter "a," where A_1 is the equilibrium level" of specific activity of C-14 in the atmosphere, which he does not specify. With this equation he then calculates a radiocarbon age, R, vs a Biblical Model Real Time age, T, and concludes his paper with reasons supporting it.

32. Aardsma, Gerald E. 1990. Radiocarbon, dendrochronology, and the date of the Flood. Proceed*ings Second International Conference on Creation*ism. Pittsburgh. pp. 1-10.

In this paper Aardsma evaluates radiocarbon and tree-ring data "in light of current creationist understanding of the impact of the Flood on global geophysical systems to deduce a most probable date for the Flood."

He claims to have found a Flood date "within a few thousand years of 12,000 BC," i.e. about 14,000 B.P. Using this date, he derives a "creationist model for the increase in global C-14 specific activity following the Flood, and claims that the model "readily explains the long-term past behavior of atmospheric C-14 recorded by approximately 9,000 year continuous tree-ring sequences in Europe and America."

Aardsma does not make use of the classic work of Lammerts in 1983 (Paper 26 above), showing that climatic conditions can produce multiple tree rings per year. Rather he appears to assume that a reliable 9,000-year sequence of living and dead tree-rings is possible, and that C-14 specimens of such rings are uncontaminated.

Aardsma claims "strong support for the validity of the model (and hence the approximate date for the Flood upon which it is based) as well as the legitimacy of these long dendrochronologies." The reasoning used to support this claim appears circular in that an assumed date of the Flood is used to validate an assumed analytical model.

The author concedes that his model "implies that conventional radiocarbon dates" (i.e. those computed by the uncorrected Libby method as published in *Radiocarbon)* "in excess of about 11,000 B.P. greatly exceed true dates"; and concludes his abstract with the claim that his model "provides a rational basis for calibrating conventional C-14 dates, thus providing creationists with an objective and universal radiometric chronometer for determining the chronology of earth history from the Flood to the present."

Aardsma's discovery that C-14 published dates in excess of 11,000 B.P. greatly exceed true dates is of course in complete agreement with the findings of Paper 10 and others above, findings based on the SDR/SPR disparity which Libby dismissed. Aardsma however comes to this conclusion independently by correcting Libby dates of tree-rings to fit his 9,000-yr tree-ring sequence. In doing so he must assume that, (1) the C-14 specimens taken from his tree-rings are uncontaminated, (2) the vast majority of the rings in his sequence were annual, and (3) the ring patterns used to compare rings from living trees to older fallen logs and snags all give perfect matches. The reader may judge for himself whether this set of assumptions gives a better method of correcting uncorrected Libby dates than using the well-established exponential buildup curve based on the SDR/SPR ratio.

Most remarkable in this paper is the assertion of a Flood date of 12,000 B.C. (+/- a few thousand) since it challenges the strict biblical chronologies of Genesis 5 and Genesis 11. The widest variation in the date of the Flood among many Bible scholars who have studied it is about 600 years. Here however we have a theory by Aardsma that all such scholars are in error by some 9,000 years, based on a model that makes no use of Scripture (Note 8).

Summary of Views Pertaining to Validity of Radiocarbon Dating and Associated Questions

A. VIEWS ON PUBLISHED RADIOCARBON DATES (i.e. By the uncorrected Libby method)
   1. Papers that appear to accept them as reliable with minor correction: 1, 3, 5, 8, 12, 14, 20, 29
   2. Papers that view them as supporting the biblical Flood and/or Creation: 30
   3. Papers that view them as destroying evolution and Lyellian geology: 10, 16
   4. Papers that consider them unreliable or having little relevance to creationism: 1, 2, 10, 16, 20, 24
   5. Papers expressing other views on relevance of C-14 dates: 3, 7

B. VIEWS ON NEED FOR CORRECTING RADIOCARBON DATES
   1. Papers that view published dates as a strong witness to a biblical Creation when corrected by buildup curve of SDR/SPR Ratio: 4, 6, 8, 9, 10, 22, 23
   2. Papers that view published dates, corrected as above, as a strong witness to *both* the biblical Flood and Creation 10, 16, 22
   3. Papers that perceive the need to correct published dates when SDR/SPR < 1, but are not aware that such corrected dates would confirm the biblical Flood or Creation: 2, 3, 17, 31
   4. Papers that view C-14 dates as valueless unless corrected by dendrochronology: 5, 32
   5. Papers that view C-14 dates as needing many corrections, not all known, before being of significance to biblical creationism: 15, 19, 21, 24, 29, 30, 32

C. VIEWS ON QUESTIONS ASSOCIATED WITH RADIOCARBON DATING
   1. *Production Rate of C-14 in the Atmosphere:*
      A: Papers that accept it as essentially constant since Creation: 1, 5, 7, 10, 16, 22
      B: Papers that reject assumption of constant production rate: 3
   2. *Specific Production Rate (SPR) of C-14,* dis/gm-min in Carbon Cycle:
      A: Papers accepting constant SPR since Creation: 1, 10, 16, 17, 22
      B: Papers accepting constant SPR since the Flood, and greater between Creation and the Flood: 5, 10, 17, 22
      C: Papers that deny ability to know SPR variation in past: 27

3. *Specific Decay Rate* (SDR) of C-14, dis/gm-min in specimen:
   A: Papers that agree with Libby in assuming constant SDR in past, i.e. in equilibrium with SPR, therefore accepting published C-14 dates: 1
   B: Papers that endorse buildup of SDR as required by SDR/SPR ratio: 4, 9, 10, 16, 21, 22, 31
   C: Papers that assume no C-14 in biosphere before the Flood (due to canopy): 5, 31
   D: Papers that propose biosphere SDR > atmospheric SPR: (a) before the Flood: 17 (b) since the Flood: 13
   E: Papers that assume SDR in biosphere random in time and location: 13, 14
4. *Canopy Theory:*
   Papers assuming some form of vapor canopy before the Flood, and need of interpreting all C-14 dates accordingly: 2, 8, 12, 13, 14, 17, 19, 28
5. *Dendrochronology* (Tree-ring Dating):
   A: Papers that doubt its reliability for correcting C-14 specimen dates: 20, 26
   B: Papers that see it as reliable wherever an unbroken sequence is found: 8, 13, 18, 32
6. *Archeological Dates:*
   Papers that view C-14 dates as superseding traditional methods of archeology;
   A: Even when using published Libby dates: 13, 28
   B: Only using corrected dates and uncontaminated specimens: 18
7. *Views on Other Sources of Error in C-14 Dating:* Papers that view unknown factors (e.g. earth's magnetic field, etc.) as nullifying confidence in C-14 dates: 19, 24
8. *Views on Biblical Genealogies:*
   A: Papers that accept Genesis 5 and 11 (best mss) as basis for reliable chronology back to the Flood and Creation: 4, 10, 16, 22, 23, 29, 31
   B: Papers that reject Genesis 5 and 11 as basis for chronology prior to Abraham: 2, 32
9. *Papers Proposing Other Mathematical Methods for Evaluating C-14 Dates:* 11, 17

End-Notes

NOTE 1: Other than using radiocarbon dating, it is possible to arrive at the death-date or birth-date of a standing or fallen dead tree by measuring a large set of its growth rings, where visible, and by finding a perfect match of wide and narrow rings in a nearby living tree. This is called dendrochronology. Such a date is only valid however if the number of rings per year are known. Nor does such a date tell us the death-date of a fossil in the same area unless one can correlate the radiocarbon date of both ring and fossil and prove that both have not been contaminated by infusion of later carbon.

NOTE 2: But consider a once-living specimen of, say, 1.2 gm total carbon, containing 6×10^{22} atoms of which 56 billion would have C-14 nuclei. Such a large number would have insignificant variations in effective half-life from the "effective" constant statistical value of 5730 years used today (or from the 5568 years used in the Libby Method) and a specimen with less carbon than this would rarely be acceptable. Nevertheless, for very small specimens (e.g. bones or teeth which contain very little carbon) and very low specific activity at death, i.e. between Creation and Flood, Hanson's "sensitivity analysis" might give a better measure of probable error.

NOTE 3: In estimating radiocarbon buildup after creation, a better approach might be to assume SDR = 0 at creation and solve for the pre-Flood SPR that would bring SDR up to the necessary ratio R at the Flood. With this approach Hanson would obtain a pre-Flood SPR close to 64, as found in Paper 10, and would have no need of the canopy theory to account for it. SPR is specific to the inventory in the carbon cycle, so that with nearly constant cosmic radiation one need only show the reasons why the inventory in the world's carbon cycle was much less before the Flood.

NOTE 4: For readers wishing to implement the method described by Tyler in Paper 18a this reviewer has prepared a sequence of nine mathematical steps by which to take account of the probable errors in going from tree rings to archeological dates. These may be obtained from the reviewer on request; or author Tyler may have a similar calculational sequence to offer.

NOTE 5: Author DeYoung does not mention a third hypothesis, described in Paper 25 and presented at the 1983 Minneapolis Conference. This would account for a step-change in the *specific* production rate (SPR) of C-14 without need of either vapor canopy or vast increase in primordial magnetic field.

NOTE 6: So far as known to date, the two naturally-occurring stable isotopes of carbon (C-12 and C-13) occur everywhere on earth in the same ratio of abundance, 98.89 and 1.11 percent. This is also true of the isotopes of argon in the atmosphere, and of the three long-life radioactive isotopes of uranium, U-234. U-235, and U-238, where ore is found.

NOTE 7: By "biblical genealogies" in Paper 23 is meant the numbers in the original autographs of Scripture, especially of Genesis 5 and 11. Of these at least four different versions are extant, by which to deduce a fairly reliable original chronology, putting the Flood close to 3,000 years before the Cross, and Creation some 2,000 years earlier.

NOTE 8: In Paper 32, the possibility of a Flood-date some 9,000 years earlier than allowed by the strict chronology of Genesis 11 was also contemplated (if not exactly endorsed) by Appendix II (pp. 483-489) of *The Genesis Flood*, (Paper 2), a book viewed by many as the definitive creationist position on biblical chronology. In the above pages the authors reject Genesis 5 and Genesis 11 as genealogies and suggest that Genesis 11 alone (the generations from the Flood to Abraham) might be "stretched" to 5,000 years. They do concede that assuming a period of 100,000 years here would be "very hazardous."

Adhering to Genesis 11 as father-son genealogies, the period from the Flood to Abraham's departure from Haran is 365 to 447 years, based on various versions of the Hebrew text, while versions of the Greek Septuagint allow up to 1150 years.

QUOTE

The jarring element in our life, which makes us inhospitable to the religiousness of the East, is peculiarly modern and peculiarly Western: it is the scientific spirit. The scientific drive in the West is but little more than three centuries old, but in that time we have more and more deeply abandoned ourselves to it. It is now our theoretical scientists, our applied scientists, and our practical men of affairs, who mostly decide the conduct of our intellectual life.

Ransom, John C. 1965. *God Without Thunder.* Archon Books, Hamden, CT p. 27.