[6]Tyler, J. E. and R. C. Smith 1970. Measurements of spectral irradiance underwater. Gordon and Breach, Science Publishers, Inc., New York, p. 52.

[7]Kondratyev, K. Y. 1969. Radiation in the atmosphere. Academic Press, New York, p. 239.

[8]McGraw-Hill Encyclopedia of Science and Technology 1971, Vol. 4, p. 284.

[9]*Ibid.*, pp. 284-285.

[10]Handbook of Chemistry and Physics, 56th Edition 1975-1976, p. E-19.

[11]For an atmosphere containing one constituent gas in accord with the perfect gas law at a uniform temperature and in a uniform gravitational field, the density expressed as a function of altitude is $\rho(h) = \rho(0)e^{-ah}$
where

$$\rho(0) = \frac{Mp(0)}{RT}$$

$$a = \frac{Mg}{RT}$$

M = molecular weight
R = gas constant
T = absolute temperature
$p(0)$ = surface pressure
g = gravitational acceleration

The formula for the altitude below which a given fraction f of the total atmospheric mass resides is $h(f) = \dfrac{-2.303 \log(1 - f)}{a}$

[12]The electrostatic energy of a charge Q placed on a sphere of radius r is $E_e = Q^2/r$. To concentrate a charge $Q = 2.5 \times 10^{36}$ statcoulombs on a sphere of radius r = 8000 km would require energy imput of 7.8×10^{63}ergs. The gravitational self energy of the galaxy is of the order $E_g = GM^2/R$, where G is the gravitational constant, M the mass, and R the average radial distance of mass from the center. The magnitude for our galaxy is about $E_g = 1.3 \times 10^{59}$ergs. So such a hypothetical charged earth could blow up 10,000 galaxies!

[13]McGraw-Hill Encyclopedia of Science and Technology 1971, Vol. 6, p. 630.

[14]*Ibid.*, Vol. 1, p. 678.

[15]Udd, Stanley, V. 1975. The canopy and Genesis 1:6-8, *Creation Research Society Quarterly*, 12(2):90-93.

WHAT ABOUT DENDROCHRONOLOGY?

HARRY V. WIANT, JR.*

The field of dendrochronology is reviewed and probable sources of error, especially for the bristlecone pine chronology, are indicated.

Creationists are interested in all dating schemes, including dendrochronology.[1] An attempt will be made in this paper to outline the state of this science, based on a very readable work by Avery[2], and point out probable sources of error in a tree-ring chronology.

Origin of Dendrochronology

Andrew E. Douglass, an astronomer in Arizona, became interested in the early 1900s in the cyclic nature of solar activity, especially sunspots, as possibly related to climatic variations on earth. He surmised that variations in the width of tree rings might indicate past climatic changes.

Studies by Douglass showed that precipitation is the most limiting climatic factor affecting tree growth in the southwestern United States, with narrow rings associated with years of low precipitation. As climatic variations tend to encompass large regions, narrow rings in two or more trees may be matched although they grew over 200 miles apart. This matching of corresponding growth rings is called crossdating.

Crossdating

By matching tree-ring patterns of old living trees and long-dead wood, with special attention to narrow rings, a chronology can be established reaching far into the past. A wood sample, from an Indian ruin, for example, may be found to match that chronology at some point, thereby indicating the date the tree was felled and the structure was built.

Ring patterns of ancient wood which do not fit the "absolute chronology" established from the present backwards provides a "floating chronology". The discovery of a wood specimen which bridges the gap between an absolute chronology and a floating chronology is of great value.

Generally, trees growing under adverse conditions provide more distinctive ring patterns. Most studies in the United States have used ponderosa pine (*Pinus ponderosa*), pinyon pine (*P. edulis*), limber pine (*P. flexilis*), bristlecone pine (*P. aristata*), Rocky Mountain juniper (*Juniperus scopulorum*), Douglas-fir (*Pseudotsuga menziesii*), and giant sequoia (*Sequoia gigantea*). Conifers tend to display "sensitive" ring patterns in contrast to the more "complacent" ring patterns of hardwoods.

Methods of Ring Pattern Matching

The matching of ring patterns is usually done by one of three methods: (1) memory, (2) skeleton plots, (3) graphic plots of ring widths. Also, computer-programmed correlation routines are sometimes used to evaluate all possible matches between two series of ring indices.

How reliable are these techniques? This is an important question to creationists, for by these techniques the oldest living bristlecone pine ($\approx$ 4000 years) and dead wood have been crossdated to provide a chronology assumed to extend back 8200 years, about twice the time allowed in some creation models.

Few workers would claim much reliability for the **memory method**, which requires committing entire ring series to memory; although it appears Douglass had unusual ability in this respect.

Skeleton plots consist of a graphic representation of relative ring widths over dates, with the greatest value assigned to "missing rings", almost as great a value for a microscopic ring; and average ring widths are often

*Harry V. Wiant, Jr., Ph.D., is professor of forestry, West Virginia University, Morgantown 26506.

ignored. Extremely wide rings may be noted. Ring widths are judged in relation to nearby rings, thus removing the effect of the tendency of tree rings to decrease in width as trees age.

Missing rings occur when portions of a tree stem show no discernible growth during years of severe environmental stress. The subjective judgement exercised to determine where missing rings should occur in a skeleton plot casts doubt on the bristlecone pine chronology.[3]

Ring widths can be accurately measured under magnification with machines designed for this purpose. Hamilton[4] has described an instrument which can be built in the average university shop. These measurements can then be graphed for visual or statistical comparisons. Visual comparisons, again, inject a subjective element reducing the reliability of assumed chronologies.

Correlation coefficients calculated between all possible matches for two series of ring indices tend to be randomly distributed around "zero", except at the match point where a highly significant positive correlation may be obtained.

Attention to Some Problems

Baillie and Pilcher[5] recommended the transformation of ring-width data for this analysis by (1) expressing the ring width as a percentage of the mean of the five ring widths of which it is the central value, and (2) normalizing by taking the log to the base *e* of the percentage figures. They emphasized, however, that this analysis is valid only where no missing or double rings occur. Again, the bristlecone pine chronology, with many missing rings[6], would not be useful in this less subjective statistical approach.

Also, A. C. Barefoot[7], a professor at North Carolina State University, working with oaks in England found correlation coefficients of .99 between ring-width series known to be wrong while those known to be correct were .90. I conducted a preliminary study with oaks in West Virginia and noted the same tendency. The probability of this type error can be calculated of course, and increases with poorer correlations.

Double, multiple, or false rings may occur when suitable growth periods are interrupted by droughts, defoliation by insects or late frosts or other unusual conditions.[8] False rings appear to occur more frequently in *Pinus* as one moves south, presenting a serious problem in tree-ring studies in Mexico. The unusual climate which must have followed the deluge may have caused the formation of many false rings in the older bristlecone pines in what is now the southwestern United States, increasing their apparent age.

Conclusion

Dendrochronology, as all dating schemes, is based upon certain assumptions and subjective procedures, and creationists need not be dismayed by the long chronologies claimed to have been established. This field should be a fruitful area for more study by those accepting the young-earth model.

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HEART MOUNTAIN REVISITED

CLIFFORD L. BURDICK*

At the Heart Mountain formation, Wyoming, and at other places, strata are in the wrong order, according to the uniformitarian view, supposedly older rocks being on top of supposedly younger ones. Such formations have been ascribed to the overthrusting of older rock over the younger. However, at many of these formations, including Heart Mountain, there is no physical evidence for such sliding; nor is there any proof that such motion is mechanically possible. Some recent investigation has again failed to provide any evidence that Heart Mountain was overthrusted; but there is evidence that a normal vertical fault was involved.

Introduction

Structural geologists have long recognized low-angle faults or thrust faults as one of the effects of tectonic activity in the crust of the earth, along with normal faults and strike-slip faults.

Regardless of the type of fault, where there has been differential movement along a fault plane, there is bound to be a grinding action, as is the case with the plates of any mill. Contact metamorphism may be one effect, especially where heat and pressure are involved. Other physical criteria resulting are:

1) Ground up rock, or mylonite, a layer between the moving blocks.

2) Tectonic breccia, or large fragments of broken, angular rock.

3) Slickensides, or fluting or grooves where the rough or angular projections have grooved the other plate.

Some early paleontologists were not well versed in structural geology and were inclined to ignore structure. They believed that the fossil evidence was so

*Clifford L. Burdick, D.Sc., is a geologist who has done much exploration for minerals. His address is 924 North 6th Avenue, Tucson, Arizona 85705.