

How Accurate Is CARBON-14 DATING?

A human bone, a mammoth carcass, a fossilized stratum — How old are they? This question has puzzled laymen and scientists for decades. No one, it seemed, had the answer. Then came carbon-14 dating. This new method was hailed as the tool to unscramble history. But has it?

by Paul W. Kroll

WHO hasn't read such newspaper headlines as — "Evidence of 35,000-year-old human remains found," "Archaeologists uncover ancient 20,000-year-old artifact," "Mammoth hunts in Siberia 39,000 years ago"?

We are assured by these newspaper and magazine columns that such dates are absolute and measure actual spans of time.

Yet, shockingly enough, in many cases measurements and estimates of time were based on very meager facts.

Quest Into Antiquity

For decades archaeologists struggled to put together a chronological framework of prehistory — but with little success. There seemed to be as many theories as there were archaeologists and geologists. Controversies raged back and forth.

Then, a startling new approach to the problem was developed. It all began in the mid-1940's. The place was the University of Chicago.

Here, a relatively unknown chemist, Willard F. Libby, was working with a revolutionary new idea.

The result of his work catapulted him into international prominence. For his work, Dr. Libby received the Nobel Prize in chemistry for the year 1960.

His method of measuring time is called radiocarbon (carbon-14) dating. Dr. Libby, according to noted scientist Frederick Johnson, "Dropped the equiv-

alent of an atomic bomb on archaeology." More than twenty-five years later, impact from this scientific explosion has not yet subsided.

The Archaeological Method

Before carbon-14 — jokingly referred to as B. C. — little was really understood about recent earth history.

Archaeologists, said Frederick Johnson, were guilty of "steering by the seat of their pants"! The reason was simple. Archaeological estimates of time were really guesses compiled from very fragmentary data. Radiocarbon dating made havoc with these archaeological estimates of time. Frederick Johnson explained how:

"With few exceptions, this [archaeological] extraction was by inference and guessing... Libby's provision of a means of counting time — one that promised a definable degree of accuracy and worldwide consistency — caused all sorts of consternation because many of the new findings threw doubt on the validity of some established archaeological opinions" (Frederick Johnson, "Radiocarbon Dating and Archaeology in North America," *Science*, Vol. 155, January 11, 1967, p. 165).

Johnson then cited on the same page a typical comment of one very reputable archaeologist, "We stand before the threat of the atom in the form of radiocarbon dating. This may be the last chance for old-fashioned, UNCONTROLLED GUESSING."

Archaeology Versus Chemistry

Even after radiocarbon dating became established, disagreements were widespread. Consider one example — that of a hunting people, called Solutreans, in Europe. "Guesses as to when they arrived vary widely. Peake and Fleure think it was about 12,000 years ago, while Zeuner puts them back to 67,000 years before our time. Radiocarbon dates indicate only 18,000 years" (Kenneth Macgowan and Joseph Hester, *Early Man in the New World*, New York: Natural History Library Edition, 1962, p. 102).

Why such confusion? The reason is clear.

Archaeologists had no way to accurately count actual years. Consequently, no way initially existed to check the dates radiocarbon gave in the prehistoric period. Dr. Libby and his associates were faced with this problem when they first devised the radiocarbon method. They had expected a historical check, through the use of historically known dates, all the way to the limits of the method. But they were in for a shock.

Dr. Libby, writing in the January, 1956, issue of the *American Scientist* recounted briefly the history of radiocarbon dating: "The first shock Dr. Arnold and I had was that our advisors informed us that history extended back only 5000 years.

"We had thought initially that we would be able to get samples all along the curve back to 30,000 years, put the

points in, and then our work would be finished.

"You read in books and find statements that such and such a society or archeological site is 20,000 years old.

"We learned rather abruptly that these numbers, these ancient ages, are not known; in fact, it is at about the time of the first dynasty of Egypt that the earliest historical date of any real certainty has been established. So we had, in the initial stages, the opportunity to check against knowns, principally Egyptian artifacts, and in the second stage we had to go into the great wilderness of prehistory to see whether there were elements of internal consistency which would lead one to believe that the method was sound" (Willard F. Libby, "Radiocarbon Dating," *American Scientist*, Vol. 44, No. 1, January, 1956, p. 107).

What About "Historical" Dates?

Egyptian history begins around 5,000 years ago, according to the most liberal estimates. Some historians believe that Egyptian history does not extend that far into the past. The idea that the various Egyptian dynasties existed one after another in time has been questioned not only by scholars in antiquity, but even today.

This factor alone would have a great bearing on the radiocarbon method of dating. Without KNOWN historical dates to gauge an object to be dated, one could not know for certain that the indicated radiocarbon years were the same as actual calendar years.

And what about dating objects older than 5000 years?

"There was only one way to check the reliability of radiocarbon dating over a longer span," said archaeologist Edward S. Deevey, Jr., "and that was to test it on the materials of geology and prehistoric archaeology. The age of such materials is not 'known' in the same sense as that of mummy cases or trees" (Edward S. Deevey, Jr., "Radiocarbon Dating," *Scientific American*, Vol. 186, No. 2, February, 1952, p. 25).

There were no dates historically fixed with which to check. Radiocarbon was entirely alone.

In the more recent historic period, radiocarbon dates generally seemed to

HOW CARBON-14 CRACKS THE RIDDLE OF AGE

The carbon-14 dating method is based on an ingeniously simple process.

Cosmic rays bombard the upper atmosphere with tremendous energy. These rays produce great numbers of rapidly moving neutrons which collide with nitrogen atoms in the atmosphere. The bulk of these atoms are chemically transmuted into carbon-14. Chemically, a positive proton in the nucleus of the nitrogen atom is knocked out and replaced by an uncharged neutron.

The carbon-14 then diffuses throughout the atmosphere. It makes up a tiny fraction of all the carbon dioxide available to plants for photosynthesis. When the plants use carbon dioxide during photosynthesis, they automatically absorb this carbon-14. Plants are eaten by animals and humans. These also acquire carbon-14 in their tissues. All living things become equally "tagged" with carbon-14.

But at death, an organism no longer takes in carbon-14. Meanwhile the amount possessed by this organism at death begins to decay. Every 5730 years one half of the carbon-14 will decay back into nitrogen-14. In the next 5730 years, half of the remaining carbon-14 will decay. Now, only one fourth of the original amount is left.

This process continues until the carbon-14 remaining cannot be measured by current laboratory equipment. The practical range for most laboratories is the measurement of 35,000 radiocarbon (carbon-14) years; isotopic enrichment can stretch the measurement to 70,000 radiocarbon years.

The reason for the limits is the

infinitesimally small number of carbon-14 atoms to ordinary carbon atoms. There is only one radioactive carbon-14 atom to every trillion atoms of ordinary carbon. The abundance of carbon-14 atoms in modern wood is this tiny percentage: 0.00000000107%.

If carbon-14 years equal calendar years, it would make every organism a living clock that reveals elapsed time since death. Any organic material — flesh, bone, peat, dung, charcoal, nuts, beeswax — thus would reveal its actual age.

All one would have to do is measure the faint pulses of this disintegrating carbon-14. Once the amount of radiocarbon left at any point was determined, it could be measured against a calibrated scale based on the carbon-14 content of modern carbon.

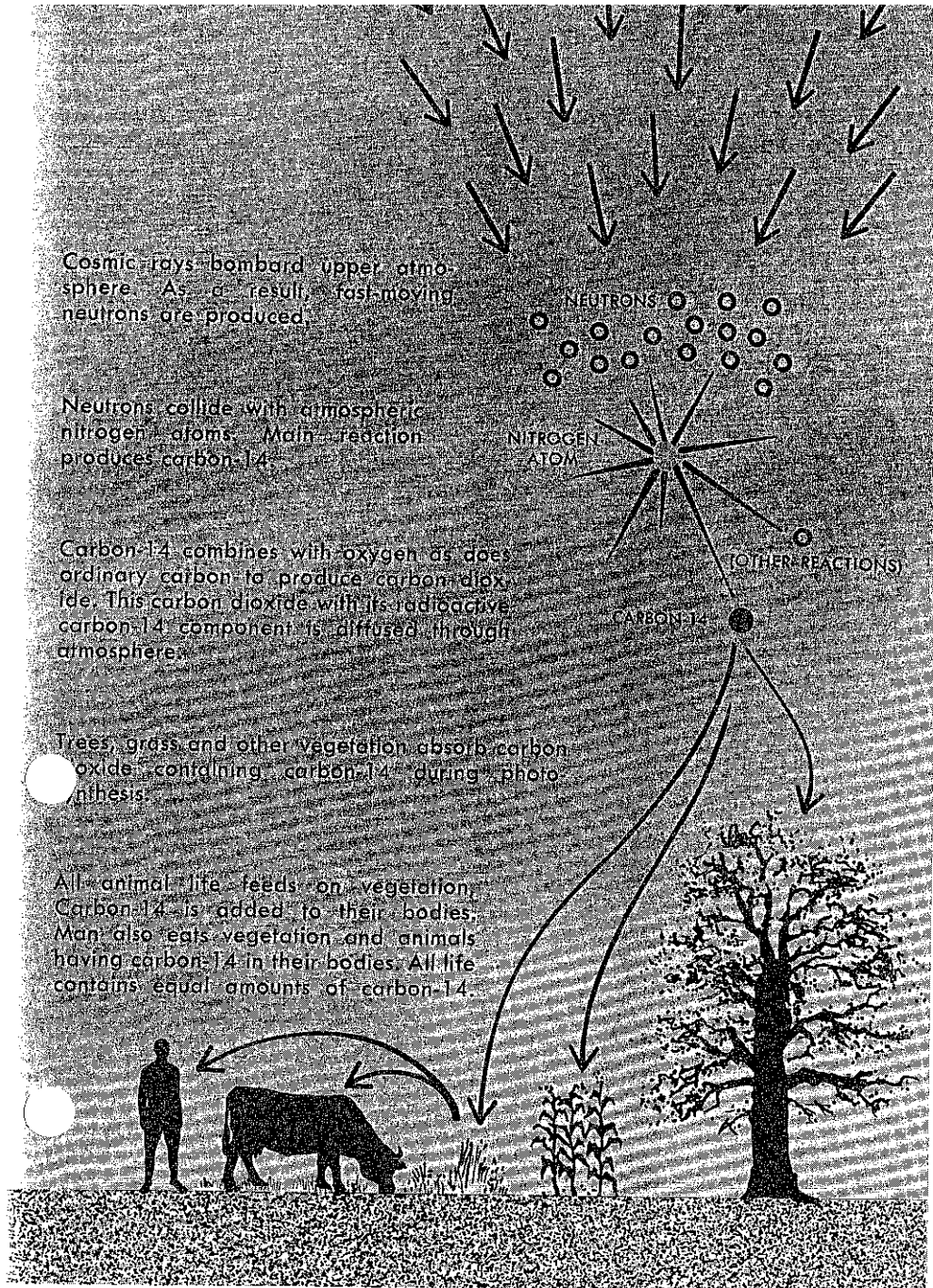
If the ratio of carbon-14 to ordinary carbon found in, say, wood today is the same as for wood which lived thousands of years ago, then the dating method is simple. The present becomes a "key to the past." Carbon-14 years equal calendar years. But if for some reason the ratio of carbon-14 to ordinary carbon was different in the past, then there would be no way to determine the calendar age of the specimen. For example, if a sample measured at 20,000 radiocarbon years originally had only $\frac{1}{8}$ of the present strength of carbon-14, it would be only 5000 years old!

Increasing evidence indicates that there are grave problems in the crucial carbon-14 to ordinary carbon ratio in the prehistoric past. However, for at least the last three thousand years, the method is remarkably accurate.

agree with historical dates. With the apparent success of radiocarbon dating in the historic period, Libby very cautiously stated: "In terms of physical principles of course, a method which works for three thousand years might extend all the way to fifty thousand..."

He did admit, "However, this is MERE CONJECTURE" (Willard F. Libby, "History of Radiocarbon Dating," *Symposium on Radioactive Dating and Methods of Low Level Counting*, March, 1967, page 24).

Dr. Libby very heavily qualified his statements. But most writers simply



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glossed over such points. Laymen were led to believe the method was infallible.

Basic Assumptions

The entire radiocarbon method stands on certain basic assumptions which have never been proven to be true. Experimental evidence indicates rather clearly that some of the assumptions may, in fact, be wrong.

For example, has the amount of radiocarbon in the atmosphere remained fairly constant in past ages?

Scientists are not sure.

"An assumption on the constancy of atmospheric radiocarbon concentration

in the past is *basic* for radiocarbon dating. However, the atmospheric radiocarbon concentration depends on the production rate of radiocarbon by cosmic rays in the stratosphere and the carbon cycle on the earth, and there is NO EVIDENCE that either was constant in the past" (Kunihiko Kigoshi and Hiroichi Hasegawa, "Secular Variation of Atmospheric Radiocarbon Concentration and Its Dependence on Geomagnetism," *Journal of Geophysical Research*, Vol. 71, No. 4, February 15, 1966, p. 1065).

That assumption is recognized by scientists but ignored by laymen who almost superstitiously accept radio-

carbon dates as true calendar years.

Scientists, of course, generally *assume* any variation has not been great enough to upset the method in prehistory. But there is no way to be sure of this assumption.

Suppose cosmic radiation varied for a considerable time and magnitude in the past? Suppose some shielding effect negated the cosmic shower's production of radiocarbon?

What would be the result if the carbon-containing ocean reservoir had been significantly disturbed? What about extreme volcanic activity and mountain building — would they have affected this crucial relationship? Had some catastrophic series of events dumped old nonradioactive carbon dioxide into the atmosphere? How drastically would these affect the apparent ages of specimens?

Suppose these and/or other factors had disturbed the critical relationship of radioactive carbon-14 to ordinary carbon-12?

In spite of the attractiveness of radiocarbon dating, these and other basic unanswered problems plague the researchers. There is no way to get away from these assumptions for the prehistoric period.

In order to postulate the relative constancy of carbon-14, several other assumptions had to be made.

One basic assumption is that "the cosmic-ray flux, and, hence, the PRODUCTION RATE of radiocarbon in the atmosphere has remained constant for several half-lives [the half-life of carbon-14 is presently calculated at 5730 ± 30 years]" (Hans E. Suess, "Secular Variations of the Cosmic Ray Produced Carbon-14 in the Atmosphere," *Journal of Geophysical Research*, Vol. 70, No. 23, December 1, 1965, p. 5937).

Dr. Suess also gives another related assumption on the same page: "Carbon contents of the various reservoirs containing cosmic-ray-produced C^{14} have remained constant over such a period of time" (*ibid.*, p. 5937).

For carbon-14 dating to be valid, even a third assumption is needed. The "rates of C^{14} transfer from the atmosphere into the other reservoirs, in

particular into the oceans, have also remained constant over this length of time" (*ibid.*, p. 5937).

These assumptions really cannot be proven. But they are accepted on the premise that the present is the key to the past. It is assumed that no extraordinary occurrences have ever significantly disturbed the production of carbon-14 or other related factors. This fundamental belief is a highly dangerous assumption to make. But it has been made!

"It is generally accepted that during the last 8000 years NO LARGE changes over prolonged intervals of time have occurred in the average cosmic flux, in the magnitude of the magnetic field in the vicinity of the earth, and in the degree of mixing in ocean water" (E. I. Hamilton, *Applied Geochronology*, London: Academic Press, 1965, p. 35).

Searching for the Answers

It is difficult — if not impossible — for scientists to prove that these crucial assumptions of the radiocarbon method are correct. Come with us into a laboratory to see what researchers found in trying to prove one of them.

The problem is: Can we prove the assumed equilibrium between production and disintegration of carbon-14? This assumption is basic to the method.

In the later 1940's, Dr. Willard Libby and his associates set up experiments to discover the present production rate of radiocarbon. They handled the problem in this manner. The researchers first calculated the average production rate of free neutrons in the outer atmosphere.

(Neutrons, produced by cosmic rays, are considered the key factor in the production of carbon-14.) Once Dr. Libby established a *present* average production rate of neutrons, he calculated the present production rate of carbon-14.

Next, Dr. Libby proceeded to calculate the average rate of decay of carbon-14 in modern living organisms.

Finally, he calculated the total amount of carbon in the world exchange reservoir. This was necessary because a radiocarbon date depends on the RATIO of carbon-14 to ordinary carbon. With this information and other

critical facts, radiocarbon dating seemed to be on its way.

Plunging Into the Unknown

At this stage, everything seemed quite plausible. It was all a matter of chemistry, physics and mathematics.

Now, Dr. Libby was required to make one *basic assumption*. It did not necessarily invalidate the method, but if this assumption were incorrect, it would have grave implications for certain ranges of dates. It was also crucial in terms of the time of the *beginning* of radiocarbon in the living carbon cycle of the earth.

The assumption and its implication are the following:

As mentioned, cosmic ray particles produce free neutrons when they smash into the atmosphere. These neutrons react with nitrogen atoms. A neutron, when it enters the nitrogen nucleus, knocks out a proton, which converts the nitrogen atom to a carbon-14 atom.

Libby calculated the PRESENT PRODUCTION RATE of these carbon-14 atoms. Now, if the *present production* has been going on for thousands upon thousands of years at its present rate, then the following evidence *must be found*:

"If this production has proceeded at a constant rate for many thousands of years, then the amount of C¹⁴ present on the surface of the earth should reach a CONSTANT value" ("Radiocarbon Dating," *McGraw-Hill Encyclopedia of Science and Technology*, 1966 edition, Vol. 11, p. 291).

This "constant" amount was further explained by Dr. Libby himself: "... We can see that if the cosmic rays have been bombarding the earth in essentially THEIR PRESENT INTENSITY for 10 or 20 thousand years, we can expect that A STEADY-STATE CONDITION had been established, in which the rate of formation of carbon-14 is equal to the rate at which it disappears" (Willard F. Libby, "Radiocarbon Dating," *American Scientist*, Vol. 44, No. 1, January, 1956, p. 99).

In other words, on this assumption the carbon-14 ratio of any ancient specimen could be related to the present ratio of carbon-14 in modern specimens. Dating then becomes simple. *If no other unknown factors* had disrupted the

method, a radiocarbon year would equal a calendar year.

An analogy explains why this equilibrium is vital.

Suppose There Is No Equilibrium

Think of a bathtub filling with water — but without a plug in it. If the tap pours water into the tub at a certain constant rate, the level of water in the tub will reach a constant height. This height will remain unchanged. In other words, the amount of water pouring into the bathtub will *just equal* the amount of water draining out through the plug hole. The idea being that the production of carbon-14 equals the amount leaving the system in disintegration.

In terms of the bathtub, it takes only a few minutes to establish this equilibrium. However, it would take a long time to bring the radiocarbon level into equilibrium.

If the system is not yet in equilibrium, it simply means not enough carbon-14 has been produced to fill up the atmospheric bathtub. And apparently old dates by radiocarbon would really be much more recent.

Was equilibrium a fact? Here is what Dr. Libby found.

Would the Equilibrium Assumption Hold True?

Dr. Libby and his associates calculated that there were 18.8 atoms of radiocarbon being produced every minute, per gram of carbon.

If there were an equilibrium between the rate of production and disintegration, living samples should show a disintegration rate of 18.8 radiocarbon atoms per minute per gram of carbon.

However, the average of 18 samples taken from various latitudes did not show an equilibrium! The disintegration rate of the samples only averaged 15.3 disintegrations per minute per gram. The rate of production was almost 19% greater than the rate of disintegration.

Libby preferred a value of 16.1 (value of inorganic samples) for the disintegration rate — even though the average for organic specimens was 15.3. However, there was still a discrepancy of almost 15% between production rate and disintegration rate.

How did Libby resolve this problem

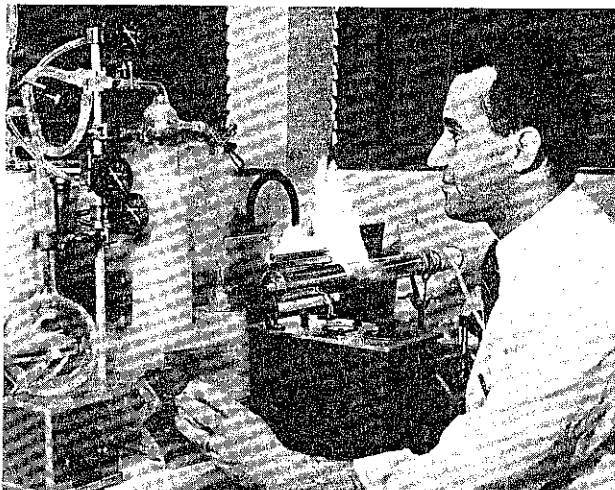


HOW A LABORATORY DATES SPECIMENS

SAMPLE EXAMINATION — A sample to be dated is identified, examined and cleaned in the first step of a radiocarbon dating laboratory's procedure. Tedious but vital removal of foreign matter such as root hairs from charcoal is vital. In the series of photos, the Humble Oil and Refinery Company laboratory in Houston, Texas, is pictured.

As part of the purification process, material — in this case charcoal — will receive a bath and chemical treatment with acid.

After a thorough washing, the sample will be dried in a laboratory oven.



A PROCESS OF CONVERSION. Sample, whether wood, charcoal, or other organic matter is then burned in combustion apparatus. Flame is hot enough to melt ordinary glass. During the fiery combustion process, sample is converted into carbon dioxide gas. This is collected as dry ice in the frosty liquid nitrogen trap.

The carbon dioxide will then go through various other purification procedures. Next, the gas will be re-collected in a liquid nitrogen cold trap. Now the sample has moved through the final step of purification. It is then pumped into the counter.

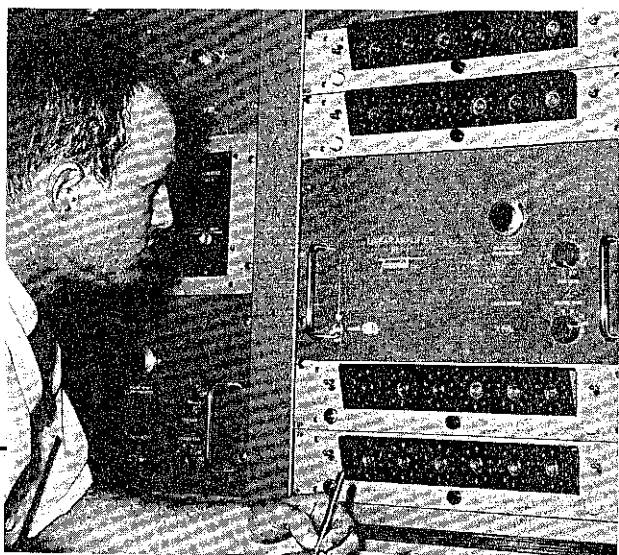


READY FOR MEASUREMENT. Sample is now trapped in one of three counters pictured in center of apparatus. These are ringed by twenty geiger counters and a 4,000-pound lead-mercury shield.

ATOMS CLICK AWAY. The scientist has wound up the atomic clock by setting the high voltage on counting system. It counts the click of the carbon-14 atoms as they revert to nitrogen. Preliminary data are examined as they come in. Normal count is over a period of 1,000 minutes. This, of course, varies with the laboratory and individual specimen measurement. Automatic equipment counts throughout the night.

Archaeology, as well as geology, benefits from the findings of radiocarbon dating. If the proportion of radiocarbon to ordinary carbon has remained steady — and no other factors have upset the method — dating can reveal the actual calendar years of a sample. Also, if properly interpreted, radiocarbon dating can reveal flaws in archaeological and geological estimates.

Humble Oil and Refining Company Photos



in his mind? He answered this very question in his book *Radiocarbon Dating*:

"The agreement seems to be sufficiently within the *experimental errors* involved, so that we have reason for confidence in the theoretical picture set forth above" (p. 7).

This, of course, was conjecture. It was possible that the discrepancy was experimental error.

Why So Crucial?

Why was it so important to have this equilibrium and agreement? Again, Libby puts his finger on the crucial point:

"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 of living matter would be much less than the rate of production calculated from the neutron intensity" (Willard F. Libby, *Radiocarbon Dating*, Chicago: University of Chicago Press, 1955, p. 8).

Yet, the first sketchy bits of evidence indicated that equilibrium has not yet been reached. If so, the cosmic system may have been turned on just a short time ago.

There simply may not have been enough elapsed time to produce the quantity of radiocarbon to bring the system to a steady-state equilibrium.

If lack of equilibrium is a fact, what implications would it have for radiocarbon dates? It could mean something like the following. Of two samples, one registers, say, 26,000 radiocarbon years; another registers 18,000 radiocarbon years. Yet, both samples might be only about 5,500 years old, or less, and almost contemporaneous.

New Evidence Found

In 1963, geophysicist Richard E. Lingenfelter published a disturbing report in the journal, *Reviews of Geophysics*. His calculations and conclusions seemed to spell death to the possibility that the lack of equilibrium was only "experimental error."

Lingenfelter's conclusion was that "there is strong indication, despite the

large errors, that the present natural production rate exceeds the natural decay rate by as much as 25 percent... it appears that equilibrium in the production and decay of carbon-14 MAY NOT BE MAINTAINED in detail" (Richard E. Lingenfelter, "Production of Carbon-14 by Cosmic Ray Neutrons," *Reviews of Geophysics*, Vol. 1, No. 1, February, 1963, p. 51).

Almost three years later, scientist Hans E. Suess commented on the experiments of Lingenfelter by saying, "It seems probable that the present-day inventory of natural C¹⁴ DOES NOT CORRESPOND to the equilibrium value, but is increasing" (Hans E. Suess, *Journal of Geophysical Research*, "Secular Variations of the Cosmic-ray Produced Carbon-14 in the Atmosphere and Their Interpretations," Vol. 70, No. 23, December 1, 1965, p. 5947).

Of course, scientists felt any discrepancy could be explained without jeopardizing the method. But all explanations are still UNPROVED hypotheses.

Depending on what base figures were used, the production rate seemed to be 20 to 30 percent GREATER than the disintegration rate — or perhaps even larger.

Various "explanations" were put forth to rectify this discrepancy. But once again — there simply was NO WAY to be sure. Lack of equilibrium could be a FACT! It could have meant that this was the effect of some drastic change in the radiocarbon inventory in prehistoric times. Was the radiocarbon system "turned off" in terms of its effects on earth until just a short while ago? Had other factors disturbed the crucial carbon-14-to-ordinary-carbon ratio? Are all the great stretches of years — from 50,000 B.P. [Before the Present] downward — to be telescoped into a few thousand years?

Evidence Overlooked?

The laboratories continued pouring out thousands of dates. Meanwhile, the average person was absolutely certain that science — chemistry and physics — had proved that relatively recent animal and human fossils were anywhere from 8000 to 53,000 B.P. One date of 64,000 B.P. was measured.

According to the evidence, however, these dates may have only been 6000 years old or younger.

Meanwhile Dr. Lingenfelter continued his studies on cosmic radiation and its relationship to carbon-14 production. Despite his positive findings published in 1963, he reconsidered them and, in 1969, said, "The uncertainties in... the production rate and the inventory are large enough to accommodate a wide range of R₀ [ratio between production and decay of carbon-14] including PERFECT EQUILIBRIUM" (personal communication).

After a quarter of a century of experimentation, scientists still could not be sure if a BASIC ASSUMPTION of the carbon-14 dating method were true! They were not even certain of the production rate of radiocarbon.

Then why have thousands of radiocarbon dates been published? Why have newspapers, magazines and books been written as though radiocarbon dating were certain?

Whither Carbon-14 Dating?

With such obvious difficulties, scientists now only had one alternative: submit carbon-14 dating to the tree ring dating method for verification. It was a tacit admission that attempts to verify basic assumptions of the carbon-14 method were inconclusive at best!

Geophysicists, like Richard Lingenfelter, were now falling back on tree ring dating to TEST the soundness of radiocarbon dating. In his own words, "Because of the uncertainties in the calculation of both the production rate and decay rate of C¹⁴ we find that the BEST DETERMINATION of the ratio of these two rates is obtained from the C¹⁴ variations determined from dendrochronology [tree ring dating]" (Richard E. Lingenfelter and R. Ramaty, *Astrophysical and Geophysical Variations in C¹⁴ Production*, Maryland: Goddard Space Flight Center Publication, July, 1969, p. 29).

How accurate is tree ring dating?

The One-Ring/One-Year Theory

Does one tree ring always represent one year? Not necessarily so. In fact,

the possibilities of "false rings" are rather common knowledge in botanical circles.

A botany text says, "The occurrence of false growth rings may cause the age of the tree to be overestimated. Such rings are produced by a temporary slowing of growth during the growing season" (Carl L. Wilson, et al, *Botany*, New York: Holt, Rinehart, Winston, 1966, p. 130).

Other facts causing false rings would be defoliation by insects, drought, and variation in rainfall (Wilfred W. Robbins, et al, *Botany*, New York: John Wiley, 2nd edition, 1959, pp. 110, 111).

But there was something more disturbing.

Most people do not realize that NO LIVING TREES older than about 5000 years have been found. More lengthy chronologies — the latest at just over 7000 tree ring years — are built up from DEAD tree stumps. These are pieced together in a delicate manner.

Surprising Age of Living Trees

There are no live 50,000-year-old trees. None at 25,000. None at 10,000.

As a matter of fact, the oldest known trees pose an enigma to uniformitarian — noncatastrophic — thinking.

Speaking of the bristlecone pine, famed dendrochronologist Edmund Schulman said, "Microscopic study of growth rings reveals that a bristlecone pine tree found last summer at nearly 10,000 feet began growing more than 4,600 years ago . . . Many of its neighbors are nearly as old; we have now dated 17 bristlecone pines 4000 years old or more" (Edmund Schulman, "Bristlecone Pine, Oldest Living Things," *National Geographic Magazine*, Vol. 113, No. 3, March, 1958, p. 355).

Dr. Schulman had years before been puzzled with the same approximate age limit to the giant sequoia trees which he studied. These trees enjoy near-perpetual life in the absence of gross destruction. They appear to be immune to insect attack.

Since this is so, Dr. Schulman asked the following question as early as 1934:

"Pertinent also is the well-known

fact that standing snags of this species, other than those resulting from factors of gross destruction, are unknown. Does this mean that shortly preceding 3275 years ago [or 4000 years ago, if John Muir's somewhat doubtful count was correct] all the then-living giant sequoias were WIPED OUT BY SOME CATASTROPHE?" (Edmund Schulman, "Longevity Under Adversity in Conifers," *Science*, Vol. 119, March 26, 1934, p. 399.)

That is something to think about!

Why is it that these still-living trees seem to be the original trees that grew in the present stands?

That some series of cataclysmic occurrences wiped out numerous forms of mammal life on earth cannot be disputed. Did that occur just beyond the historical era — around 4300 years ago? (If you have not yet read the astounding proof of this, write in for our FREE reprint, "Worldwide Mammal Massacre.") Had something happened in the recent past to "turn on" the system? Did the effects from a catastrophe or series of catastrophes gravely distort dates from the prehistoric period? Were conditions different in the prehistoric period — gravely affecting radiocarbon and tree ring dating? These were still unanswered questions.

Libby challenged some of the tree ring findings in 1963. "Recently, it has been reported that some trees add more than one ring per year, and thus a question has been raised about the accuracy of tree ring dates.

"This finding indicates that rings sometimes have been incorrectly correlated with years, too great an age having been assigned from tree rings" (Willard F. Libby, "Accuracy of Radiocarbon Dates," *Science*, Vol. 140, No. 3564, April 19, 1963, p. 270).

More Than One Ring Per Year

Libby's statement was partially based on researches done in the state of Texas. Much of the work, supervised by W. S. Glock, revealed that SPECIAL conditions are required for trees to put on only a single ring per year consistently.

In an article appearing in the journal *Endeavor*, W. S. Glock and S. R. Agerter wrote:

"It has long been supported that tree rings are formed annually and so can be used to date trees. The studies of tree ring formation . . . have shown that this is not always so, as more than one ring may be formed in one year.

"Two growth layers, one thick, the other thin and lenticular, proved to be more common than one growth layer in this particular increment [that was studied]. Three growth layers, in fact, were not unusual. A maximum of five growth layers was discovered in the trunks and branches of two trees.

"It must be pointed out that these intra-annuals were as distinctly and as sharply defined on the outer margin as any single annual increment" (W. S. Glock and S. R. Agerter, "Anomalous Patterns in Tree Rings," *Endeavor*, January, 1963, Vol. 22, pp. 9, 13).

The researchers stated it would have been IMPOSSIBLE to know which rings were put on what year — except for effects of frosts in various years visible in the trees.

A Big Challenge

Dendrochronologists challenged Libby's assertion that bristlecone pine put on more than one ring per year. In their researches, they found no false or additional rings per year.

"These results," they said, "are in contrast to the findings . . . where branches from a wide variety of Texas-grown trees reveal multiple growth layers attributed to varying temperatures and soil moisture" (Harold C. Fritts, *Bristlecone Pine in the White Mountains of California*, Tucson: University of Arizona Press, 1969, p. 32).

The above results, the author said, were on young branches of LOW-elevation trees. These, they admitted, might grow several times a year during a long frost-free season.

This multiplicity of tree rings in young, low-elevation trees, "Led Libby [1963] to improperly infer that discrepancies between tree-ring and radio-carbon dates in HIGH-elevation bristlecone pine may be attributed to frequent double rings. All studies that have been conducted in the White Mountains indicate that distinct double rings rarely occur" (*ibid.*, p. 32).

Again, the present had to be used as

the key to the past. Suppose the White Mountain area was for a long period of time a LOW-LEVEL area — to be dramatically raised up during a period of mountain building? Could the climate of the White Mountain area at this time have been similar to the climate of Texas?

One could not know whether it was low-level and climatically different. But neither could one know it WAS THE SAME as it is today.

Therefore, dendrochronology was forced to extrapolate as was radiocarbon. If conditions were different in the prehistoric period, then tree rings may also need correcting.

A Forgotten Source of Information

In all this controversy and lack of irrefutable proof of how much time has elapsed, one important document full of pertinent information was totally ignored.

Yet, this was the ONLY document that could set the record straight. The Preserver of this document claimed to have been on the scene during pre-history. Other observers wrote for Him

— observers who LIVED THROUGH the very events which would clarify the problem of “How much time has elapsed since...”

These observers wrote down key information which would unlock the secret of time — which would give meaning and direction to researches into carbon-14 dating and dendrochronology.

That document is the Bible.

It records that after a great destruction of life on earth — the globe lay desolate for an indeterminate period of time. If you have not read the astounding proof of that series of catastrophes in the dim past, then write for our FREE reprint, “Dinosaurs Before Adam?”

“The earth,” says the Bible, “was without form and void [the proper translation is “*became* without form and void”]; and darkness was upon the face of the deep” (Genesis 1:2). After this period of chaos, life was *re-created* — as recorded in Gen. 1:2-26.

Here then may be part of the answer to the carbon-14 researcher’s dilemma. If the earth was in darkness, could the carbon-14 production system have been *turned off until a short while ago?* Here

would be the answer to a lack of equilibrium in production and disintegration.

Next, what catastrophic occurrences happened in the days of Adam and Cain, when immense climatic catastrophes caused fundamental changes in the growing cycle? (Genesis 3:17-19; 4:12.) Would this have affected carbon-14 dating?

And what of the great occurrences which once again devastated the earth in the days of Noah (Gen. 7-8)? Did they gravely affect carbon-14 dating?

If scientists had accepted and studied these KEY events in the history of man, they would have been able to rightly apply the information gleaned from carbon-14 and tree ring dating.

But scientists — using the scientific method — have rejected REVEALED knowledge. They have relied solely on laboratory experimentation. That is why, twenty-five years after the carbon-14 dating method has been put into practice, a basic assumption of this tool has not been proved to be true. That is why, the Bible, the Word of God, stands as the needed KEY to human knowledge. □