

Geologic Time: The Scientific Evidence and the Genesis Record

by P. E. Hare

The crucial battle in the present war between science and scripture seems to be centered on the question of time. How much time is represented by the stratigraphic succession of rocks in the earth's crust? Do the ages of fossil-bearing rocks extend back to 600 million years (Cambrian), or even farther back into the Precambrian as suggested by radioactive age dates? Or are most of the fossil-bearing rocks the products of a recent catastrophe as advocated by "flood geologists"? This seems like a straightforward question that could be approached from a number of scientific disciplines. But it is obviously much more than a scientific question. Many scholars, including a number who have been trained in science, believe that the earth is only about 6,000 years old. Their belief is based not so much on scientific evidence as it is on an interpretation of "divinely inspired statements" that limits the earth's age to thousands of years. The obvious danger in this approach is to assume our interpretation of scriptural data as infallible, as did most Christians in the

controversies of the sixteenth and seventeenth centuries. Equating inspiration and infallibility is a deadly error and is a trap that must be avoided as we seek to harmonize the works and words of God.

For those who believe that "true science is but an interpretation of the handwriting of God in the material world,"¹ that nature and revelation shed light on each other,² and that "a correct understanding of both will prove them to be in harmony,"³ it is a serious matter to disregard either scientific or scriptural data. The committed Christian takes *both* scripture *and* science seriously, since he believes God to be the author of both. When problems of harmonizing occur, the natural impulse is to choose sides and dismiss the opposing side as in error or irrelevant. Most fundamentalist Christians — including many of the Seventh-day Adventist scientific community — reject the scientific evidence for an old earth, feeling that an old earth is not compatible with scripture. They stand in opposition to the group (most of the non-Christians in scientific disciplines) who reject the relevancy of scripture and feel only the scientific evidence can be trusted.

Some Christians compromise by separating the inorganic earth from the fossils and accepting the scientific evidence for the age of

Ed Hare, of the Carnegie Institution, Washington, D.C., has his doctorate from the California Institute of Technology. He has taught at Pacific Union College and is a former member of the Geoscience Research Institute.

the inorganic materials. They suggest that the present crust of the earth was formed at "the time of the flood" by reworking the old inorganic rocks and incorporating fossils from various ecological zones into various layers. Reworking the older rocks, they argue, has resulted in a series of apparent ages, as the radioactive clocks were contaminated or only partially reset.

Still others, attempting to find harmony between scripture and science, consider both sources to be essentially correct as a starting point at harmonization. Let them both speak for themselves, they argue. If the interpretation of the evidence for an old earth is correct, there must be a problem, not with scripture but in our interpretation of scripture. It should be possible to harmonize most, if not all, of the existing problems between science and scripture by allowing each source to shed light on the other. This approach is not the easy way out. An individual may find it a real struggle to modify concepts, scientific or scriptural, he has held for many years. It is not easy to evaluate data, especially if they are not in one's area of training. To determine what the data of science may really say as opposed to someone's interpretation of the data is just as important as approaching scripture and deciding what God is saying through the inspired human agencies. The prophets of God were inspired, but not infallible, as the story of the disobedient prophet in 1 Kings 13 so dramatically records.

Clearly, many scriptural passages must be interpreted in the context of the time in which they were written. When Joshua commanded the sun, "Stand thou still" (Joshua 10:12), he was speaking in the framework of his scientific concepts, not twentieth-century concepts. There was no thought of settling a future scientific debate between the followers of Copernicus and the followers of Ptolemy. The reformer Martin Luther used Joshua's statement to "prove" that the Bible taught the earth was fixed and it was the sun that moved around the earth!⁴ The astronomical evidence is so obvious to the trained mind of the twentieth century (common-sense observations still suggest the sun moves around the earth) that we

interpret Joshua's statement in its historical context to achieve a harmony between scripture and science.

Many feel that this method of harmonization is not valid for geological data on the age of the earth and the age of fossil-bearing rocks. It is felt that if much more than 6,000 years is allowed for the age of the earth this will prove evolution to be true. Actually, the probability for the spontaneous generation of a living cell is still infinitely small even if 4.5 billion years were allowed instead of 6,000.⁵ The evolutionist who rejects God and the supernatural must believe in spontaneous generation in one form or another. Pasteur in the nineteenth century presumably discredited this theory and put it to rest, but in recent decades the theory has rebounded and is again a respectable scientific concept to many scientists.⁶ To believe in the origin of living organisms from the spontaneous chance organization of inorganic matter requires a faith not unlike that required of the Christian to believe "In the beginning, God created. . . ." Science may never be able to provide data to answer the great questions of origin. How and when was the universe created? How and when was life created? Faith apparently will always be necessary whether in science or in scriptural understanding.

To many scientists, the evidence for an age of billions of years for the earth is convincing. Consider a brief geological case study of Crater Lake in Oregon. A spectacular series of volcanic explosions of ash, pumice and other volcanic debris, followed by the collapse of the top of an ancestral peak into a craterlike depression (called a caldera) formed what we now know as Crater Lake. By piecing evidence together from a number of geographical areas and different disciplines, scientists have reconstructed the past events in detail and have suggested that Mount Mazama lost its top about 6,500 years ago at a time when the wind was blowing from the southwest and glaciers still covered much of the upper reaches of Mount Mazama.

Geological evidences of past events are much like the clues found at the scene of a crime. Each clue needs to be evaluated and

interpreted within a time sequence. Most geological evidence involves the sequence or succession of past events. An obvious but important concept is that in a series of superimposed, undisturbed sedimentary layers the lower layers are older than the upper layers. Another is that volcanic ash from a volcanic explosion can be carried hundreds of miles from its source and be deposited in the ocean, lakes, peat bogs or permanent ice sheets nearly simultaneously, forming a marker ash bed that can be used for correlating events prior to and subsequent to the volcanic explosion. "Tephrochronology" is the term applied to geologic age-dating and correlation by means of volcanic ash. (Tephra is the general term for ejected volcanic material.)

Consider some of the geologic evidence for the history of Crater Lake. The casual visitor to Crater Lake is impressed by its deep blue color, size (approximately five miles in diameter) and depth (about 2,000 feet). The steepness of the rim around the shore indicates an unusual setting for a lake, since no rivers can be seen entering or leaving the lake. The rugged, uneven surface of the rim is an important clue to the possible ancestral mountain. Glacial evidence in the form of U-shaped notches in the rim, polished bedrock and moraines at the foot of the U-shaped valleys suggest extensive glaciation in the past. The U-shaped notches in the rim resulted when the upper part of the peak with its glaciers and upper parts of the U-shaped valleys collapsed into the caldera, leaving only the lower part of the glacial valleys intact. The obvious conclusion is that in order to support such extensive glaciers there was a high elevation source for snow and ice accumulation; hence, the reconstruction of Mount Mazama to 12,000 feet elevation or more.

The direction of the wind when Mount Mazama exploded is known, of course, from the distribution of airborne pumice and ash. Deposits of tephra extend toward the northeast and diminish in particle size and thickness with distance from Crater Lake. Ash from the explosion blanketed thousands of square miles and has been incorporated into the sedimentary record of peat bogs and lakes

throughout the northwest.⁷ The layers of Mount Mazama ash provide useful horizon markers for relating other sedimentary structures such as pollen profiles. Recognition and identification of ash layers are aided by chemical and petrologic analysis of the particles. Different volcanic sources — and successive ashes from the same source — have distinctive chemical "fingerprints." Fission track dating of glass "shards" in the ash is also useful in correlation and identification of ash layers.

When Mount Mazama exploded, the tephra, of course, was hot. The finer ash particles remained airborne and eventually cooled; but the larger ash and pumice fragments fell to the ground in an incandescent avalanche. The fiery cloud charred and buried not only trees growing around Mount Mazama but some up to 35 miles away! Some of these charred trees were discovered during the construction of a road cut and sent to a radiocarbon laboratory for C-14 dating. The analyses of several specimens in different laboratories yielded radiocarbon dates of about 6,500 + 200 years B.P. (before present) as the time when these trees were killed and buried and Crater Lake was born.⁸

Regardless of whether or not a date of about 6,500 years ago is accepted as a reasonably accurate estimate of the time since Mount Mazama exploded, it must be realized that this event is just one of the most recent geological events that has occurred in the area. Before the explosion, a mountain existed that was high enough to sustain major glacial activity for some period of time. Three episodes of glaciation are recognized with glacial debris alternating with volcanic rocks.⁹ Evidence also suggests ice thickness to 1,000 feet and glaciers ten or more miles in length. The building of Mount Mazama to an elevation of 12,000 feet or more (8,000 feet above the surrounding plateau) did not occur overnight but apparently built up over a period of time by intermittent activity with ejection of ash, pumice and other debris alternating with outpourings of lava. The postmortem anatomical record of these episodes in the building of

Mount Mazama can be clearly seen today in the steeply dipping layers of rock forming the rim around Crater Lake.

The most interesting information relating the demise of Mount Mazama with other geological events comes from the layer of ash that blanketed much of Oregon, Washington and Idaho as well as parts of Montana, British Columbia and Alberta. This time-stratigraphic marker is found preserved in numerous lake sediment cores and peat bog

“Preservation of delicate plant structures is so nearly perfect that it seems unlikely that fossil remains were transported any great distance.”

sections throughout the Northwest. In some deposits, other volcanic ash layers are found in addition to the Mazama ash layer.¹⁰

Ash falls older than Mazama ash are abundant and widespread. One particularly widespread ash deposit originated from Glacier Peak and when found in the same lake sediment core or peat bog section is found considerably below the Mazama ash, indicating an earlier date for the Glacier Peak ash. Stratigraphic estimates based on average sediment accumulation rates suggest Glacier Peak ash to be roughly twice as old as the Mazama ash.¹⁰ Radiocarbon dates confirm this estimate and indicate that the Glacier Peak ash is about 12,000 years old.⁷

As spectacular and awesome as active volcanoes are, they do not represent the ultimate in volcanic activity. The most extensive volcanic areas often do not even have true volcanic mountains. Fantastic amounts of very fluid lava have poured out through great fissures and spread out over the earth's surface for thousands of square miles. Known to geologists as plateau or flood basalts, individual lava flows commonly range from 21 to 100 feet in thickness and may exceed 5,000 feet of total accumulation.

Over 200,000 square miles of the states of Oregon, Washington and Idaho are covered

by plateau basalts, the Columbia River Basalt Group as they are referred to in the scientific literature.

The Columbia and Snake Rivers have cut spectacular channels and canyons into the Columbia River basalts, exposing in the canyon walls the history of successive outpourings of lava. Frequently, individual flows show evidences of weathering and erosion, indicating again the lapse of time and the intermittent nature of volcanic activity. Fossil evidence preserved in soil zones between lava flows suggests that a wide variety of plants and animals existed locally during the quiet periods between the outpourings of molten rock. Molds of upright trees several feet in diameter appear to be in position of growth with even the impressions of the tree bark preserved in the lava molds. In at least one case, the bloated body of a rhinoceros left an almost perfect lava mold!¹¹

The enormous volume of lavas that makes up the plateau basalts of the Columbia River Basalt Group is *considerably older* than Mazama or Glacier Peak ash. In places, nearly 2,000 feet of younger sediments (Mascall and Rattlesnake formations) overlie the Columbia River Basalt Group, and lake and peat bog sediments containing Mazama and Glacier Peak ash layers, in turn, overlie the eroded (glacially eroded in some places) surfaces of those formations.¹²

Below (and therefore older than) the extensive lavas of the Columbia River Basalt Group are the John Day and Clarno formations, which contain some of the richest vertebrate and plant fossil beds in the Northwest. Volcanic explosive material makes up a large part of the thousands of vertical feet of strata represented. The flora and fauna represented by fossils show a far different panorama of life than is found anywhere near the area today. Fossil evidence points toward a mild temperate and wet environment in contrast to the semiarid, continental-type climate prevailing today. Preservation of delicate plant structures is so nearly perfect that it seems unlikely that fossil remains were transported any great distance.

Still older rocks of Mesozoic and Paleozoic age are found stratigraphically below the Clarno formation.¹² Some of the formations

are similar to rock types and fossil assemblages found in the cliffs of the Grand Canyon far to the south and east. All of these stratigraphic units can be arranged in order from youngest to oldest based strictly on the principle that in a series of superimposed sedimentary beds the top layer is the youngest and the bottom layer is the oldest. Nowhere, of course, do you find all the units intact at any one locality. Erosion has removed some units from some places and re-deposited them as younger rock layers. Nevertheless, by careful mapping of various units and making use of drill core data, it is possible to arrange the sequence of geologic events (erosion and deposition) that has produced the geologic column. This has been the principal work of geologists over the last century and has made possible the production of geologic maps and the correlation of stratigraphic units over widely separated areas.

If geologic science is on the right track and the geologic column does represent a sequence of events over the vast span of time, how can the scriptural record be harmonized with this evidence? Let's explore some possible approaches.¹³ The scriptures are concerned primarily with the creation of man and the subsequent history of civilization. In the geologic record, human fossils are found only in the uppermost stratigraphic layers, the Pleistocene. This would seem to indicate that the geologic record of pre-Pleistocene rocks took place before the time recorded in scripture, concerning which scripture is silent.

What about the flood? Where does it fit into the geologic record? The scriptural account suggests that man had populated a sizable geographical area of the earth. If we use the principle of letting each record shed light on the other, we would look for geological evidences of the flood within the Pleistocene. There would seem to be several possibilities, including the worldwide catastrophic rise in sea level during the melting of the continental ice accumulations. It follows that if this approach is correct, then most of the sedimentary rocks of the geologic column are not the

result of the flood. Along with most scientists of the eighteenth century, George McCready Price in his flood model assigned virtually all the stratified rocks to the flood. The question of time is crucial. How much time is represented by the sequence of rocks in the geologic column? Age-dating methods suggest billions of years. Flood geologists believe most of the sedimentary rocks were formed by the flood in a short span of time. If flood geology is on the right track, then it should be possible to show that the various age-dating methods are totally in error. This seems unlikely in view of the fact that estimates based on realistic sedimentation rates of carbonate rocks — as well as other sediment types — are in general agreement with results from other age-dating techniques.

It is interesting to note that the same age-dating tools (radiocarbon) and stratigraphic principles used in geology are frequently used in archeology to date material and to determine the relative succession of occupational levels to substantiate Bible history. The Dead Sea Scrolls have a radiocarbon date of about 2,000 years and show that the much later manuscripts upon which our present

“If geologic science is on the right track . . . , how can the scriptural record be harmonized with this evidence?”

Bible translations are based have changed very little from these manuscripts dating to 100 B.C. Radiocarbon dating was used to show these manuscripts were not just recent fakes. A quotation from *Time* shows an example of what happens when scientific methods are applied to Biblical archaeological problems:

Christians revere the Bible as a treasury of divine revelation; skeptics regard it as an unreliable collection of fable and folklore. Over the past century a host of scientists — archaeologists, geologists, astronomers, botanists — have added a third perspective. Beneath the barren plains and foothills of the ancient Biblical country, they

have made discoveries revealing that whatever else it may be the Bible is a remarkably faithful chronicle of history.¹⁴

Again, why is it so many of us use scientific evidence when it supports our opinions but denounce the evidence obtained by identical methods when it conflicts with our concepts? If we really believed that nature and revelation shed light on each other, we would be more careful in our evaluation of data from both scientific and scriptural sources.

Should the committed Christian even be concerned about harmonizing scripture and science? Perhaps God intends this science-scripture conflict as a test of loyalty! Is it necessary as a sign of loyalty to deny one's own physical senses? Some use the quotation, "Are the people of God so firmly established upon His word that they would not yield to the evidence of their senses?"¹⁵ When read in context, this quotation deals with the miracle-working power of Satan used to impersonate Christ, "to deceive if it were possible the very elect." We are not expected to deny our senses when our senses tell us that real miracles are being performed, but rather we are expected to see through the deception of Satan and not credit the miracles to Christ!

The history of science and the Seventh-day Adventist church shows that the church has allowed a number of various ideas on geology to be published in the official church publications. From a literal interpretive point of view in which the entire universe — or at least the solar system — was created 6,000 years ago in six literal days, the possibility has been suggested that there may have been an initial creation of the earth's inorganic matter long before the creation week of Genesis.¹⁶ This would allow the light from stars millions of light years away to reach the earth instead of having intact light paths created along with the stars 6,000 years ago. It would also allow for the cooling of the tremendous quantities of plutonic igneous rocks (mainly granites) that make up the cores of the continents. Radioactive age-dating clocks could be operating during this interim between creations, and the ages now determined would reflect this primordial state of an earth "without form and void."

For a number of years, the author has been involved in the development of a chemical method of dating fossils that uses the breakdown of proteins and changes in the amino acids from protein in bones, shells and teeth to estimate the ages of certain fossils as well as the effective temperatures at which the fossils have been subjected to since deposition.¹⁷ Chemical changes, unlike nuclear reactions, are affected by temperatures. Higher temperatures speed up the rate of reaction, while lower temperatures slow down the rate. With a single chemical reaction, it would not be possible to determine both the temperature and time of the reaction. One of the two variables would have to be known or estimated. Usually, the temperature can be estimated by reference to present and inferred past climatic changes. It is often possible to simultaneously determine the age of a fossil and the effective temperature the fossil has experienced by using several different chemical reactions. The results on several fossil samples that have been dated by the amino acid technique tend to confirm the general validity of radiocarbon dating as well as other radioactive methods. The amino acid method is subject to a number of potential problems such as contamination, possible local high-heat source (such as a nearby lava flow), leaching by ground water, possible microbiological decomposition and perhaps many others. Some of these potential problems are easily recognized, others are more subtle. The use of different materials like teeth, bone and shell from the same stratigraphic horizon helps to reveal those systems that may not be suitable.

In every method of age-dating there are problems with discordant data and interpretation. Frequently, in apologetic literature, the problems and discrepancies are emphasized and the entire scientific discipline of geochronology is ridiculed. It is somewhat reminiscent of the arguments used against a rotating spherical earth in the scientific controversies of the sixteenth and seventeenth centuries (e.g., a rotating earth would fling objects out into space and create a continual violent wind). Because progress in science is often accomplished by trial and error, it is not

surprising that new concepts initiate controversy. In fact, controversy plays an important part in the scientific method, because it usually leads to further investigation and data that relate to the concept. A valid scientific concept survives the test of time, rarely, however, without some modification. Because of the tentative nature of scientific advances, scientists are generally reluctant to pronounce a scientific concept to be in its final form, realizing that new discoveries often lead to modification of existing concepts. Nevertheless, after a period of controversy and more data gathering, a surviving concept is considered to be on the right track and is useful for generating further scientific advances.

In the eighteenth century and the early part

“The scriptural data might be interpreted in other ways to harmonize with the scientific data currently available as well as with future scientific discoveries.”

of the nineteenth century, the concept of the flood as the prime geologic agent and the concept of the age of the earth as 6,000 years were serious scientific concepts. Neither concept stood the test of time required of scientific concepts. Were they abandoned prematurely? If so, by the very process of the scientific method, new data will eventually emerge to challenge the present concepts, or an outright scientific revolution will take place to completely replace the present theories.

Serious attempts have been made by Adventist scientists of the Geoscience Research Institute to reinterpret the data in terms of flood geology models, but little or no progress has yet been made on the real crux of the whole geologic column: time. It should be possible to show that the fossils in different stratigraphic layers are at least approximately the same age and thus lend credibility to a

flood model, or it should be possible to show that the fossils in the geologic column are of substantially different ages and hence lend credibility to the concept that the geologic column does, in fact, represent an appreciable sequence in time as well as space. Time is the important element and must be considered.

Unfortunately, prospects do not seem bright for a resolution of the difficult situation. The formulation by the church of a “creation statement” seems to be a first step in an attempt to control the beliefs of certain church members.¹⁸ Some administrators understandably want to maintain the concepts of flood geology and a short chronology. Allowing broad viewpoints, especially among denominational teachers who will influence students, is considered akin to fostering apostasy. Little or no consideration seems to be given to the possibility that the scriptural data might be interpreted in other ways to harmonize with the scientific data currently available as well as with future scientific discoveries. As long as this position is maintained, there seems no way that the two sets of data can “shed light on each other.”

The geologic record indicates climatic conditions and various kinds of animals and plants existed in the past history of the earth that were far different from what exists on the earth today. Many sincere, committed Christians maintain that “the time when these conditions existed can be learned only from the Inspired Record.”¹⁹ Does this mean we are to dismiss as irrelevant the methods used in determining the ages of rocks and fossils such as radiocarbon dating and potassium-argon, etc.? Virtually all the scientific methods currently used to date the past have been developed within the last 25-30 years. Obviously, we must be cautious in accepting premature, tentative scientific data. However, when several methods have been developed and applied and the results are generally consistent, can we still dismiss the data as premature? An individual must decide for himself if the data and interpretation are reliable and if so how they shed light

on statements from inspired authors that seem to be in conflict. Were these statements "present truth" in the historical context of the time when they were written, or were they statements of absolute truth for all time? We cannot rely on others to make up our own minds any more than we can depend on others for our own salvation.

Whether future discoveries will disprove the current concepts of geology or disprove the current concepts of flood geologists remains to be seen. Regardless of what future

scientific discoveries reveal, it is essential that we seriously consider the possibility that as far as the concept of time is concerned, the present geologic estimate of billions of years for the age of the earth may be essentially correct and also that fossil-bearing sedimentary rocks are substantially older than 6,000 years. How would such "truth" shed light on the written word? There will not be any significant effort at harmonizing science and the written word until we take *both* sources seriously.

NOTES AND REFERENCES

1. E. G. White, *Patriarchs and Prophets* (Mountain View: Pacific Press, 1890), p. 599.
2. E. G. White, *Education* (Mountain View: Pacific Press, 1952), p. 128.
3. E. G. White, *The Ministry of Healing* (Mountain View: Pacific Press, 1942), p. 462.
4. Angus Armitage, *Sun, Stand Thou Still* (New York: Henry Schuman, 1947), p. 90.
5. A. A. Roth, "Science Against God?" *Origins*, 1 (1974), 52-55.
6. John Farley, *The Spontaneous Generation Controversy From Descartes to Oparin* (Baltimore: Johns Hopkins University Press, 1977).
7. Roald Fryxell, "Mazama and Glacier Peak Volcanic Ash Layers: Relative Ages," *Science*, 147 (1965), 1288-90.
8. Willard F. Libby, *Radiocarbon Dating*, 2nd ed. (Chicago: University of Chicago Press, 1955), p. 118. Lyman J. Briggs, "When Oregon Eruptions Gave Birth to Crater Lake," *National Geographic Magazine*, 122 (July 1962), 128-33. See also reference 7.
9. Ann G. Harris, *Geology of National Parks* (Dubuque: Kendall/Hunt, 1975), pp. 124-125.
10. Ray E. Wilcox, "Volcanic-Ash Chronology," in H. E. Wright and David G. Frey, eds., *Quaternary of the United States* (Princeton: Princeton University Press, 1965), pp. 807-16. R. W. Lemke, M. R. Mudge, Ray E. Wilcox, and H. A. Powers, "Geologic Setting of the Glacier Peak and Mazama Ash-Bed Markers in West-Central Montana," *U.S. Geological Survey Bulletin*, 1395-H (1975).
11. W. M. Chappel, J. W. Durham, D. E. Savage, "Mold of a Rhinoceros in Basalt, Lower Grand Coulee, Washington," *Geological Society of America Bulletin*, 62 (1951), 907-18.
12. Numerous reports of geologic studies of the northwest United States are available to the serious student. A useful summary with references to the original literature is E. M. Baldwin, *Geology of Oregon*, revised ed. (Dubuque: Kendall/Hunt, 1976).
13. An excellent volume on relating science and scripture and containing a useful history of the attempts at harmonization is the book by Bernard Ramm, *The Christian View of Science and Scripture* (Grand Rapids: Erdmans, 1954).
14. *Time*, October 29, 1956, p. 50.
15. E. G. White, *The Great Controversy* (Mountain View: Pacific Press, 1911), p. 625.
16. M. C. Wilcox, *Questions and Answers* (Mountain View: Pacific Press, 1911), pp. 201-203.
17. P. E. Hare and R. M. Mitterer, "Laboratory Simulation of Amino-Acid Diagenesis in Fossils," *Carnegie Institution of Washington Year Book*, 67 (1969), 205-208. P. E. Hare, "Amino Acid Dating — A Review and an Evaluation," *MASCA Newsletter*, 10 (1974), 4-7. J. Wehmiller and P. E. Hare, "Racemization of Amino Acids in Marine Sediments," *Science*, 173 (1971), 907-11.
18. See SPECTRUM, Vol. 8, No. 4 (1977) for a discussion on creeds.
19. E. G. White, *Patriarchs and Prophets*, p. 112.