

Creation Research Society Quarterly

Haec credimus:

For in six days the Lord made heaven and earth, the sea, and
all that in them is, and rested on the seventh. - Exodus 20:11

VOLUME 33

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CREATION RESEARCH SOCIETY

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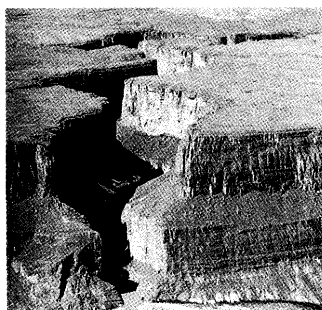
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Santa Elena Canyon, Big Bend National Park. See p. 89ff for the details of how this great canyon may have formed catastrophically. Photograph by Robert L. Goette.

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Distant galaxies as seen with the Hubble Space Telescope. See photo essay, p. 88.

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CREATION RESEARCH SOCIETY

History The Creation Research Society was organized in 1963, with Dr. Walter E. Lammerts as first president and editor of a quarterly publication. Initially started as an informal committee of 10 scientists, it has grown rapidly, evidently filling a real need for an association devoted to research and publication in the field of scientific creation, with a current membership of over 600 voting members (with graduate degrees in science) and over 1100 non-voting members. The *Creation Research Society Quarterly* has been gradually enlarged and improved and now is recognized as the outstanding publication in the field.

Activities The society is solely a research and publication society. It does not hold meetings or engage in other promotional activities, and has no affiliation with any other scientific or religious organizations. Its members conduct research on problems related to its purposes, and a research fund is maintained to assist in such projects. Contributions to the research fund for these purposes are tax deductible. The Society operates The Van Andel Creation Research Center in Chino Valley, Arizona.

Membership Voting membership is limited to scientists having at least an earned graduate degree in a natural or applied science. Dues are \$22.00 (\$27.00 foreign) per year and may be sent to Glen W. Wolfrom, Membership Secretary, P.O. Box 8263, St. Joseph, MO 64508-8263. Sustaining membership for those who do not meet the criteria for voting membership, and yet who subscribe to the statement of belief, is available at \$22.00 (\$27.00 foreign) per year and includes a subscription to the Quarterlies. All others interested in receiving copies of all these publications may do so at the rate of the subscription price for all issues or one year: \$25.00 (\$30.00 foreign).

Statement of Belief Members of the Creation Research Society, which include research scientists representing various fields of successful scientific accomplishment, are committed to full belief in the Biblical record of creation and early history, and thus to a concept of dynamic special creation (as opposed to evolution), both of the universe and the earth with its complexity of living forms. We propose to re-evaluate science from this viewpoint, and since 1964 have published a quarterly of research articles in this field. All members of the Society subscribe to the following statement of belief:

1. The Bible is the written Word of God, and because it is inspired throughout, all its assertions are historically and scientifically true in all the original autographs. To the student of nature this means that the account of origins in Genesis is a factual presentation of simple historical truths.

2. All basic types of living things, including humans, were made by direct creative acts of God during the Creation Week described in Genesis. Whatever biological changes have occurred since Creation Week have accomplished only changes within the original created kinds.

3. The Great Flood described in Genesis, commonly referred to as the Noachian Flood, was a historical event worldwide in its extent and effect.

4. We are an organization of Christian men and women of science who accept Jesus Christ as our Lord and Saviour. The account of the special creation of Adam and Eve as one man and woman and their subsequent fall into sin is the basis for our belief in the necessity of a Savior for all people. Therefore, salvation can come only through accepting Jesus Christ as our Savior.

Editors' Comments

Earth is where we live and is the only planet we know of that has life. Jerry Bergman reviews various facts about the earth that point to a Designer. The Creator must have had man in mind when He formed the solar system. The size of earth, the size of its orbit, the composition of earth and its atmosphere, the size and composition of our sun, all point to a design argument similar to that put forward by William Paley in the 1700s. Paley compared the intricacies of a fine tuned watch to the various delicately adjusted factors involved in making life possible.

Emmett Williams and George Howe continue a series of papers on the geology of Big Bend National Park, Texas. They have also shown an ongoing interest in the origins implications of canyons. Canyons demonstrate catastrophism in the geologic record, and this paper examines Santa Elena Canyon.

John Reed, Carl Froede, and Chris Bennett contribute an article connecting energy requirements to quantity of sedimentary deposition. Recently, within creationist circles, a controversy has been developing. Some young-earth creationists wish to assign large parts of the geologic record to events other than the Genesis Flood. Can the entire Mesozoic and Cenozoic be assigned to post-Flood deposition? Reed and Froede's discussion of the energy required to deposit thousands of feet of strata is a critical issue in these considerations.

Creationists need to understand the significance of radioactive dating results within the context of the Young-Earth model. In this issue Herbert Gill examines the concept of an *isochron* to determine whether the isochron method is statistically sound. This question is important in deciding whether trends exist in radiometric ages of properly chosen rock samples, as one moves from top to bottom in the rock record. We hope that readers will appreciate the mathematical insights offered in this paper.

In recent years a cosmological model consistent with a young age for the universe has been offered by D. Russell Humphreys. This model relies upon time dila-

tion equations from general relativity. The universe is modeled as an expanding, white hole with the earth located near an event horizon. Since the Earth is located at a special position, this led to a model in which, from an earth-centered point of view, only thousands of years would pass while millions of years would elapse in distant galaxies. Whether this model proves to be viable remains to be seen, but in this issue Mike Maiuzzo offers some parables illustrating what the time dilation schemes involve.

The Big Bend National Park in Texas is a huge playground for geologists. Carl Froede examines the question of subaqueous (under water) versus subaerial (under air) deposition for strata in and near Goat Mountain. Ample evidence exists for volcanic activity, and also for catastrophism.

At the Hanson ranch in Wyoming, fascinating fossils abound and these fossils are being offered for study by teams of creationist scientists. Read the article in this issue to see what promises to develop.

In Colorado and Wyoming a catastrophic and rapid sedimentation occurred in prehistoric times, including the deposition of charcoal fragments and plant fossils. Edmond Holroyd examines the mixing of the charcoal fragments with the surrounding silt and sand. He compares this to a modern forest fire site, and presents the consequent evidence for a catastrophic and energetic debris flow. Since the formations correspond to the Mesozoic Era of conventional geology, the reconstruction of this scenario has important implications for Flood geology.

Also in this issue there are some Panorama Notes, book reviews, and letters which we will not mention individually but which we hope the readers will enjoy. Please notice the dialogue between Socrates and Darwin which Dr. Gary Colwell offers as an example of important points in the creation-evolution debate.

Eugene Chaffin
George Howe

PERSONALITIES IN CREATIONISM

JERRY BERGMAN



The Society is featuring as its first personality in creationism a man who is well-known to Quarterly readers. Many of you have read and have appreciated his writings, thus by this means, we hope you will become better acquainted with this dedicated and prolific creationist.

Dr. Jerry Bergman holds six college degrees, including two master's (one in counseling and the other in social psychology), a Ph.D. from Wayne State University (major course work was psychology and research methodology and measurement), a Ph.D. in human biology and he has completed most of the course work for a third Ph.D. from Bowling Green State University. His over 20 years of college teaching experience, at both the graduate and undergraduate level, is primarily in the behavioral and natural sciences. Dr. Bergman was on both the undergraduate and graduate faculty at Bowling Green State University for seven years. He was also an Associate Professor of Psychology at Spring Arbor College and has taught both graduate and undergraduate classes at the University of Toledo for six years. He currently teaches psychology, sociology, physics and chemistry at Northwest State Community College in Ohio.

He has authored or co-authored over 40 books, monographs and book chapters, has published over

400 articles in professional journals and popular publications, and his work has been published in eight languages, including German, French, Italian, Dutch, Polish and Swedish. Among his books is a monograph on peer evaluation published by the College Student Journal Press, a Fastback on the creation-evolution controversy published by Phi Delta Kappa, a book on vestigial organs with Dr. George Howe,* a book on psychology and religious cults, a book on religious discrimination published by Onesimus Press, and a book on mental health published by Claudius Verlag. He has also published a college textbook on measurement and evaluation (Boston, Houghton Mifflin Co.), and has contributed to dozens of other textbooks.

Dr. Bergman has presented over 100 scientific papers at professional and community meetings in the United States, Canada and Europe. To discuss his research, he has been a featured speaker on many college campuses throughout the United States and Europe, and is a frequent guest on radio and television programs. His research has made the front page in newspapers throughout the country, has been featured by the Paul Harvey Show several times, and has been discussed by David Brinkley and other nationally known commentators on national television.

His other work experience includes over 10 year's experience at various mental health/psychology clinics as a licensed professional clinical counselor and three years full time in corrections research for a large county circuit court in Michigan and inside the walls of Jackson Prison, the largest walled prison in the world. He has also served as a consultant for CBS News, ABC News, *Reader's Digest*, Amnesty International, several government agencies and for two Nobel Prize winners, including the inventor of the transistor. In the past decade he has consulted or has testified as an expert witness or consultant in almost 100 court cases. A Fellow of the American Scientific Association, a member of the National Association for the Advancement of Science and many other professional associations, he is listed in *Who's Who in America*, *Who's Who in the Midwest* and in *Who's Who in Science and Religion*.

It is an understatement to say that Dr. Bergman's phenomenal career has been achieved by monumental personal effort, occasionally against terrible obstacles. I appreciate Jerry's uncompromising creationist standards and it is an honor to have him write for the Quarterly and as coauthor of one of our books.

Emmett L. Williams

Time dependent book offer not transcribed

***"Vestigial Organs" Are Fully Functional** published by Creation Research Society Books.

IN MEMORIAM — WALTER E. LAMMERTS

September 25, 1904—June 4, 1996

Dr. Lammerts, the founder of the Society, served for four years as its first president and five years as the first Quarterly editor. The successful development and early growth of the Society are largely due to his influence and wisdom. He continued to be active and instrumental in Society affairs until the late 1980's. His last major effort was to select the site for the Grand Canyon Research Center along with George Howe and Emmett Williams. Also he contributed regularly to the Quarterly from the 1960's into the 1980's.

Walter Lammerts was born in Terre Haute, Indiana. When he was four years old, his family moved to Kennewick, Washington to purchase 10 acres of land on which to grow fruit trees. Frequently late frosts would kill all blossoms and fruit on the trees, thus his parents decided to grow asparagus and strawberries. Dr. Lammerts' talents as an horticulturalist were evident when he was quite young. He planted his own strawberry patch using discarded plants and became a successful strawberry grower!

His family moved to Southern California in 1918 where he went to high school. Later he received a bachelor's degree in entomology in 1927 and his Ph.D. in genetics in 1930 from the University of California at Berkley. He was a fellow of the National Research Council at California Institute of Technology from 1930 to 1932. Then from 1935 to 1940 he was actively engaged in the breeding and development of roses and peaches for Armstrong Nurseries, Ontario, California. His most successful peach variety, the Robin peach and his famous Charlotte Armstrong rose were developed at this time. Dr. Lammerts was professor of ornamental horticulture at the University of California at Los Angeles from 1940 to 1945 where he worked with New Zealand tea plants and mountain lilacs. In the latter species, he developed Sierra Blue and Mountain Haze.

In 1945, Walter accepted the position of horticultural consultant for Manchester Boddy, the publisher of the *Los Angeles Daily News*. In this capacity, he helped to plan Descanso Gardens in La Canãda, California. Within this park, operated by Los Angeles County, Dr. Lammerts created the Rose History Garden showing the history of the roses with living specimens that were developed from 1500 to the present.

Dr. Lammerts began research and plant breeding for Germain's Inc. in Livermore, California in 1953. He earned 12 All-American rose selection awards. He developed the red rose hybrid Chrysler Imperial and Chrysler Corp. gave him a new Chrysler Imperial automobile, carefully painted the same color as the rose. The Organization of World Rose Societies, at their fourth world convention (Rosafari '79) selected Dr. Lammerts' famous rose, Queen Elizabeth, as the World's favorite rose. A painting of this beautiful flower was featured on the cover of the June 1980 Quarterly along with a tribute to our founder (pp. 1-3).

Walter developed many new roses, lilacs, thornless varieties of the *Pyracantha* shrub, camellias, sunflowers and peaches. He retired in 1964, but continued to be active in genetic research and plant hybridization. In this time period, he became more active in creationism and the first *Creation Research Society Quarterly* was published in 1964 under his leadership. The June 1970 Quarterly was dedicated to Dr. Lammerts (Howe, 1970, pp. 3-4) for his contributions to creationism and science. He was a member of Phi Beta Kappa, Sigma Xi, Botanical Society of America, American Pomological Society as well as numerous plant breeding societies. He authored over 50 scientific papers, wrote chapters in many books and edited others.

He was married twice and both wives preceded him in death. He is survived by two daughters, five grandchildren and two great-grandchildren.

Some of us on the Board of Directors worked with Dr. Lammerts on various projects and enjoyed his companionship, sense of humor and absolute dedication to the creationist world view. He was bold in his stand for a young earth, global flood and creation "after their kinds." His vision, brilliant intellect and tireless efforts guided the Society for many years. He was a talented man who defended God's word effectively in the realm of science.

References

- Howe, G. F. 1970. Walter E. Lammerts. *Creation Research Society Quarterly* 7:3-4.
 Queen Elizabeth Rose. 1980. Queen Elizabeth given award as the world's favorite rose. *Creation Research Society Quarterly* 17:1-3.

Emmett L. Williams

INSTRUCTIONS TO AUTHORS

1. Manuscripts shall be typed and double spaced.
2. An original plus two copies shall be submitted to the editor of the Quarterly.
3. All submitted articles will be reviewed by at least two technical referees. The editor may or may not follow the advice of these reviewers. Also, the prospective author may defend his position against referee opinion.
4. The editor reserves the right to improve the style of the submitted articles. If the revisions of the editor and referees are extensive, the changes will be sent to the author. If the changes are not suitable to the prospective author, he may withdraw his request for publication.
5. Due to the expense involved, manuscripts and illustrations will not be returned to authors.
6. All references (bibliography) must be presented in the style shown in the Quarterly. If a prospective author is not familiar with the CRSQ format, the editor will furnish an example reference page.
7. All figures and drawings must be prepared professionally. No sloppy hand drawings or freehand lettering will be accepted. The

editor reserves the right to approve submitted figures. Unacceptable illustrations will result in rejection of the manuscript or publication. Do not send slides.

8. Any manuscript containing more than 25 pages is discouraged. If a topic cannot be covered to the author's satisfaction in this length of pages, the author must divide his material into separate papers that can be serialized in the Quarterly.
9. The Quarterly is a journal of original writings. Only under unusual circumstances will we reprint previously published manuscripts. Never submit an article to two or three journals, including ours, hoping all of them will publish your work. When submitting an article, please state if the material has been published previously or has been submitted to other journals.
10. Book reviews should be limited to 500 words or fewer.
11. Authors are requested to supply a list of key words for subjects covered in their articles.

THE FINE-TUNED WATCH REVEALED IN THE DELICATE BALANCE OF THE EARTH'S FORCES

JERRY BERGMAN*

Received 23 November 1994; Revised 18 February 1995

Abstract

A review of several energy-matter cycles reveals that the Earth can be compared to a finely tuned watch, adjusted to the degree that minor mistuning can have critical adverse repercussions for life here. Paley's watch design argument thus applies not only to living organisms, but also to the complex entity called the Earth. We are only beginning to understand the workings of its complex balance and recycling mechanisms. In this paper I briefly review a few of the many mechanisms that exist illustrating Earth's complexity.

Introduction

The classic proof of God is the conclusion that the existence of a creation demands a Creator. In the late 1700s, William Paley published his extremely successful book titled *Natural Theology*. His theme was that the enormous complexity of the human body argues that its reality proved the existence of a Creator. He reasoned that a person who found an expensive watch lying by the roadside would know that it was engineered by an intelligent designer, and that such an object could easily be distinguished from objects lacking human design, a pebble for example. The analogy is also extremely relevant for the Earth itself, which is actually a far more intricately designed precision machine than a finely crafted watch. As the Scriptures declare, "God . . . formed the Earth. . . to be inhabited" (Isaiah 45:18) and an impartial study of the Earth soon convinces the student that tremendous meaning exists behind this simple statement.

The Earth

The Earth is the only planet circling our Sun on which life as we know it could (and does) exist. A brief glance at the Earth and all other known planets reveals many startling contrasts. Fully 98% of the physical Earth consists of iron, oxygen, sulfur, silicon, magnesium, and nickel, and the other two percent is made up of about 100 other elements. Like no other planet, ours is covered with green vegetation, blue-green oceans, streams, rivers, mountains, 500,000 islands and deserts which produce a spectacular variety of color and texture—all other known planets are covered with lifeless soil which varies only according to slight movements made by gas currents on those planets with an atmosphere (as Saturn, Jupiter, and Uranus) or by volcanoes or meteorites. Even from a distance, Earth's bright welcoming colors are quite lively-blues, white and bright greens—in marked contrast to the surface of all other known planets, which are dull and hostile. This difference is immediately apparent from the excellent photographs produced by our space program.

The Earth is immense—its equatorial diameter is 7,926 miles, and its mass is 6.6×10^{21} tons. If the Earth traveled much faster in its 595 million-mile-long orbit around the Sun, inertia would pull it away from the Sun, and if it moved too far out, all life would cease to exist. If it traveled slightly slower, the Earth would

move into a path closer to the Sun, and if it traveled into an orbit too close, all life would likewise perish.

An evaluation of the properties necessary to allow life to exist has found that only an extremely narrow range of possible temperature, pressure, atmospheric composition, and even physical constants must exist in order for life to live. Scientists up to the nineteenth century recognized, and were guided by the belief that God "had so arranged the laws of nature [so] that humanity . . . derived a maximum of health and happiness . . . the laws of nature are deliberately set up in such a way that life is preserved" (Kippenhahn, 1991, p. viii). Breuer eloquently provides "an impressive list" of the many universal constants which, if different, the universe could not support life (Breuer, 1991). Many conditions are necessary for life—the existence of a molecule like H₂O which has all the traits of water, the existence of a carbon atom which has four strong covalent bonding sites, and the numerous constants of physics, i.e., gravity, and the laws of electromagnetism are a few salient examples. Any alternate physics or chemistry would not allow life to exist.

Many of these facts are well known, but Breuer eloquently shows that thousands more exist—vanadium, copper, the laws of biomolecule spatial folding, and even night and day and the neutrino, are all necessary for life to exist. This concept was first made famous by Barrow and Tipler (1986) and further elaborated by Barrow (1988, 1991). It has been shown by Harris (1992) that the discoverers of physics, chemistry, and especially biochemistry and molecular biology "reinstated the traditional arguments for the existence of God" specifically the conclusions of Paley. Ross has listed these constants in his articles and books (1994, 1993, 1991).*

The Earth is not only an extremely beautiful, but also an incredibly complex dynamic changing machine whose many parts all function in amazing balance with each other. Research in the last century is only beginning to show the extent to which the external and internal forces of the Earth balance each other in incredibly remarkable and complex ways, producing the Earth's internal harmony that we often take for granted. Its complexity and structure is also in enormous contrast to every other known planet (Ager, 1993). The conclusion is inescapable: The Earth was created for life and if certain aspects of it were slightly different, life could not exist here (Comins, 1993).

*Jerry Bergman, Ph.D., Northwest College, Archbold, OH 43502-9542.

*Editor's note: The Creation Research Society does not condone Dr. Hugh Ross's long-age approach to origins.

Temperature Balance

For life to exist an incredibly narrow temperature range must be consistently maintained. If the yearly average temperature on Earth rose or fell only a few degrees, most life on it would soon roast or freeze. This would upset the water-ice and other balances with disastrous results. The mean Earth temperature is remarkably stable only because of a set of complex mechanisms that produce a precision balance in its energy gains and losses. These balance mechanisms are so finely tuned that the Earth's annual world wide temperature rarely varies more than a degree or so. Most of the energy that reaches the Earth's surface is primarily solar radiation, but small amounts are reflected from the moon and some even comes from the stars. A major means of energy loss is the diffusion of heat energy into outer space primarily by radiation as the Earth circles the Sun. Also, the upper atmosphere loses primarily its more energetic gas molecules, thereby cooling in the same way that evaporation cools. Loss also occurs by both conduction and convection of energy into the thin gas envelope existing in outer space surrounding the Earth (Shimer, 1968).

The Earth's atmosphere is also heated primarily by the Sun's incoming solar radiation. Fully 40% of the incoming radiation is reflected back into outer space essentially unchanged, about 20% is absorbed by the atmosphere, and the remaining 40% is absorbed by land, rocks and sea water. The energy which is absorbed by the land, sea and atmosphere results in effectively raising the heat level to the ideal temperature for life. The world temperature averages about 15° C, and the most extreme normal ranges are from about -40° C to +40° C (Miller and Oberlander, 1984). Much of the 60% of the Sun's energy that is absorbed is eventually radiated back into outer space, producing the critical balance necessary for life to live (Skinner and Porter, 1987, p. 44).

The total amount of internal heat energy that reaches the Earth's surface and is likewise eventually radiated into outer space is estimated to be about 2,700-billion joules per second (a joule equals about 1/4 of a calorie). The Sun's rays that reach the ground heat the surface soil and rocks which in turn warm the air. The heated air rises and is replaced by cooler air, a process which continually pumps heat from the Earth's surface into the atmosphere. The Earth radiates much of this energy back into outer space as long-wave-length, lower frequency electromagnetic waves. The Sun provides the Earth with a constant supply of more than 240 trillion horsepower, about 46 thousand horsepower for each current resident. Of all the energy the Sun gives off, only an estimated 0.45 billionth of its daily output is picked up by the Earth.

If the balance did not exist and the Earth radiated even just slightly more energy into outer space than it absorbed, the Earth would slowly cool, eventually becoming a frozen, lifeless mass. If the reverse occurred and Earth absorbed more heat than it lost, all surface liquids would soon boil and the Earth would likewise become a barren desert, void of all life. The critical balance of forces that drives the rain, rivers, streams, wind, waves, and glaciers would also be destroyed. The energy absorbed by sea water causes water evaporation needed to produce the vapor which is needed to

form rain clouds. The wind carries the clouds over the land surface, producing the precipitation-including rain, snow and hail—that waters our crops and provides us with the thousands of food types that we need for a healthy and enjoyable life. The local surface winds are created by the land absorbing heat which warms the surface air causes it to rise resulting in the cooler air rushing in to take its place.

Heat is the end point of all chemical reactions, the eventual graveyard of all energy forms. The energy from gasoline, both that causes a car to move and that which is wasted, all forms heat. This is also true of the energy obtained from food and used to enable all life to live. Not only does the use of fossil fuels produce heat, but even food metabolism caused by life adds heat to the atmosphere. All animal movement and all kinetic energy also eventually becomes heat energy, which eventually adds heat to the Earth's total heat load.

The Heat From the Earth's Core

The Earth's surface also receives much energy from both its extremely hot but solid inner iron-nickel core (solid because of the enormous pressure existing there) and its hot molten iron-nickel liquid outer core. The Earth's interior heat energy was produced during the Earth's original formation, most of which is still present in the molecules in its liquid and solid inner cores. Another source of Earth's heat is from the decay of radioactive potassium, uranium, thorium and the other radioactive isotopes found abundantly in the Earth's crust. We know that the Earth has received much energy from these sources in the past because of the existence of comparatively large amounts of radioactive decay products. The most common radioactive isotopes found in the crust are K-40, U-235, U-238, and Th-232, and these radioactive isotopes, together with those of a few less common elements such as rubidium, are "widely distributed in tiny amounts through the crust and the mantle" (Skinner and Porter, 1987, p. 41). The core heat, plus that which radioactive elements generate, is significant enough to keep the Earth's interior "exceedingly hot" (Skinner and Porter, 1987, p.41). Yet another source of Earth's interior heat is the conversion of gravitational energy to thermal energy (Press and Siever, 1978).

Most of the heat produced or existing inside of the Earth reaches the surface by the slow but steady process called *conduction*, the transfer of energy from molecule to molecule. The average total level of heat flow from the Earth's interior is 1.5 microcalories per square centimeter per second (Mallory and Cargo, 1979). Without a balance of these many heat gains and losses, the Earth would soon be a barren planet void of all life.

The atomic energy reactions occurring in the Earth are different processes from those which occur in the Sun. The most widely accepted theory is that most of the energy produced in the Sun is from nuclear fusion, the combining of atoms. The enormous heat and pressure in the Sun forces atoms together—usually four hydrogens—to produce a net end result of one helium atom (Milton, 1983). Spontaneous decay is a result of the atom's own instability and is a natural decay process, whereas the energy from fusion is not directly

due to the internal conditions of the atoms involved, but to the enormous heat and pressure in the Sun which forces the smaller atomic nuclei to unite. In both of these processes *mass defection* occurs, a conversion of mass into energy according to the $E = mc^2$ relationship. Another source of the Sun's heat is the conversion of gravitational energy to thermal energy (DeYoung and Rush, 1989).

Other Heat Stabilizers

A major reason that the world-wide temperature remains nearly constant is that 71% of the Earth's surface consists of oceans, and the land surface also contains large reservoirs of water in snow, ice, lakes, rivers, streams, and ponds. This is critical because water has an enormous capacity to store heat, and consequently rapid and extreme temperature fluctuations on Earth are minimized (Croneis and Krumbein, 1936). The *specific heat* of water—its capacity to store heat—is among the highest of all known substances. Of all common room temperature liquids and solids, only ammonia's heat capacity is greater.

Upsetting the delicate heat balance on Earth will eventually cause many catastrophic changes on its surface. A rise in the temperature would cause some of the enormous north and south pole ice sheets to melt, raising the ocean water level to heights which could cover significant portions of the existing land mass. The rise in sea level from this melting could potentially be as much as several meters (Skinner and Porter, 1987, pp. 20,584). Considering that the average height of the Earth's surface is only 0.8 kilometers above the mean sea level, relatively small amounts of water will submerge large amounts of land. Melting of the ice sheets would allow isostatic rebound of the underlying lithosphere. Especially threatened would be the coastal areas which tend to be both at a lower elevation than the interior land, and are also the home of a large percentage of Earth's human inhabitants. Among the many other changes that will result from even a small average temperature rise include increased cooling costs (but lower heating cost) and rapid increases in certain kinds of bacteria which would thrive if the Earth was but a few degrees warmer.

We must be aware of these factors because a major activity that has the potential of slowly changing this energy balance is the huge amount of fossil fuels burned by humans. This activity not only adds heat to the Earth, but it also influences the carbon cycle by increasing the rate of atmospheric CO_2 influx from various solid carbon storage forms such as coal or petroleum. One result of this process is to increase the reservoir of atmospheric CO_2 , which some conclude could contribute to a greater greenhouse effect.

The Greenhouse Effect

The greenhouse effect is necessary to produce the temperatures on Earth in which life can exist. The electromagnetic radiant energy that strikes the Earth's surface becomes *longer* wavelength and lower frequency due to energy loss from its collision with the Earth. The energy consequently moves into the heat area of the electromagnetic spectrum, and therefore much more of it becomes trapped by the atmosphere, producing what is called a greenhouse effect because this

principle is used to heat greenhouses. The heat is trapped primarily because of the atmospheric water vapor, but also due to carbon dioxide and other gases which produce a "thermal blanket" that retards the escape of this now long wavelength radiation. The same phenomenon is illustrated by the rapid increase of an automobile interior temperature that occurs on a clear day: visible light passes easily through the car's glass, striking the seats and becoming lower frequency, longer wavelength electromagnetic energy, a form that tends to be trapped in the car by the automobile glass. The glass and the atmosphere thus both function as one-way valves.

Other sources of carbon gases are volcanic action, animal respiration and weathering. Past measurements indicate the concentration of CO_2 in the atmosphere has increased from 316 ppm in 1959 to 338 ppm in 1980, a 7% rise during the short 12 year span between these two measurements. Some computer simulation attempts suggest that a doubling of CO_2 may result in a surface warming temperature increase of about 4°C (Skinner and Porter, 1987, p. 583).

This small temperature fluctuation may seem minor, but the average global difference between the ice age and non-ice age sea surface temperature is only 2.3°C (Skinner and Porter, 1987, p. 573). The average is, of course, not the average everywhere—in some areas little change evidently occurred, in others an estimated drop of 14°C or more existed. Although this small increase is enough to significantly affect all life on the Earth, the Earth has several complex homeostatic mechanisms that normally mediate to reduce CO_2 unbalances. One is a sea water system that can absorb much excess CO_2 , and another is higher CO_2 levels spurs plant growth—the latter effect is often ignored as a beneficial aspect of atmospheric CO_2 increases. Another, described by Kunzig, relates to the CO_2 absorbed by sea life, much of which will

. . . sink to the bottom of the ocean—in the form of plankton corpses or plankton parts or fecal pellets excreted by the things that eat phytoplankton. Oceanographers know this carbon sinking goes on all over the world; they call it the biological pump . . . it may take as much as 3 billion tons of carbon each year—half of all the carbon we pump into the atmosphere annually with our power plants and cars—and put it out of harm's way in the deep ocean . . . [and] it might be possible to speed up the pump in places where, for lack of iron, it isn't running up to speed.

Unfortunately, though, all of these systems have limits, and this is the major debate about greenhouse gases. The concern here is not whether current human activity will upset this balance, but the fact that a balance exists as well as numerous physical mechanisms that serve to stabilize it. Others argue that since carbon dioxide is not the principle greenhouse gas—water vapor is—that we should be far more concerned with other balances and that focus on CO_2 could distract us from the core of the problem (Mims, 1995, p. 18).

The Tidal Energy

The consistency of the Earth's spinning is maintained by a balance in losses and gains in rotational energy. It

loses rotational energy from such sources as friction with the molecules around the Earth's orbit. The Earth gains rotational energy from sources which include the ocean tides which are in turn a result of the Earth, moon and Sun rotation system (Berger, Loutre and Laskar, 1992). The movement of tidal water also produces enormous amounts of kinetic energy, much of which ends up as heat. The tides are caused principally by the effect of the moon's gravity pulling on the Earth plus the Earth's rotation on its axis. The result is a periodic rise and fall of the Earth's major bodies of water—as well as a similar rise and fall of the Earth's bulk (Stacey, 1992, p. 115). This produces a high tide on both sides of the Earth, the side facing the moon as well as on the opposite side, and a low tide on the two sides in between. The Sun opposes the moon's pull when it is at right angles to it, *reducing* the effect of its tide, but when it pulls in the same direction, it *increases* the moon's effects (Shimer, 1968).

The tide flow moves forward in the ocean area largely unhindered until it runs into the continents, resulting in water crashing up against the continental borders. Consequently, the coast line “runs into a mass of water at every high tide” a collision that causes the Earth to lose rotational energy (Skinner and Porter, 1987, p. 44). Since the loss of rotational energy from this process may affect the Earth's rotation speed, some claim that its speed is slowly being reduced. The conclusion that the Earth's rotation rate is not slowing down is supported by measurements that indicate new sources of kinetic energy are being added by the motion of the solar system. Measurements for the last three centuries support this conclusion, finding that the length of the Earth day has at most increased by only 0.002 seconds per century, if that. This calculation could also be the down swing of a cycle; only long term data collection can answer this. As a result of the absorption of outside energy, such as from the other planets, the Earth's rotation energy loss is balanced. Consequently, the Earth's 365 day, 6 hour, 9 minute and 9.54 second a sidereal year) 66,600 mile an hour round-trip varies from the mean by less than an estimated hundredth of a second! If it rotated much slower on its axis, all life would in time die, either by freezing at night because of lack of heat from the Sun, or by burning up during the day from too much Sun.

The Miracle of the Atmosphere

Air, after it is warmed, rises—and the air close to the surface of the Earth is heated via light energy from the Sun. The air near the surface then rises upward, allowing the air near the Earth's surface to maintain a temperature in which life can exist. The movement of warm air from the surface rising upward creates air currents (wind) which are an important part of the Earth's ecological system. They carry carbon dioxide from areas which over produce, such as cities, and move oxygen to areas in need of it, as large urban population centers.

If air acted the same way that water below 4°C did, the temperature on the Earth's surface would be unbearable—and life could not survive for very long. The temperature a few hundred feet above the surface, on the other hand, would be quite cold and, likewise, life could not exist there either. The only habitable

region would be a thin slice of air, but even there life could not exist for long. Plants and trees which would be necessary to support the life in the atmosphere could not survive as they would be in the cold zone. Thus birds would have no resting place, or food, water or oxygen. But air rises when heated, and thus life can exist on Earth.

The mixture of gases usually found in the atmosphere minus the human pollution is perfect for life. If it were much different (more oxygen, less carbon dioxide, etc., or the atmospheric pressure was much lighter or if our atmosphere were thinner, some of the millions of meteors which now are burned up by friction with the atmosphere would reach the Earth's land surface, causing fires and destruction.

Balance in the Earth's Chemical Cycles

Balance is not only necessary for energy gain and losses, but also for the Earth's numerous chemical cycles. The carbon and water cycles are well known, but at least 50 other mineral cycles are all equally important to all life on Earth. Much phosphorus, which is a critical mineral to both plants and animals as part of the ATP energy transfer system and in hydroxyapatite in the teeth and calcium-phosphate skeletons, among other uses, would become chemically or physically bound up in rocks, and thus removed from the cycle if it was not for the constant weathering of rocks. This weathering breaks down the rock, allowing the phosphorus it contains to become available for use by plants. The plants are in turn consumed by the heterotrophs, and consequently the phosphorus again becomes part of the cycle.

Reservoirs of phosphorus exist not only in rocks, but also in the ground water, the biosphere, the soil, and the ocean. The importance of a rock source of phosphorus is illustrated by the fact that the mining of phosphate rock for fertilizer has added huge amounts of phosphorus to our lakes, rivers and coastal marine waters. Humans have upset this balance, resulting in an increase in biological activity—which is positive for the farmer, but since much of the phosphorus goes into the lakes and rivers, it has caused massive growth of certain kinds of algae and water plants. This offsets the balanced cycle because algae suppresses other life forms which are critical in the food chain, adversely affecting the whole chain. The end result of excess algae growth is that many higher animals will not be able to survive, producing major alterations in the cycle elsewhere. Excess phosphorus can also contribute to general *eutrophication*, excessive water plant growth of all types. When the plants die, they accumulate in thick layers on the lake bottom and their decomposition results in greatly diminishing the dissolved oxygen level in the water affecting the survivability of fish and other lake and river life.

The Nitrogen Cycle

The nitrogen cycle is one of the most important, which, along with the phosphorus, potassium, and sulfur systems, cycle critical elements needed by plants and animals. The air consists of about 78% nitrogen, but it is not in a form that can be used by plants. The triple bond in the N₂ nitrogen molecule found in the air is far too strong for most plant metabolic systems to break.

Nitrogen fixing bacteria in the soil, though, are able to break the bond and assemble nitrogen in a form in which it can be used by plants, which in turn allows it to be used by animals. Nitrogen is critical in compounds used to synthesize protein. Certain types of nitrogen-fixing bacteria form a symbiosis with green plants including clover, alfalfa, beans and peas. The bacteria are found in grape-like clusters on the plants' roots and live there in a symbiotic relationship—the plant furnishes the sugar which the bacteria needs to live, and the bacteria furnish fixated nitrogen which they obtain from the air or soil. The protein made by the bacteria is in turn used by the plant to build protein in its own cells.

For this reason, crop after crop of clover, alfalfa and other legumes can often be produced without the farmer needing to nitrogen fertilize his fields. Some farmers "rotate" their crops and plow in the soil the nitrogen-fixating plants which often releases enough nitrogen in the soil to grow other crops for several years without adding more nitrogen fertilizer. Understanding this cycle has enabled humans to learn how to fix nitrogen and hydrogen to form ammonia (NH_3). Of course, when plants and animals die, nitrogen is also released back into the soil, a recirculating process so effective that the soil in many regions of the world has been able to sustain flora for centuries. When plants and animals die they no longer have an active repair or immune system, consequently, their bodies are rapidly broken down by bacteria, resulting in free nitrogen, ammonia and other compounds which fertilize the soil. Plant and animal rotting and decaying is therefore part of the necessary cycle which allows nitrogen to be endlessly reused. Further, natural fertilizers have always been recognized as superior—it is now known that natural fertilizers contain not only nitrogen and other essential nutrients, but also hormones which facilitate increasing the efficiency of the whole process.

This research has inspired the development of a new field called *chemurgy* which is the science of the industrial use and recycling of organic farm products, allowing tons of farm waste to be converted into valuable raw materials. Examples include the use of grains and even potatoes to produce alcohol and other chemicals by the action of bacteria and casts. Even plastics can now be made from waste substances, including soybean, wood pulp, milk and animal wastes. Corn stalks can be converted into products such as sound deadening wall board, and peanut oil into vegetable shortening, oleo margarine, explosives, rubber substitutes, dyes, various face powders, inks, linoleum and the hulls for fiberboard and soap.

The Miracle of Water*

Another example which illustrates the rigidity of environmental variations needed for life to exist is that of water. The Earth is the only planet with huge bodies of water—about 70% of its surface area consists of oceans, lakes, and seas which surround huge bodies of land. The amount of water is so great that it is estimated that if the continents were leveled, water would cover the entire surface to the depth of a mile and a half! The

few planets that have water contain only moisture floating as vapor on their surface or in the soil or relatively small amounts of surface ice, not numerous large bodies of liquid water as found on Earth.

Water is unique in that it absorbs huge amounts of heat with comparatively little alteration in its temperature. Its absorption capacity (specific heat) is also extremely large—about 10 times greater than steel. During the day, the seas rapidly soak a great deal of heat, and consequently the land surface stays fairly cool. At night, the oceans release some of the vast amount of heat that they received during the day which, combined with atmospheric effects, prevents large areas of it from becoming too cold at night. If it were not for the tremendous amount of water on the Earth's crust, far greater day and night temperature variations would exist. Many parts of the surface would be hot enough to boil water in the day and the same place would be cold enough to freeze water at night.

When materials are heated, they expand, and when cooled, contract. Consequently, given two objects of the same size and material, if one is cooler, it will be denser. This may not seem like a problem, but it would be in the case of water if it were not for a rare chemistry anomaly. Water, as does almost all other substances, contracts when cooled but, in contrast to virtually all other materials (the few exceptions include ammonia, rubber and antimony), it contracts only until it reaches 4° C, then it *expands* until after it freezes. If water continued to contract when cooled, it would become denser and thus sink to the ocean bottom. Further, when water turned to ice, it would likewise sink to the ocean bottom as does most all substances. As a result the oceans would eventually become largely solid ice as more water froze on the surface and sank, accumulating at the bottom.

Because of this anomaly, the ice that forms in seas, oceans, and lakes stays near the surface where the Sun and the warm water below can melt it in the areas that have summers. Water that is warmer than 4°C is carried by various wind and water currents to the bottom which helps to warm the ocean depths. This process of surface water warming the bottom, plus the Coriolis effect, helps to produce the ocean currents. These currents and other factors insure that most of the ocean stays in the liquid form.

The Balance of the Earth's Crust

The shape of the Earth is also a result of a delicate balance of many separate powerful forces. The Earth's gravity pulls the Earth's entire mass *towards* its center, pulling equally along all possible radii, producing a spherical shape (Watt, 1982). The *forces opposing* this effect include the centrifugal force that results from the Earth's spin. The force consistently acts perpendicular to the axis of rotation, producing a bulge at the equator and giving the Earth its slightly ellipsoid shape. The source of the centrifugal force in this case is Newton's first law of motion which says objects travel in a straight line unless acted on by an outside force. This movement is resisted by gravity and the various adhesive and cohesive forces in the Earth, producing a balance which results in the equator bulge. The bulge is slight; the difference between the diameter at the poles and the equator is only about 42 kilometers.

*Editor's Note: Readers will be interested in an earlier Quarterly article on the designed properties of water, DeYoung, D. B. 1985. The water of life. CRSQ 22:107-114.

It was once thought that the continents were non-movable, firm land masses. Modern research indicates that the Earth's crust is now in a state of dynamic equilibrium. Evidence now exists that its top layer, the *lithosphere*, works like a conveyor belt. The *mid-oceanic ridge* produces new lithosphere as the old lithosphere disappears back into the mantle at a zone called the *edge of consumption* (the subduction zone). The lithospheric plate does not move through the Earth as an intact unit, but is reheated as it is absorbed and melts, slowly blending in with the mantle material. At the oceanic ridge, the molten magma rises to form a new oceanic crust which solidifies, and thus the plate is formed anew at this point. The density of the continental crust must also be balanced. It is not subducted into the Earth because it is less dense than that part of the mantle it floats on called the *asthenosphere*. The continental crust is just buoyant enough so that it resists being pulled down into the sea floor trench at the subduction zone.

The most obvious balance relates to the continental movements, a field called *plate tectonics*. Their shape indicates that at some time in the past the major continents have broken and moved away from one super continent called *Pangea* (Cailieux, 1968). An example of the evidence which argues for this conclusion is the good fit of the eastern South American coastline into the western African coastline. Evidence of their movement that is observable on the Earth's surface is the edges that slide past each other at vertical fractures called *transform faults*. The most famous of these is the huge San Andreas fault in California. One result of these two plates sliding past each other is the movement of Los Angeles northwest in the direction of San Francisco. Another major evidence of plate tectonics is the highly deformed lithosphere areas called mountain ranges which are a result of one plate crashing into another one. The most well known example is the Australian Indian Plate which produced the Himalayan Mountains north of India. Interestingly this research also hypothesizes that a smaller Earth existed in the past:

If we pick a diameter for the globe of about 80 percent of the present figure, and reconstruct the fit of South America and Africa, the correspondence this time is excellent! Not only do the big bumps and indentations match up, but the little features on them do as well. The gores disappear, and the resulting picture is thoroughly satisfying to a geographer's mind (Ritchie, 1988, p. 61).

While much has yet to be learned about the earth's crust, that it is a dynamic, complex process is not in doubt (Chatterjee and Hotton, 1992).

Balance of the Land Mass Height

Other internal processes such as uplift which builds up the Earth's surface, and yet others, such as erosion, wear it down, maintaining the balance. Scientists once assumed that the height of the land is static, yet research has found that billions of tons of sediment are carried into the world's rivers and oceans annually. The reason that the Earth is not worn flat is because the rock cycle

brings new rock to the surface as fast as old rock is removed by erosion. The balance between internal

and external activities provides indirect evidence that materials inside the Earth must be capable of movement; for without internal movement to counteract erosion, how could the continents remain above sea level? (Skinner and Porter, 1987, p. 406).

Much other evidence exists for this internal movement which produces equilibrium, and also that there must be an elaborate mechanism much like a fine watch that allows this balance to produce the general steady state that we now know exists. Further discoveries have helped us to realize that this amazing balance is fine-tuned to such a degree that few persons have even suspected that these tearing down and building up forces existed. An analogy is being on a train which runs so smoothly that the passengers do not know it is moving until they look around to explore the question.

The Earth's Dynamic Balance

Another aspect of the finely tuned clock is the Earth's rotation. Its tilt averages 23.5° which deviates plus or minus 1.5° during an estimated 41,000 year time span. Secondly, the Earth's orbit changes—called the *precession of the equinoxes*—which will slowly cause the day and night length and spring and autumn equinoxes to change. The day length is now the longest in the summer, shortest in the winter. One full cycle is estimated to take 23,000 years, and at the half cycle point, the spring equinox would then have the *shortest* day, the autumn equinox the *longest* day. Further, the shape or eccentricity of the Earth's orbit changes so that the orbit would become more and more circular until an estimated 100,000 years from now its circularity would peak, then it again will become more eccentric as the cycle progresses, eventually reaching its maximum eccentricity as it progresses toward repeating the cycle. This cycle may also be highly interconnected with global climate and many other aspects of earth history (Hays, Imbrie, and Shackleton, 1976, p. 1131).

The Role of the Moon

If the Earth was not tilted 23° on its axis, but was at a 90° angle in reference to the plane of the Earth's orbit, we would not have four seasons. Without seasons, life would soon not be able to exist here—the poles would lie in eternal twilight, and water vapor from the oceans would be carried by the wind towards both the north and south, and would freeze when it traveled close enough to the poles. In time, huge continents of snow and ice would accumulate in the polar regions, leaving most of the Earth a dry desert. Eventually the oceans would disappear and rainfall would cease.

Research has found that the moon apparently functions as a gravitational gyroscope which helps to stabilize the Earth's 23° axis tilt—the slight skew that produces the seasons on our planet. The Earth is the only inner planet that has a large enough satellite to achieve this axis tilt (Murray, 1993). Research indicates that without the moon's effect, the Earth, like the other inner solar system planets including Mercury, Venus, and Mars, would tilt as much as 85° off vertical with the plane perpendicular to the Earth's orbit around the Sun. A tilt this large would be catastrophic because the seasons would not occur (Laskar and Robutel, 1993).

Murray (1993) noted that a tilt greater than 54° would also produce enormous differences in the Earth's temperature pattern—so much that the equator would receive even less sunshine than the poles. He concludes that the influence of the moon is so critical that, “variations as small as $\pm 1.3^\circ$ may trigger ice ages” consequently, “the forecast for a moonless-Earth would have been bleak” for life (p. 586).

The effect of the moon on the Earth's tilt can be studied by the evaluation of other planet systems, specifically how their moons or lack thereof affects the planet. We have found from this research that the moon applies a slight torque which shifts the axis when the planet spins. For example, Mars has two very small moons which researchers calculate cause chaotic tilt estimated at from 0° to 60° , and its current 25° is not stable (Comins, 1993). Further, the moon is believed to play a “vital role” in the development of the atmosphere which allows the Earth to support life—and no other planet in the solar system to do so.

Comins (1993) also concludes from his study that lack of our moon would have drastic consequences for the Earth's ability to support life for other reasons. Even if the moon was much closer, farther away or had a different rotational speed, it would radically affect the Earth—and, depending upon the deviation from the ideal position it is currently in, these changes could be lethal to life on the Earth. If the moon were much nearer to Earth, one result would be huge tides which would overflow onto the lowlands and erode the mountains. Even moonlight is so important that its lack would drastically change life. Nocturnal animals, an important animal group in the Earth's ecological balance, require moonlight to survive. Another example that Comins gives is moon light initiates the changes that convert some freshwater species such as salmon into fish that can live in salt water. Yet, another important role of the moon long known to be critical is to function as a clock to control the life cycles of many animals.

The Principle of Uniformity

The research into the dynamic balance found everywhere in the natural world has now seriously challenged the *principle of uniformity*, the assumption that geological processes in action today have been in operation essentially unchanged during much of the Earth's history and that “the present is the key to the past.” This principle* was critical to geology because it was a major means used to understand and interpret the past. This science concludes that the older rock was likewise formed in the same way as was modern rock. If a certain modern rock was formed by sedimentation and a similar but far older rock has the same physical morphology and chemical composition (and consequently is judged to be the same type of rock) we may assume that it was formed in similar ways. This principle, while incredibly helpful, is not infallible (Allmon, 1993).

Nineteenth century geologists wrongly assumed high consistency of geology rates from the uniformity doc-

trine, and consequently erroneously concluded that “rates of deposition remained constant and equal to today's rate of deposition.” For this reason, they erroneously calculated past sedimentation rates based on today's rate (Skinner and Porter, 1987, p. 35). Historical events or conditions could have either retarded or accelerated a given sedimentation rate, thus the current average (arithmetic mean) does not directly apply to many historical situations.

The assumption of consistency is now known to be incorrect, but it was so widely accepted that this view was erroneously incorporated into the *Principle of Uniformity* which guided interpretation of geological history for generations. We now know that

the more that is learned of the Earth history, and the more extensively the timing of past events are determined through radiometric dating . . . the clearer it becomes that the rates of the cycles have not always been the same (Skinner and Porter, 1987, p. 36).

In the words of Davies:

We are rewriting geohistory. Where once we saw a smooth conveyor belt, we now see a stepped escalator. Upon that escalator the treads are longer periods of relative quiescence when little happens. The risers are episodes of relatively sudden change when the landscape and its inhabitants are translated into some fresh state. Even the most staid of modern geologists are invoking sedimentary surges, explosive phases of organic evolution, volcanic blackouts, continental collisions and terrifying meteoroid impacts. . . . Catastrophism was originally born during the seventeenth century in an attempt to cram some inkling of the complexity of geohistory into the pint pot represented by biblical chronology. I suspect that the catastrophists of that distant age might well find themselves far more at home in our modern departments of geology than would their uniformitarian successors in the nineteenth century (Davies, 1993, p. 115).

Consequently, to achieve the fine balance needed, the dynamic Earth needs far more complex and radical balancing systems than we concluded a few years ago were needed, and we are only now beginning to understand these forces. Scientists have recently begun to tell the story of the fine tuned watch-like Earth we live on, but have uncovered enough evidence to demonstrate that Paley's conclusion is as valid for the Earth as it is for the human body.

The outer planets have also been found to be essential to produce the solar system stability required for life on Earth (Laskar, 1994). Not only are the Earth and solar system fine-tuned for life, but the entire “universe is fantastically hospitable to life” and the list of factors which cause the universe to be hospitable to life are now “simply too long to ignore” (Greenstein, 1988). This presents major problems for evolutionary naturalism because how we get here

. . . cannot be a matter of life seeking out the appropriate location in which to flourish, for the evidence refers not merely to the Earth, but to the cosmos as a whole—to all reality. It cannot be a matter of evolution surmounting obstacles strewn

*Editor's Note: For a recent creationist interpretation on this so-called principle see Williams, E. L. 1995. Providence Canyon, Stewart County, Georgia—Evidence of recent rapid erosion. *CRSQ* 32:37-40.

in its path by the environment for it is the fitness of the environment itself that is at issue. Neither of these suffices to explain how . . . the laws of nature, came to be so anomalously suited to the requirements of life. "How did it happen that, with what seem to be so many other options, our universe came out just as it did?" George Wald has asked. "From our own self-centered point of view, that is the best way to make a universe . . ." (Greenstein, 1988, p. 188).

Adaptation to Environment or the Creation of the Environment for Life?

If evolution works to evolve life to fit the existing environments, why has it not equally conquered all of the environments here and elsewhere? Earth is far better suited for life than any other planet, yet most of the environments *even* here are either too wet, too hot or cold, too far under-ground or above ground to support such life. In the several thousands of miles of changing environments from the center of the Earth to the edge of its atmosphere, only a few feet are ideal for life, and consequently almost all creatures are forced to live there.

Although of all the planets in our solar system, only the Earth was made to be inhabited. Even on the Earth only a thin slice is ideally suited for life. This section, though, is teeming with plants and animals. It is estimated that an acre of typical farm soil, six inches deep, has several tons of living bacteria, almost a ton of fungi, two hundred pounds of one-cell protozoan animals, about one hundred pounds of yeast and the same amount of algae. And an estimated two to 10 million species live on our planet.

Yet, *some* type of life is found in almost every niche on the Earth. Even in the extremely cold Antarctica, penguins and seals wander, large numbers of hardy microscopic creatures exist in ponds, tiny wingless insects inhabit the patches of moss and lichen found there, and even two types of plants flower yearly. From the top of the atmosphere to the bottom of the oceans, from the coolest part of the poles to the warmest part of the equator, life persists everywhere. However no sign of life has ever been found on any other planet.

Objections to This Argument

Many of those who philosophically hold to a naturalistic world view are aware of the numerous books and journal articles which have eloquently documented how precisely the universe is designed for life. In one critique, Silk endeavors to put to rest "the notion that because the universe is hospitable to life, it was designed to harbor life" by arguing that this analogy is "like a flea's believing that a dog's back was designed to harbor fleas," (Silk, 1993). This view is both egocentric and naive. In fact, a flea is remarkably adapted to living on a dog in an incredibly complex way—actually to the degree that the flea's *only* habitat is on the skin of a habitable animal. Without the dog's back, or that of another similar animal, the flea would become extinct. It has the numerous adaptations, physiological, biochemical, and behavioral, specifically designed so that the flea can survive in its habitat—and it survives there quite well as any dog owner knows. The flea is

itself actually an eloquent argument for design. Many such relationships are not parasitic, but symbiotic and hundreds of examples have been elucidated in the literature as excellent examples of design (Perry, 1983). Thus, rather than negating the design argument, examples that its critics use actually eloquently support the design hypothesis.

Conclusions

The chances of a planet being just the right size, the proper distance away from the right star, and having the many necessary variables to support life in other areas are extremely small. Even if some stars have planets circling them, as some speculate, the mathematical odds that all of these and other essential conditions exist there are astronomically minute. Of the likely several hundred billion galaxies in the universe, depending on how the dark matter controversy is resolved, an estimated one atom exists for every 88 gallons of space. This means that most of the universe (the vast majority actually) is largely empty space! The extremely fine line between an environment where life can and cannot exist produces tolerances that are extremely small, and if there are any other planets in the universe, it is *unlikely* that any of them could support life, even if it were created on them, due to the extremely rigid conditions necessary for life to exist.

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PHOTO ESSAY

Hubble Space Telescope Photographs Distant Galaxies*

The three images on the back cover represent select portions of the sky photographed December 18 to 28, 1995 in the Hubble Space Telescope's "Deep Field Observation." The never before seen galaxies are nearly 30th magnitude. Six of the galaxies in the Hubble Deep Field have redshifts between 2.5 and 3.4, but

most of the estimated 1500 galaxies in this field have not yet been measured. If distance goes with faintness, then these galaxies would have to represent an early time in the history of the universe. (Photograph courtesy NASA.)

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Quote

Isaiah 40

21 Do you not know? Have you not heard? Has it not been told you from the beginning? Have you not understood since the earth was founded?

22 He sits enthroned above the circle of the earth, and its people are like grasshoppers, He stretches out the heavens like a canopy, and spreads them out like a tent to live in.

Holy Bible, New International Version, NIV publishers.

THE FORMATION OF SANTA ELENA CANYON, BIG BEND NATIONAL PARK: ORIGIN SPECULATIONS

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Abstract

The formation of Santa Elena Canyon located in Big Bend National Park, Trans-Pecos Texas is discussed. All speculations are developed within a young-earth Flood model. Two phases of canyon formation are suggested. One period of extensive erosion occurred during the time of exiting Flood water and another period of considerable erosion occurred during a post-Flood warm ice age to form the canyon.

Introduction

Acceptance of a recent Creation and Flood model of earth history implies that many natural events, such as canyon formation, are assumed to have occurred quickly. Involved in rapid canyon formation is rapid erosion, a topic often discussed in the Quarterly. For instance, three articles (Williams, Meyer and Wolfrom, 1991, 1992a, 1992b) presented various views of the formation of the Grand Canyon of the Colorado River. (Also see Austin 1984a, 1984b, 1986, 1994a, 1994b; Brown 1989; Oard 1993; Williams 1993a.) An introductory study on the erosion of Pine Creek Gorge in Pennsylvania has been published (Williams, Chaffin, Goette and Meyer, 1994). A discussion of the formation of Bangs Canyon, Colorado was given by Holroyd (1994). The rapid erosion and canyon formation caused by the 1993 Midwest floods was graphically illustrated by Wolfrom (1994). In a 10-year study at Providence Canyon, Georgia, Williams (1995) outlined the effects of recent catastrophic erosion. This treatise on Santa Elena Canyon in Big Bend National Park, Texas (Figures 1 and 2) is another introductory study reflecting the continuing field work of the Society on the topics of rapid erosion and canyon formation, important aspects of Flood geology. A glossary of geological terms used in this paper is provided after the acknowledgments.

Canyon Location

The Rio Grande courses through three principal canyons, Boquillas, Mariscal and Santa Elena, in Big Bend National Park on its way to the Gulf of Mexico. Santa Elena is the western-most canyon and the first one that the river enters in the park. Its location is shown in Figure 2. The canyon is approximately 18 miles long, beginning near Lajitas at the northwest corner of the park. The lower seven-mile section of the canyon is narrow with steep walls (Figure 3). The walls of the canyon are approximately 1700 ft (520 m) high and in the lower seven-mile portion, the walls are often no more than 30 ft (9 m) apart in places (Figures 4a and 4b). The impressive mouth of the canyon (Figures 5 and 6) can be seen in the Park from an overlook about 32 miles (51.5 km) southwest from the intersection of the Ross Maxwell Scenic Drive and the main park road. It is also possible to walk along a trail across Terlingua Creek into the mouth of the canyon for a short distance. The Rio Grande enters the lower seven-mile stretch (11.3 km) of the canyon about 11 miles

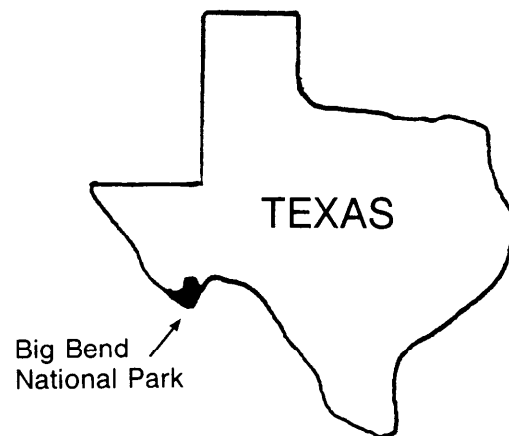


Figure 1 Location of Big Bend National Park in the state of Texas.

(17.7 km) southwest of Lajitas. This entrance into the high-walled, narrow section is not as impressive (Figure 7) as the mouth of the canyon.

Stratigraphy at the Mouth of the Canyon

Rusch (1988) and Williams (1988) wrote brief letters for the Quarterly concerning Santa Elena Canyon. Rusch presented a stratigraphic column of the canyon. Maxwell (1968, p. 87) state that "... the canyon walls show the best cross section of the Lower Cretaceous formations exposed in the Park." Table I details the exposed stratigraphic column at the mouth of the canyon. Also see Figure 6. A general stratigraphy for Big Bend National Park is given in Williams and Howe (1993).

Origin of the Canyon-Variou Concepts

Most uniformitarian scientists consider that the Rio Grande formed Santa Elena Canyon. The different theories involve various quantities of water, i.e., generally small amounts of water flowing over long periods of time or larger amounts of water flowing over shorter periods of time. The various origin concepts will be reviewed and then our hypothesis of canyon origin within a young earth-Flood model will be presented.

Antecedent Stream View

Probably the first known published suggestion of how Santa Elena Canyon formed was written by Udden (1907) [as documented by Maxwell, Lonsdale, Hazzard and Wilson (1967, p. 20)]. In discussing the Rio Grande, the following statement was made by Udden, Baker and Böse (1916, pp. 21, 22):

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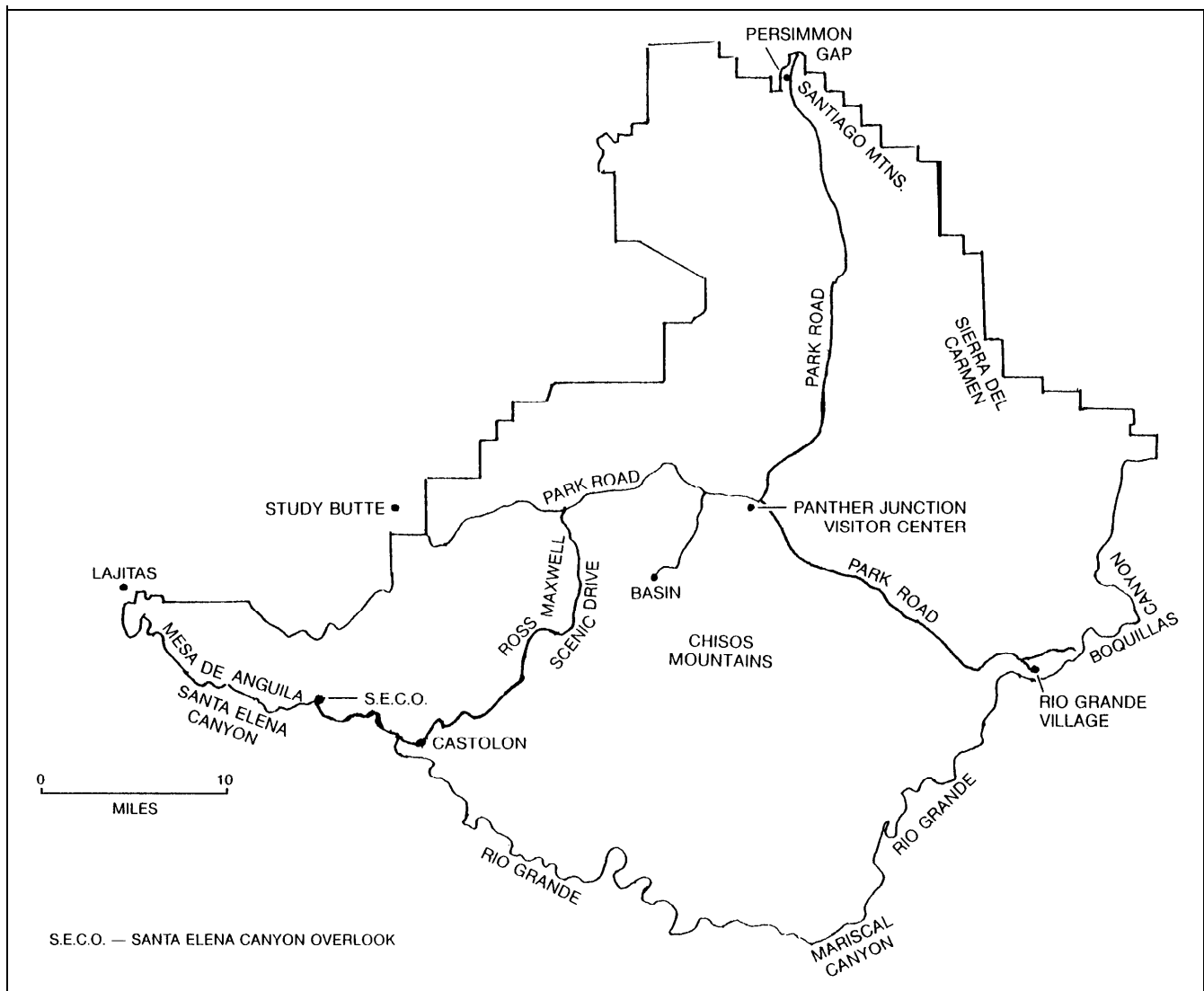


Figure 2 Simplified map of Big Bend National Park.

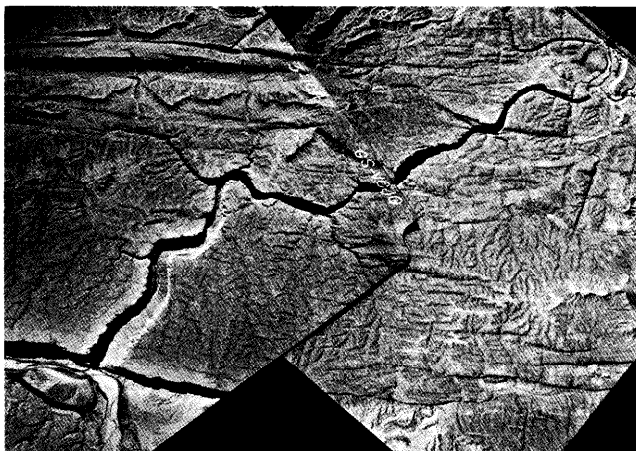


Figure 3a Composite of U.S. Geologic Survey high altitude photographs of Santa Elena Canyon through Mesa de Anguila (right) and Sierra Ponce (left) by Robert L. Goette. Sierra Ponce is in Mexico whereas Mesa de Anguila is in the United States. Rio Grande flows from right to left.

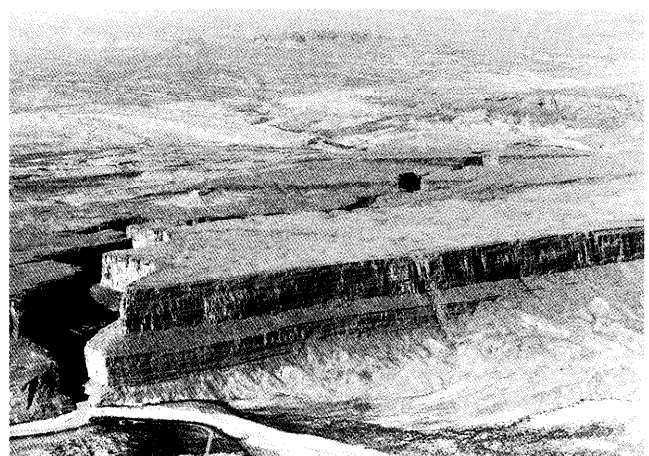


Figure 3b Oblique aerial photograph of Santa Elena Canyon (lower seven-mile length) through Mesa de Anguila (right) and Sierra Ponce (left). Rio Grande turns to the left as it exits the funnel-shaped mouth of the canyon. Terlingua Creek is seen entering the Rio Grande at the mouth of the canyon. Photograph by Robert L. Goette.

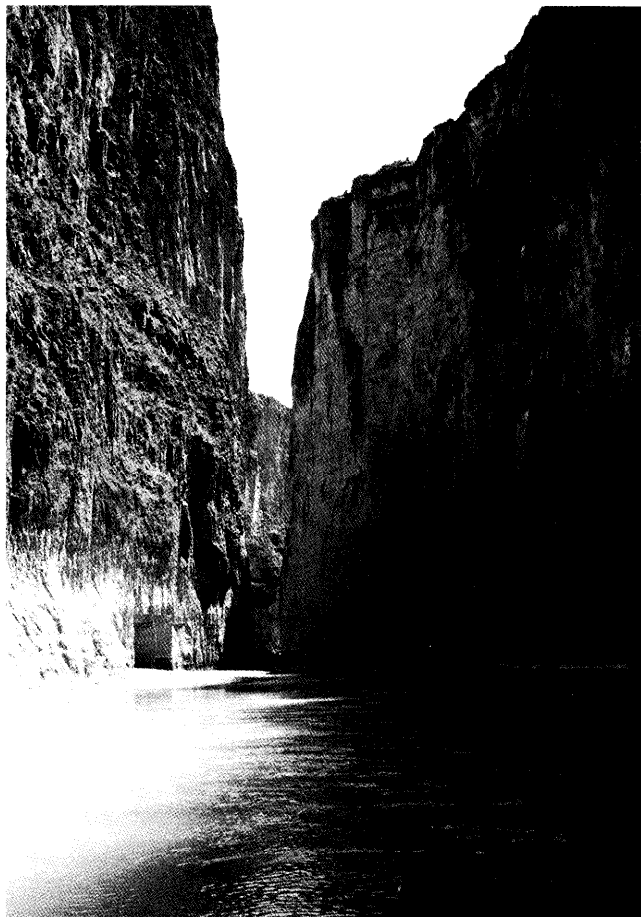


Figure 4a Note the high walls and narrow canyon width from water level as one floats the Rio Grande through Santa Elena Canyon. Photograph by Emmett L. Williams.

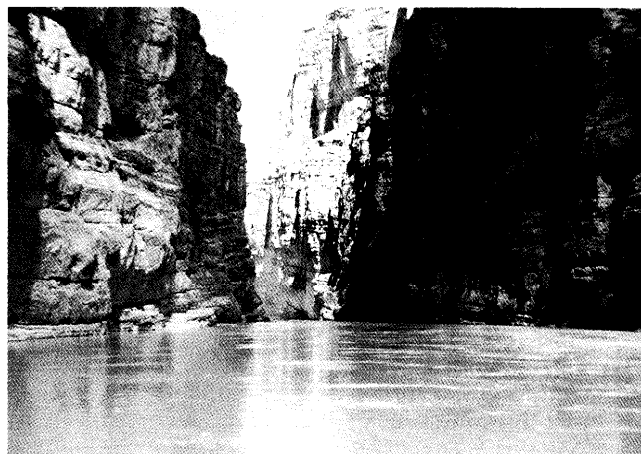


Figure 4b The tilted strata inside Santa Elena Canyon create an optical illusion giving the appearance that one is floating down an incline toward the mouth of the canyon. Photograph by Emmett L. Williams.

At a time which we cannot as yet definitely state, but either at the end of the Tertiary (late Pliocene) or early in the Quaternary (Pleistocene) the mountain ranges of West Texas were uplifted athwart its



Figure 5 The funnel-shaped mouth of Santa Elena Canyon as seen from the air. Terlingua Creek empties into the Rio Grande as the river exits the mouth of the canyon; left-Sierra Ponce, right-Mesa de Anguila. Photograph by Robert L. Goette.

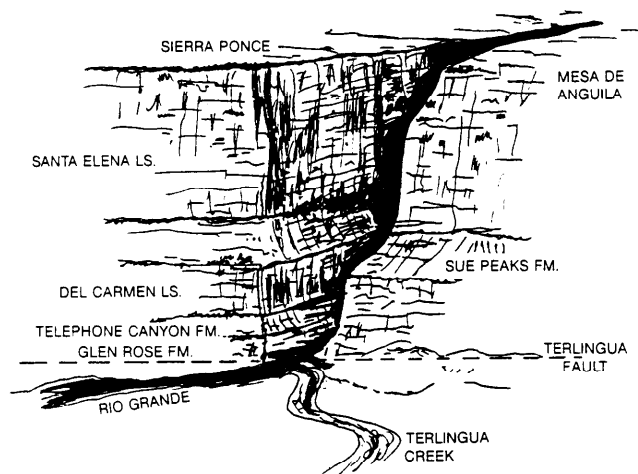


Figure 6 Drawing of the mouth of Santa Elena Canyon with the superposition of the various formations noted. The Terlingua fault line runs along the base of Mesa de Anguila and Sierra Ponce (after Stevens and Stevens, 1990, p. 49).

course. The river was able to cut down as fast as the mountains rose, and so today its course through the mountains is marked by a series of canyons.



Figure 7 The Rio Grande enters the lower section of Santa Elena Canyon about 11 miles (17.7 km) southwest of Lajitas. Photograph by Emmett L. Williams.

Possibly Udden was influenced by the ideas of John Wesley Powell (1961, pp. 89, 90) and his antecedent stream views of the formation of the Grand Canyon by the Colorado River—see Williams, Meyer and Wolfrom (1991). The gist of the antecedent stream view of canyon formation is that as the river runs along its course over a region where a canyon is “destined” to form, this course is established and the river will continue this path during and after canyon formation. It is speculated that the land along the path of the river uplifted slowly. As the slow uplift occurred, the erosive forces of the flowing water cut into the uplifted rock as rapidly as it rose. Thus the river continued along its original course during the entire uplift process and a canyon formed through the uplift. This view of canyon formation was very popular in the late 1890’s and early 1900’s. Many geologists still adhere to the antecedent stream view for the formation of many canyons. For instance Spearing (1991) believes that the Rio Grande is antecedent to Santa Elena Canyon:

An obvious question is why the Rio Grande cuts across this massive uplifted block of limestone—why doesn’t the Rio Grande just go around it on the way to the Gulf of Mexico? The answer is that the Rio Grande (or its ancestor) was here before the block uplifted! And, as the block rose along the fault in earthquake increments of a few inches to a few feet at a time, the river simply downcut a little faster to accommodate the small change in slope caused by the last earthquake and uplift. Now, repeat this process many, many times over several million years, and you can see how the river cut Santa Elena Canyon little by little, inch by inch—nothing dramatic, just small effects multiplied over millions of years (p. 321).

Earthquakes can cause uplift and thrusting of inch proportions as noted by Howe (1972). Allowing millions of years of time and assuming many small uplifts, the river would erode such a rising landscape as rapidly as it lifted, and the river would continue along the same path as a canyon forms. Belcher, in discussing the geomorphic evolution of the Rio Grande, appeared to favor the antecedent stream view for the formation of canyons along the Rio Grande in West Texas (1975, pp. 15, 16, 22-34). Nelson (1992, p. 47) briefly outlined the

Table I Santa Elena Canyon-Exposed Stratigraphic Column. Modified from Stevens and Stevens (1990, p. 50).

Formation	Thickness (feet)	Lithology
Santa Elena	740 (226 m)	Massive, thick-bedded, dense, cherty, ledge-forming limestone with thin-bedded marly limestone near base
Sue Peaks	275 (84 m)	Shale, marl and thin marly, nodular limestone ledges
Del Carmen	465 (142 m)	Massive, heavy-bedded, dense, cherty, ledge-forming limestone
Telephone Canyon	145 (44 m)	Thin, nodular, marly limestone and marl
Glen Rose	~100 (31 m)	Dense limestone interbedded with calcerous shale, erodes to form step-like benches, conglomerate and coarse sandstone at base

antecedent stream theory for the formation of Santa Elena Canyon.

... the ancestral Rio Grande established its course prior to Basin and Range faulting. As it slowly cut its channel deeper into the massive limestones the uplift of one fault block continued. The end result was a magnificent steep-walled canyon.

Views of C. L. Baker—

Lake Formation and Superimposed Stream Theory

Possibly the first published view of the origin of Santa Elena Canyon that differed from that of the antecedent theory was written by C. L. Baker (1927, pp. 37, 38):

The uplifting of the present mountain ranges destroyed in large part pre-existing drainage lines ... The basin of the Rio Grande, all the way from its source to the Boquillas Cañons at the eastern side of the Big Bend syncline (this area includes Santa Elena Canyon which is west of Boquillas Canyon) was dammed and a lake or a series of lakes was formed along the present valley of the river (Parenthesis ours).

Maxwell, et al. (1967, pp. 20, 21) in discussing an unpublished manuscript of Baker (1934) claimed that he postulated the existence of a lake in the lowland “... between the Santiago-Sierra del Carmen ranges on the east and Mesa de Anguila on the west ...” The lake may have had an elevation of 4000 ft (1219 m) and covered the Mesa de Anguila leaving only the highest peaks in the Chisos and Sierra del Carmen Mountains above water. Baker offered two suggestions as to how the Rio Grande attained its present course (Maxwell et al., 1967, p. 21):

... (1) superimposition from ancient lake deposits which entirely buried some of the uplifts so that when erosion reached the base of the lake beds, the river cut downward into the massive limestone, or (2) the original Rio Grande channel was underground and the canyons were formed by collapse of the rocks of the solution channels.



Figure 8 Did a lake once cover this region of Trans-Pecos Texas? View at Persimmon Gap, Big Bend National Park looking westward into Chalk Draw Graben. Photograph by Emmett L. Williams.

It is easy to imagine that the present desert basins in Big Bend National Park once were covered by a lake or lakes (Figure 8). However the actual depth of any postulated lake or of any lake-deposited (lacustrine) material is a matter of speculation (Scheubel and Mruk, 1994, pp. 62, 66).

View of P. B. King-

Superimposed Stream Theory, Basin Fill and Overflow
In discussing the late "Cenozoic," King (1935, p. 259) dismissed the antecedent stream concept of the formation of Trans-Pecos Texas canyons along the Rio Grande by stating:

There is no evidence that these areas were connected by any large streams . . . It is probable that the Rio Grande did not take its course across New Mexico and western Texas until long after the first time of faulting and after the time of basin filling.

King (1935) proposed that during a sequence of erosion, intermontane basins (possibly shallow lakes or playas) were filled with erosional debris which was derived from adjacent mountains. The basins were filled to considerable heights and the pediment was cut so deeply into the encircling mountains that many of the valleys became connected to other basins. As the basins filled, water sought the lowest outlet and overflowed into a lower valley in a continuing process. The Rio Grande became superimposed on this type of topography. The river likely transported abrasive material (possibly a water-particulate slurry) which cut canyons into many uplifted blocks of sediment. King felt that much water was available during this period of erosion as he compared the development of the Rio Grande to that of the Colorado River (1935, p. 260):

Much water must have been shed off toward the south and southwest, filling near-by desert basins to their rims, overflowing into adjacent lower basins, and eventually establishing through-flowing drainage to the sea. One such through-flowing stream was the Colorado, another the Rio Grande.

King (p. 261) graciously acknowledged his indebtedness to C. L. Baker as to the similarity of their interpretations concerning stream development in Trans-Pecos Texas.

The superimposed stream concept of canyon formation along the Rio Grande was briefly explained by Nelson (1992, p. 47).

. . . the ancestral Rio Grande was located on the coastal plain east of the present Sierra del Carmen

and the Santiago Mountains while the Basin and Range faulting was taking place. The closed basins formed by the faulting slowly filled with sediment eroded from the Chisos Mountains and from the up turned edges of the fault blocks. Each basin then overflowed into the next lower basin until finally a single large basin formed centered in northern Mexico. As the mountains rose during the Pliocene and as the Pleistocene began, precipitation increased. The basin then overflowed the Sierra del Carmen at a structurally low point and flowed into the ancestral Rio Grande on the coastal plain.

With this scenario Boquillas Canyon in the southeastern end of the park was formed first, then Mariscal Canyon and then Santa Elena Canyon.

Maxwell (1968, pp. 91, 92) supported the superimposed stream theory for the Rio Grande canyons. Muehlberger and Dickerson (1989, p. 48) stated that:

Throughout its course the river occupies the structurally lowest areas, and in only a few places has it been superposed across Laramide or younger structures. In those areas it flows through narrow canyons orientations of which were influenced by fractures formed during Laramide deformation and enhanced during later episodes.

DeCamp (1985, pp. 127-135), in an excellent treatise on the structural geology of Mesa de Anguila, noted that in the Post-Laramide period the mesa was subjected to extension causing vertical displacements along the Terlingua and Anguila fault zones (Figure 9). He stated:

Closed basins in these fault zones accumulated thick sections of bolson fill. When these bolsons were breached, the Rio Grande, or its ancestor incised the fill. The present eccentric course of the Rio Grande in this region was probably caused predominantly by superposition of the river through the fill onto jostled fault blocks (p. 133).

The official park handbook for Big Bend (1983) offers the superimposed stream theory origin for the canyons on the Rio Grande as does a park explanatory sign at the Santa Elena Canyon overlook.

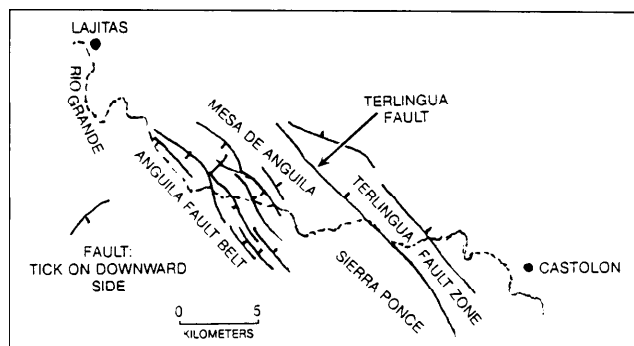


Figure 9 Representation of some of the faults in the Terlingua fault zone and Anguila fault belt. See DeCamp (1985, p. 127). Dotted line—trace of Rio Grande.

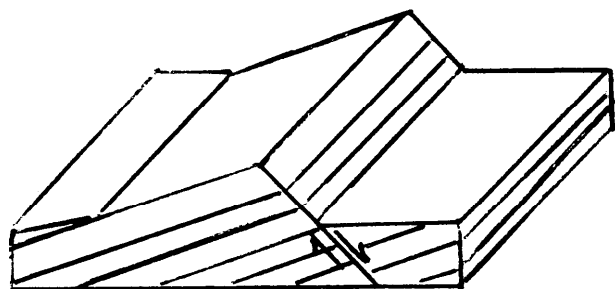


Figure 10 Representation of the development of a fault-block mountain. Arrows indicate the direction of movement of the strata.

Scheubel and Mruk (1994) explain the superimposed stream concept for canyon formation in Trans-Pecos Texas as follows:

Uplift in the Southwest during mid-Cenozoic time formed many fault-block mountains and intermontane basins. The basins received their debris from the mountains. In some of them there was not through drainage and they probably contained lakes . . . As the closed basins were filled with debris, the lower ranges were probably buried. Basin waters naturally drained through the lowest outlet into a lower basin. When the second basin was filled, the water flowed into a still lower depression. In time, through-flowing drainage was established . . . and most of the basins contained great thicknesses of rock debris . . . Once drainage was established on the valley-fill deposits, the river was trapped. When it encountered hard underlying bedrock there was no alternate but to cut a canyon (pp. 62, 66).

As has been shown, various workers who support the superimposed stream hypothesis for the Trans-Pecos Texas canyons along the Rio Grande differ on the details of the process.

Prior Creationist Canyon Formation Speculations—Big Bend National Park

The Society has sponsored several teams of scientists to do field work in Big Bend National Park. Some of the work has been reported in the Quarterly—Froede, 1994a, 1995a; Howe and Williams, 1990; Rusch, 1988; Williams, 1988, 1993b, 1993c, 1994; Williams and Howe, 1993; Williams and White, 1992; Williams and Wolfrom, 1993; Williams, Howe and White, 1991; Williams, Howe, Matzko, White and Stark, 1995; Williams, Matzko, Howe, White and Stark, 1993. Also some unpublished manuscripts and informal field notes have contained sections on the formation of Santa Elena Canyon (Howe, 1990; Waisgerber, 1990).

Waisgerber, influenced by Pause and Spears (1986, pp. 9-13), envisioned the formation of lakes over bolson sites in Trans-Pecos Texas. When the dam of a particular lake was breached, possibly by piping, the escaping lake water containing considerable abrasive material could have cut the canyons along the Rio Grande in a brief period of time. Also Howe (1990) supported the concept of the breaching of dams along bolsons releasing water filled with abrasive particles which scoured canyons in Trans-Pecos Texas. He speculated that during the Basin and Range extension, zones of weakness

along fault-block mountains (Figure 10) and in dams impounding the bolsons would have been created by the faulting. This tectonic activity may have generated preferred paths for flowing water through dams and fault-block mountains.

Current Creationist Speculations on Formation of Santa Elena Canyon

The purpose of this article, besides reviewing the various suggestions for the formation of Santa Elena Canyon, is to update the creationist model for the origin of the Canyon. The postulated model will be developed within a young earth-Flood framework.

The “Cretaceous” formations which form the walls of Santa Elena Canyon were deposited during the latter stages of the Flood.* Later as Flood water exited the continental United States and Mexico, much erosion would have occurred in Trans-Pecos Texas. Tectonic and volcanic activity would have created highlands and basins. Water moving along the highlands and into the basins would have caused tremendous erosion. Many basins would become closed either by the collection of erosional debris from the highlands, landslide blockage or uplift forming dams. Dam breaching would occur in this period as the trapped water sought lower elevations causing continued vast erosion. Possibly extreme water pressure on the unstable dams as well as piping through the weak obstruction would lead to dam failure releasing walls of water which would scour rock and soil in their path. (See Williams, 1993a.)

At the onset of a post-Flood warm ice age** as suggested by Oard (1990) this erosional process would continue as increased precipitation in Trans-Pecos Texas would provide abundant water. (While there was no glaciation in Trans-Pecos, Texas, increased precipitation would fall upon the region during a warm ice age.) Continued tectonic activity could produce uplift, again blocking the flow of water from higher to lower elevations. Bolsons would form again and dam breaching would be possible, generating more erosional action. In this stage considerable faulting likely was occurring along Sierra Ponce and Mesa de Anguila (Figure 9) creating zones of weakness encouraging the low of water through narrow faults. As the ice age abated, the Trans-Pecos Texas region became arid (Lammerts, 1971; Wells, 1985; Howe, 1996) as the supply water decreased. A “path” had been scoured for the Rio Grande to follow by the sequence of basin fill and dam breaching. The last seven miles of Santa Elena with high walls and narrow width also could have resulted from the solution of the limestone by water and subsequent collapse of the material above the solution cavity. A rapidly decreasing water supply as ice age conditions diminished could have lessened the opportunity for lateral erosion and this portion of the canyon retained its narrow width while downcutting proceeded.

Conclusions

All of the events suggested for the formation of Santa Elena Canyon from a Flood, post-Flood perspective are considered to have happened rapidly within a

*See Froede, 1995b for a discussion of the “Cretaceous Seaway” as possibly retreating Floodwater on the North American continent.

**It is suggested that these two periods need not have occurred sequentially. There could have been a drying period between the time of exiting Flood water and the ice age stage.

young-earth framework. The erosion of Santa Elena Canyon may have encompassed two separate time frames, a period of exiting Flood water and a period of increased precipitation during a warm ice age. Erosion was substantial in Trans-Pecos Texas during both periods. Tectonic and volcanic activity in the region caused the development of highlands and basins in both time frames. Erosion of the highlands, landslides and uplift blocked the flow of water out of many basins forming bolsons. Breaching of the natural dams generated considerable erosion below the dams.

Santa Elena Canyon was essentially completely formed at the end of the ice age. The curious path of the Rio Grande developed during the two erosional phases and particularly during the last phase of the ice age. The last seven miles of Santa Elena Canyon could have developed by the formation of solution cavities in the uplifted limestone blocks and subsequent collapse of overlying sediments or by the flow of water through narrow fault zones created during the waning stages of the ice age as the water supply rapidly diminished in Trans-Pecos Texas.***

The breaching of dams in debris-filled bolsons releasing large quantities of water containing considerable abrasive matter caused the major erosional action to form Santa Elena Canyon and possibly other canyons in Trans-Pecos Texas. These suggestions are tentative and are to be considered speculative.

Acknowledgments

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Glossary

- Antecedent Stream—A stream that was established before local uplift began and incised its channel at the same rate the land was rising. A stream that existed prior to the present topography.
- Bolson—An extensive flat alluvium-floored depression into which drainage from the surrounding mountains flows. An interior or closed basin with internal drainage.
- Downcutting—Stream erosion in which the cutting action is directed in a downward direction.
- Fault-block Mountain—A mountain that is formed by block faulting.
- Faulting—The process of fracturing and displacement that produces a fault.
- Lacustrine—Pertaining to or produced by lakes.
- Lateral Erosion—The erosion of a canyon or gully walls by water action and gravitational forces causing the canyon to widen.
- Lithology—The physical character of a rock.
- Pediment—A broad, gently-sloping erosion surface typically developed by running water in an arid or semiarid region at the base of an abrupt and receding mountain front.
- Piping—A process causing catastrophic failure of natural and man-made dams in which water enlarges tunnels through the dam.
- Playa—A dry, barren area in the lowest part of an undrained desert basin. A shallow, intermittent lake in an arid region.
- Superimposed Stream—A stream that was established on a new surface and that maintained its course despite different lithologies and structures encountered as it eroded downward into the underlying rocks.
- Uplift—A structurally high area in the crust produced by movement that raised the rocks.

***For a discussion of the possible formation of channels in limestone in conjunction with a lowering groundwater level, see Froede, 1994b.

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THE ROLE OF GEOLOGIC ENERGY IN INTERPRETING THE STRATIGRAPHIC RECORD

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Abstract

A creationist "geologic column" has a place in Earth history interpretation. None has been widely accepted and applied, although preliminary constructs have been proposed. We suggest that a graph of geological energy vs. time, keyed primarily to events, can form a basis for future correlation and interpretation. Although creationist field synthesis is limited, recognition of the role of extrascientific information in Earth history validates the present graph as constrained by the Bible's historical accounts. Complete development of this graph awaits extensive field research.

Introduction

In the marketplace of ideas, creationists are at a disadvantage because advocates of a naturalist-uniformitarian Earth history possess a well-developed interpretive construct in the form of the geologic column. Instead of rejecting the construct, many creationists have attempted to utilize the geologic column in their interpretations (Robinson, 1996; Garton, 1996; Garner, 1996). However, extrascientific considerations (such as consistency between fundamental assumptions and derivative conclusions; see Reed, 1996) render the present uniformitarian column untenable. Any advantage gained by having a comprehensive interpretive synthesis, such as the geologic column, is lost once the fundamental assumptions of that synthesis are shown to be wrong. Thus a complete solution would include two steps; the rejection of the uniformitarian geologic column, and the rebuilding of another based on assumptions of the biblical Christian worldview. Once past the first step, creationists still need to develop their own synthesis as a basis for interpretation of geologic earth history. Preliminary efforts have been advanced (Walker, 1994; Froede, 1995). However, there is still much work to be done.

Any new construct will be subject to various qualifications (e.g., Reed and Froede, in press), including the fundamental emphasis on the geologic event rather than geologic time as the basis for field interpretation. Often, field evidence is insufficient to define and link geologic events. Therefore, extrascientific information is utilized to help define the events to be described in the field. For example, the assumption that past geologic processes are reflections of present processes cannot be based on science, but it allows field data to be evaluated in terms of modern environments of deposition. Hence, elevating uniformitarianism over empiricism limits interpretative options that may be readily available within the same dataset. Most creationists do not accept this relationship between uniformitarianism and observation because it disallows catastrophic, large-scale, and unique events. Properly recognizing and balancing extrascientific constraints and clear implications of field observations are important for any geologist. Force-fitting geologic evidence to events defined only within a modern deposi-

tional environmental context, or doing so within a rigid speculative construct associated with the Genesis Flood, both disallow a proper emphasis on field data as the crucial component in detailed interpretation.

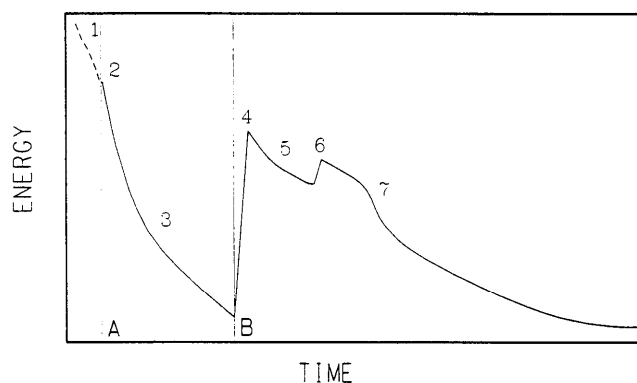


Figure 1. Proposed geologic energy versus time plot based on Scriptural interpretation. Key geologically significant dividing lines A and B mark the third day of creation and the onset of the Genesis Flood respectively. Segment 1 represents the geologic energy prior to the third day of creation; because geologic events prior to that day are not described, the line is dashed to represent uncertainty, however, it is assumed that energy levels were higher during initial creation events. Segment 2 represents the geologic upheavals caused by the separation of the land and waters on the third day of creation. Segment 3 represents the decreasing energy levels between the events of the third day and the onset of the Flood. A steady, and somewhat exponential curve is deduced by analogy to many modern natural processes. Segment 4 represents the onset and early stages of the Flood. The relative tectonic to hydraulic contributions to total energy probably were higher during segments 4 and 6. The slope of segment 4 reflects some time period for the Flood to reach its highest energy levels, rather than immediately upon onset. Segment 5 represents the decline of energy as the early Flood upheavals subsided. Segment 6 represents an increase in energy from late-Flood tectonic readjustment. Segment 7 represents the initiation of a steady energy decrease marking the post Flood and present-day times. Please note that below the level of detail of description of trends, the particular shape of a particular segment of the plot is speculative and open to further refinement.

Because the biblical Christian view of geologic Earth history lacks a comprehensive interpretive synthesis, we propose a graph of geologic energy vs. time as a preliminary step to framing such a synthesis (Figure 1). Since the major barrier to a robust creationist geologic column is the relative paucity of field interpretation performed by creationist geologists to date, this step is explicitly presented as a top-down extrascientific contribution, and it will be subject to revision based on

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field studies. However, we believe that such revision will result in the better definition of the graph, not radical changes in its general structure, since it is defined outside of science.

Geologic Energy

Energy is commonly defined scientifically as the capacity to perform work. Many scientists (engineers, physicists, chemists, etc.) have refined concepts of energy in their particular fields, and have been able to quantify energy transfers for many processes. However, geologists have generally not reached such levels of refinement. Even many modern geologic events are poorly understood with respect to energy transfers and have not been or cannot be quantified. For creationists, this problem is compounded by biblical reference to unobserved and non-repeatable past events that may have been unique in process as well as result. Therefore, the use of the term, "energy" (as well as the curve in Figure 1) in this paper must remain nonquantitative, and related to the capacity to perform work in a geological sense. An abbreviated presentation of the relationships of energy to several representative geologic processes is presented in Table I.

Geologic Product	Geologic Process	Specific Process	Transport Medium	Energy Type
Granite Pluton	magma intrusion	melting, intrusion, cooling, crystallization	crust	thermal, gravitational, hydraulic
Flood Basalt	lava extrusion	melting, extrusion, cooling, crystallization	crust, air, water	thermal, gravitational, hydraulic
Pyroclastic Deposit	volcanic eruption	melting, outgassing, explosive eruption	air, water	thermal, pressure
Faults, joints, and fractures	earthquakes	crustal dislocation	crust	acoustic, mechanical displacement
Sedimentary Rocks	erosion, sedimentation, diagenesis, lithification	erosion, fluid transport, settling, compaction, chemical alteration	water, air, glaciers	mechanical, hydraulic, gravitational, chemical, thermal
Mountains	orogenesis	uplift, faulting, plutonism, volcanic eruption	crust, air, water	mechanical, thermal, tectonic, gravitational
Landforms	climatic change	weathering, erosion	water, air	mechanical, chemical, solution, hydration

Table I. The relationships between various common geologic phenomena and their related processes are presented in terms of associated energy types. Although this presentation is simplified, the complex interrelationships between different types of energy transfers are illustrated. Please note that thermal energy includes thermodynamic effects such as mineral crystallization and hydraulic energy includes pressure effects, combined with density and viscosity properties. Tectonic energy includes mechanisms poorly defined or unknown, such as mantle motions and flow.

Other limitations of the definition of "geologic energy" are formed by the complexity of geologic processes and their natural setting and scale. Earth processes are complex, and require numerous overlapping sources of energy in their function. Also, spatial and temporal scales of these processes are not conducive to laboratory repetition. While it is helpful to consider the different types of geologic energy contributing to an energy-based approach to event definition, overdefinition would exceed the bounds of current knowledge. We believe that biblical inference does allow differentiation into tectonic and hydraulic components of the energy graph. Tectonic energy would include any structural processes of crustal dislocation including faulting, rifting, uplift, downwarping, and

fracturing. Hydrodynamic energy would encompass the processes of moving fluids on the Earth's surface. However, for the purposes of this paper, we will focus on the more general "geologic energy."

Concept of a General Energy Curve

Because any creationist geologic interpretation will emphasize events rather than time, methods of defining and delineating geologic events are of prime importance. This is a dramatic shift from the interpretive framework of the uniformitarian geologic column. In that framework, because time is the crucial factor, the column is defined by time periods, and the field evidence is examined in terms of a paradigm (i.e., evolution) that places high value on time indicators. Geologists recognize the concept of event as significant, but have not made the shift in thought that would transpose the importance of event-oriented interpretation over time-constrained interpretation. This framework creates a tension in geologic interpretation that can be resolved through a biblical Christian approach to earth history research.

One major difference between how creationists and Uniformitarians view events in the geologic record is that the latter view singular events recorded in the rock record as generic examples of types of processes that can be related to observed modern processes. Creationists, in contrast, see the record of singular events in the rock record as singular events, and have a primary interest in describing these singular events in their own light, rather than using them to extrapolate some generic process. For example, a coal seam may be of interest to a uniformitarian researcher as an example of an ancient swamp deposit (based on accepted modern analogs). Because a creationist recognizes the possibility that the coal seam is diagnostic primarily of unique past processes, he will be more concerned with its specific descriptive aspects, and his interpretation may be much more tentative regarding depositional environment. Without the comfort of a correlative modern depositional setting to frame interpretation, a potential approach to interpretation may be the inferring of an energy environment, and related minimum energy requirements for the seam's formation.

There is no lack of precedent for defining geologic processes (albeit qualitatively) by energy environments. For example, fluid transport of sedimentary materials produces a variety of bedding types that are characterized by the increasing energy levels of the fluid flow (Table II). We propose that the products of major geologic events of the past found in the rock record can be classified based on the energy environments in which those processes occurred. Even when the exact nature of the process cannot be defined, different geologic products can be compared or ranked in terms of minimum energy requirements. This approach provides a basis for the complementary use of field interpretations and extrascientific input, because extrascientific information, derived from the biblical record, allows the general definition of such a curve prior to field investigation. Field evaluation will be a further step beyond the scope of this paper.

Relating predicted relative energy levels to time allows the events of the geologic past to be defined in at least one sense in a predictive manner, and compared

	Lower Flow Regime			Upper Flow Regime		
Bedform	ripples	ripples on dunes	dunes	plane bed	standing wave	antidunes
Sand Motion	<-----	intermittent	----->	continuous	----->	intermittent or continuous
Sediment Transport	low concentrations			high concentrations		
Stratification Type	small trough sets	tabular sets	large trough sets	tabular sets	planar stratification	massive to crude foresets dipping upstream
-----> Increasing Flow Strength ----->						

Table II. An example of geologic classification by energy environment is provided in the sedimentological classification of flow regimes as they relate to sediment transport and bedforms (and thus, stratification types). Modified after Blatt, Middleton, and Murray (1980) and Lewis (1984).

to field data as they are gathered. Having a predictive construct based on the biblical narrative can both constrain and direct field research. For example, there is much discussion in creationist circles (Snelling, 1996) regarding the relationship between event boundaries and the systems of the uniformitarian geologic column (e.g., Flood strata = Paleozoic). The fundamental disjoint between time and event perspectives reflected in such comparisons can be resolved by relating events to energy environments instead of time sequences. The assignment of an event correlation to various strata in the field and the resulting derivation of event boundaries in the rock record can be constrained if the relative minimum energy requirements of the strata in question can be determined and compared to the predicted curve, rather than to the uniformitarian column.

We recognize that geologic energy will be distributed spatially as well as temporally, and the construction of a three dimensional framework that would illustrate such variations is beyond the scope of this paper. However, we are confident that spatial variations can be incorporated into the general temporal graph, based on the assumption of the global nature of the Creation and Flood events. Positing regionally widespread post-Flood events such as an ice age and volcanism can also help further define the graph. Detailed constraints from these phenomena are not included here, since this graph is explicitly derived from the biblical account, which does not directly reference these events. The true extent to which global energy environments define regional and local ones will only be defined in the field.

Structure of a General Energy Curve

The structure of a general energy curve will be derived from a geologic assessment of historical information presented in the Bible. Because that source is not specific and detailed from a geologic point of view, there is admittedly a level of inference built into the structure of the curve. We welcome discussion from both biblical scholars and scientists. The energy curve is defined in general categories by the events of creation and the Flood, with inference of conditions for the times between the two, and following the Flood (Figure 1).

Creation Events

The formation of the physical universe was an event of unimaginable energy transfer. The supernatural aspect of the creation, however, precludes any substantive scientific discussion. Although geological processes are dependent on the properties of the Earth as it was created, there is not sufficient description of the creation event to discuss them. The initial geological events that invite speculative interest during the creation week are the emergence of dry land from the primordial ocean, and the initiation of climatic controls of night and day cycles, vegetative proliferation, and "normal" geologic processes which may or may not have a modern analog. For example, the weathering and erosion generally associated with rain in the present appear to have not been operative during this time.

Our understanding of the physical and chemical properties of the Earth at the present time suggests that the energy environment initiated at the creation did not instantaneously subside to an antediluvian equilibrium. For example, isostatic rebound of the uplifted continental masses, potential tectonic activity associated with crustal dislocations, and even the establishment of fluvial baselines following the day three events all would probably continue in some measure through time. The curve in Figure 1 reflects that attenuation.

There is nothing in the historical record to suggest any major non-equilibrium events during the antediluvian period. Any geologic processes or events during this timeframe can only be speculative since (1) there is no detailed extrascientific historical record, and (2) physical crustal evidence of processes during that time period was most likely eradicated during the Flood.

Flood Events

The most dramatic geologic energy event following the Creation week was the Genesis Flood. Many authors (particularly Whitcomb and Morris, 1961) have detailed the biblical passages that describe the magnitude of these events, and they can be summarized succinctly in those passages that describe the Flood in terms of destroying the Earth's surface. A detailed analysis of the different energy environments and their relative importance during the Flood event is beyond the scope of this paper; however, we will present a rough outline of those in the following discussion of Figure 1. We agree with the historical chronology of the Flood outlined in Whitcomb and Morris (1961, p. 3).

The historical record clearly implies a sudden onset of high-energy geological events at the initiation of the Flood. These include the breakup of the fountains of the great deep. This episode has been discussed in detail (Austin et al., 1994; Brown, 1995; etc.), and although its exact technical meaning is unclear, it does clearly imply a transfer of massive amounts of thermal energy and associated crustal dislocation. Additionally, this episode marks the beginning of inundation by violent rainfall and probable associated storm events characterized by high winds, rapid and dramatic ocean surge from wind and ocean crust dislocation, and violent rainfall. Tsunamis would necessarily result from shallow dislocation of oceanic crust. The geologic results of this combination would have included pronounced erosion of the existing sediment cover and exposed igneous and metamorphic rocks, local uplift

and downwarping of the crust, intrusive and extrusive igneous activity, and rapid deposition of poorly sorted and reworked sediments deposited into local zones of crustal downwarping and faulting. Catastrophic crustal dislocation could also have created isostatic non-equilibrium conditions that would be manifested in geologic processes for a period of time following the onset of the Flood event itself.

The historical account next describes the transgression of the world's oceans over the entire surface of the continents. During this relatively short, but energetic, phase the "fountains of the great deep" continued their tectonic upheavals and storms continued unabated. Thermal and tectonic energy levels remained high, and hydraulic energy levels increased. Massive erosion, reworking, and rapid deposition would have occurred during this time. As the Flood advanced, there would have been a corresponding band of high-energy geologic activity marking the continually changing ocean-continent margin. This margin would have been subject to the conjunction of catastrophic drainage and large-scale wave and tidal actions. Field investigators should consider that as the waters moved inland, the available clastic sediment source could have been continually diminishing, and that field evidence of a decreasing clastic/carbonate ratio and decreasing grain size may not indicate decreasing energy levels.

Following the rapid transgression of the global ocean over the continents, the Flood entered a longer period of highstand. During this time the new global ocean reached a state of metastability, and we assume that the intense tectonic activity of the early phase of the Flood declined. Hydraulic interactions with land were all submarine, but would have been intense and effective nonetheless. Although clastic sources consisted entirely of reworked sediments during this time, the chemical and thermal equilibration of waters from a variety of sources would have resulted in the precipitation of a variety of chemical sediments (i.e., carbonates, halites, etc.). Several creationist authors have discussed the implications of a global ocean on winds, currents, and climatic conditions, and we defer to those discussions here (e.g., Baumgardner and Barnette, 1994; Oard, 1990).

The final phase of the Flood, the regression of the world's oceans into approximately the present accommodation space, was apparently the longest phase, commencing on the 150th day of the event (Whitcomb and Morris, 1961), and continuing into the present. The reemergence of land implies (at a minimum) vertical tectonic adjustments to create accommodation space. The same emergence would have interrupted and redirected the previously unrestrained ocean currents and winds. As the relative mean water level decreased, increasingly localized drainage patterns would have developed, and ongoing decrease of mean sea level would have contributed to comparatively underfit fluvial systems in larger drainage systems. All of these physical changes, reflecting lower levels of geologic energy, would have had profound effects on geologic processes.

In addition, initial rapid fluctuations in ocean depth, especially at the new basinal margins, could have resulted in renewed chemical sedimentation, perhaps aided by thermal anomalies associated with renewed

tectonism. The same event would have produced a period of shallow epicontinental seaways with high potential for explosive biotic development, and resulting biochemical sedimentation. Newly uplifted areas would have contributed increased clastic sediments, and the modern river-delta-shelf-slope-fan lateral depositional style would have been initiated on a globally decreasing scale. Just as the early Flood transgression led to an increasing carbonate/clastic sediment ratio (with no real change in energy level), so also the reverse processes could have led to a dramatically increasing clastic/carbonate ratio based on source, rather than energy factors.

Although the historical record describes a definitive end to the Flood from an anthropomorphic point of view, the geologic effects of the Flood probably continued for an extended period of time, and may be still at work today. However, energy available for geologic processes (e.g., erosion, sedimentation, volcanism, faulting) would have continued to decrease, and the energy curve (Figure 1) shows the decline of those levels to the present.

The basic difference between the initiation and termination energy requirements for the Flood raises an interesting point for those workers seeking to drive "golden spikes" in the Flood stratigraphic record. Figure 1 predicts much less success in finding a definitive post-Flood boundary than one for the onset of the event. Current disputes over the location of the post-Flood boundary may result more from the actual lack of any such clearly defined global horizon in the record, rather than the inability of workers to define it. The increasingly local and regional control of deposition during this period of time would also seem to preclude a global horizon definable as the post-Flood boundary.

Post-Flood Events

Although there may not be a globally correlative post-Flood horizon in the stratigraphic record, there are several manifestations of the readjusting energy environments coincident with the re-establishment of a modern relative mean sea level. The two most prominent of these events were the widespread latest Flood and later volcanism caused by renewed tectonism, and the climatic readjustments punctuated by a post-Flood ice age. Establishing the intensity of late-Flood volcanism relative to its onset and duration will be a function not only of the intensity of volcanic processes, but also of that of declining sedimentation, which would tend to mask the early effects of volcanism (Figure 2). Therefore, comprehensive field interpretation is required to relate volcanic intensity to event sequences. Sea-level reequilibration is evident in more recent sedimentary and geomorphic relicts, but the exact relationships between these events has not yet been described.

Conclusions

Extrascientific historical constraints can be used to form a general, yet predictive tool of geologic interpretation via changing energy environments inferred from the events described in the biblical record. In turn, this preliminary correlation chart offers a means of directing and constraining field research. Creationist field investigations may confirm the relative structure of the naturalist-uniformitarian geologic column, but even if

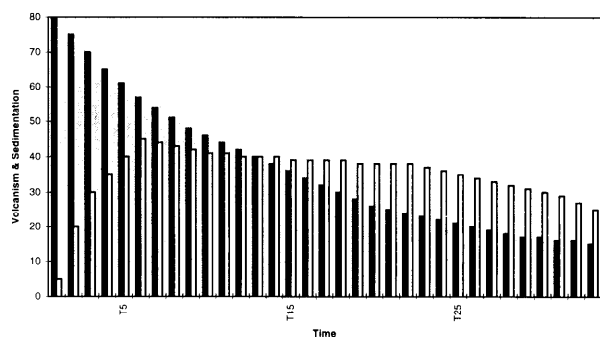


Figure 2. An example of an “energy interpretation” pitfall shown in the influence of varying sedimentation rates on perceived rates of volcanism. Even though volcanism (represented by the lighter columns) peaks early and begins to decrease, the apparent rate continues to increase because sediments (represented by the darker column) competing for volume in the rock record are decreasing more rapidly. This general configuration may reflect actual late-Flood to post Flood processes in some places. Numbers on the Y axis are arbitrary.

it does to any degree, the perspective of interpretation must change from the generic (i.e., “what depositional analog does this strata represent?”) to the specific event interpretation (“what were the specific processes and corresponding energy levels required for the deposition of this strata?”).

Field interpretation must recognize the general sequence of two similarly shaped energy curves in the geologic record. The first records the abrupt onset of the creation events, and the subsequent attenuation into antediluvian times. The extent of preservation of the geologic products of the creation curve is currently problematic, and requires resolution in the field along the lines of Austin and Wise (1994). The second records the dramatic and abrupt increase of energy levels at the onset of the flood, followed by the attenuation through the late Flood and post Flood times. Secondary variations in this second curve may be expressed by late-Flood increases in tectonism and orogeny, and by climatic readjustment, however, the basic shape remains. Several geologic consequences of this energy structure have been touched in this paper, and remain to be more thoroughly discussed at a later time. These include:

- (1) a more readily definable basal Flood boundary based on physical field evidence;
- (2) the predicted ability to recognize one massive, global transgressive-regressive sequence pattern overprinting local and regional variations;
- (3) potentially anomalous carbonate/clastic ratios that may reflect relative sea level (and thus, source availability) rather than energy levels;
- (4) difficulty in recognizing a “post-Flood” boundary in the physical rock record, based on the gradual attenuation of geologic energy in the late-Flood/post-Flood periods;
- (5) an increase in local and regional variation in the later stages of the stratigraphic record.

As the earth approached its new equilibrium (if it has indeed even reached it yet) following the Flood, the energy level of geologic processes decreased and became much more localized. Therefore, the bulk of the existing geologic record is associated with a relatively almost non-existent time frame (see Walker, 1994), especially when compared to the move away from a time-based correlation chart, which assumes roughly equal energy in separable and roughly uniform time units, to an event-based chart, which measures energy against geologic processes and products in an entirely different perspective. Thus, just as events are presented in the uniformitarian time scale only in a secondary fashion, so time is relegated to a similar priority in this proposal.

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Quote

In 1980, noted paleontologist Niles Eldridge commented on the lack of transitional forms in the fossil record: “The pattern that we were told to find for the last 120 years does not exist . . .”

Rensberger, Boyce. 1980. Recent studies spark revolution in interpretation of evolution. *The New York Times* November 4, p. C3.

THE ROAD AHEAD — LAB DIRECTOR'S REPORT

JOHN R. MEYER,* Director of the CRS Van Andel Creation Research Center

As technology advances, it is important that those on the forefront of the creationist movement take advantage of new and time-saving equipment and procedures. Because the *CRSQ* is published on a quarterly basis and all articles are peer-reviewed, the time from submission of an article to its appearance in the hands of the reader can be many months. These carefully-written, peer-reviewed articles provide the basis for formal scholarly discussions that are a major part of the foundation for the entire creationist movement.

However, it has become apparent that there is also a great need for rapid, popular-level communication among creationists operating at the cutting edge of creation research. The Internet has become an important avenue for rapid communication within the creationist community. Discussions at both the technical and popular level take place on a daily basis. The quick turnaround for requests for information, comments on daily scientific events, etc., has made the CRS NET an extremely-valuable adjunct to the work of the Creation Research Society. For more information you may contact the NET manager at CRSnetwork@aol.com.

Extended field trips for research, education, and encouragement will be a growing part of our future outreach ministry at the Van Andel Research Center. We have confirmed the Bob Marshall Wilderness pack trip for August 4 through 10. We have recently become acquainted with a family who does pack trips with horses into the Superstition Mountains, the Bradshaw Mountains, the White Mountains and Monument Valley here in the Southwest. As opportunity arises, we are considering trips to Death Valley and into the Havasupai Indian Country in the Grand Canyon area, 60 miles west of the South Rim Visitors' Center. We are also working on shorter one-day trips into the mountains near the Van Andel Research Center.

Our quarters for visiting scientists are finding increasing use from investigators working on projects both here at the lab and in the field. Development of

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our meteor radar system continues with the help of a visiting engineer. Several professional geologists have used the facility as a home base for origins studies in Northern Arizona. Scientists and students working on variability in Ponderosa pine trees have found our quarters essential for extended field trips to Mingus Mountain and other local areas. And, of course, our annual board meeting keeps our quarters occupied for a number of days, during, before, and after the meetings.

Projects for which we still need additional funding include:

1. Meteor radar system — equipment and supplies.
2. Stalactite simulation study — equipment and supplies.
3. Research quality greenhouse — building and supplies.
4. Publications storage and shipping facility — building and shelving.
5. Library expansion — shelving, filing cabinets, books, software.
6. Professional display for meetings — display board and graphics.
7. Field research — equipment and supplies.
8. Laboratory furniture — cabinets, desks, filing cabinets.

It has been said that vision fashions bricks into buildings. In like manner, donations of time and funds fashion goals into reality. The goal of the Creation Research Society is to expand our professional research center where evolutionary presuppositions are being challenged at the technical level. Because of your generous, continuing support of time and finances, this dream has rapidly become a growing reality. Together, we are making a difference in the scientific world, in our culture, and in the lives of individuals.

We now have two booklets on efficient giving: *A Living Trust, Is It For You?* and *Taking Stock . . . and Giving It*. If you would like either or both booklets, or if you know of potential donors, please contact me.

MINUTES OF THE 1996 CREATION RESEARCH SOCIETY BOARD OF DIRECTORS MEETING

The annual meeting of the Creation Research Society Board of Directors was held on April 18-April 20, 1996, in Prescott, AZ. On the evening of April 18, several motions were passed regarding proposed locations for Board of Directors (BOD) meetings for years ahead: 1997-Albuquerque, New Mexico; 1998-Santee, California; 1999-Albert Lea, Minnesota; and 2000-Atlanta, Georgia.

On April 19 between the hours of 8:15 a.m. and 5:00 p.m. the various committees of the BOD met for about two hours each to plan for the Saturday business session. On Friday evening the BOD reviewed a videotape "Catastrophism in Montana."

On April 20 the meeting was called to order at 8:15 a.m. The following board members were present: T. Aufdemberge, D. Boylan, E. Chaffin, W. Frair, R. Gentet, D. Gish, R. Goette, G. Howe, R. Humphreys, D. Kaufmann, L. Lester, R. Lumsden, J. Meyer, E. Williams, and G. Wolfrom. D. DeYoung and D. Rodabaugh were absent.

The minutes of the 1995 BOD meeting were accepted. D. Kaufmann reported that the following people were elected for a three-year term: T. Aufdemberge, D. Boylan, W. Frair, R. Gentet, and G. Howe. The treasurer's report was presented by R. Gentet and it was accepted. An informal audit was made of the

treasurer's books and they were found to be in order.

The membership secretary's report, presented by G. Wolfrom, contained the following figures: 617 voting members, 677 sustaining members, 323 subscribers, and 30 student members. The total membership for 1995/96 was 1647.

G. Wolfrom presented a report on CRS Internet activities. CRSnet is an online fellowship of those who hold to a recent creation and have email access to the Internet. Approximately 175 individuals participate via email in a private daily discussion of current topics of creationist interest. About 55 persons receive only the "basic service" which enables them to receive special announcements about CRS and other creationist activities. Also, CRS was the first major creationist organization to develop a World Wide Web (WWW) site "homepage" on the Internet.

It was noted in the editor's report by E. Chaffin that from November 1993 to March 1996 120 articles were received. Of these, 53 have been accepted for publication. It was decided that CRS purchase "Pro-Cite" software for use by the editor. It was passed that R. Lumsden become an associate editor to handle the biological papers submitted to the Quarterly.

G. Howe (acting chairman of the research committee, in the absence of D. DeYoung) reported that four research projects have been approved.

During a report from the publications committee (R. Goette, chairman) it was decided that \$3000 extra money be moved from publications to a fund ear-

marked for constructing a Publications Center building at VACRC. That brings the fund total to \$6000. It was moved and passed that we authorize construction of the building when enough funds become available.

J. Meyer (VARC director) was offered a one-year contract extending from July 1, 1996 to June 30, 1997. The VACRC director's IRA was increased and the annual salary remained at its present level. The VARC director's mileage allotment was raised. The VARC cash level at the bank in Chino Valley, AZ was raised from \$4000 to \$6000.

It was moved and passed that the BOD accept the "Long Range Plan-Goals and Strategies" presented by the Constitution/Bylaws/ Advanced Planning Committee (chairman D. Boylan).

E. Chaffin, L. Lester, R. Lumsden, D. Rodabaugh, and G. Wolfrom were nominated for the 1997 BOD election. The following BOD officers were elected for 1996/97: president - E. Williams, vice president - D. DeYoung, and secretary - D. Kaufmann. The maximum wage paid for hourly work by CRS was increased to \$10.00 per hour. "Patrons" of CRS will be listed in the December CRSQ issue each year. R. Lumsden was appointed chairman of the poster sessions to be held at the 1997 BOD meeting in Albuquerque. The 1996 budget was adopted. The meeting was adjourned at 1:45 p.m.

Respectfully submitted,
David A. Kaufmann, Secretary

BOOK REVIEWS

Show Me God by Fred Heeren. 1995. Searchlight Publications, Wheeling, IL. 337 pages. \$14.00.

Reviewed by Don B. DeYoung*

This book has been advertised widely. Its cover pictures Albert Einstein pointing to a photo of the Trifid Nebula. *Show Me God* is the first of a planned four volume series on apologetics with these topics:

- I. Cosmic Origins
- II. Examining Evolution
- III. Creation
- IV. The Bible's Origins

Fred Heeren is an old age, progressive creationist similar to Hugh Ross. Heeren does not have a science background, but is instead a writer of Christian drama, humor, and film scripts. For this book, the author interviewed many leading contemporary astronomers including Stephen Hawking, George Smoot, Arno Penzias, and Alan Guth. At one point Heeren humorously calls himself a "rotten name dropper" (p. 155). There is so much variety (fiction in Chapter 3, sidebars, boxed interviews, summaries) that the book appears poorly organized.

Some troublesome errors are found: Andromeda Galaxy's distance is 2 million light years not billion (p. 60). A figure showing curved space is deficient (p. 107). The name is Isaac Newton, not Robert Newton (p. 111)! Centripetal acceleration is confused and completely misunderstood (p. 196).

Heeren calls himself a Bible-believing skeptic (p. 1). He presents a great amount of readable logic and

philosophy. A solid testimony for Christ shows throughout the book. However, several unfortunate swipes are taken at recent creation (pp. 3, 76, 155-169). Heeren clearly does not understand the position, claiming that creationists do not take science discoveries seriously (p. 221). He elsewhere defines a creationist as anyone who accepts the big bang, a very confusing statement (p. 150). Heeren can find no place in scripture where an instantaneous creation is promoted; I would suggest he start with Psalm 33:9. A helpful appendix gives the biblical testimonies of 50 historical scientists.

Cosmology studies that combine the big bang with biblical creation have become plentiful and popular. The promise that "You too can understand the details of creation" is very inviting to the human mind. However the technical details of Genesis 1-2 lie in sacred territory, entirely beyond our comprehension. Although unintended, the title *Show Me God*, like a military command, is a commentary on the arrogance of the science mind today.

In the Beginning: Compelling Evidence for Creation and the Flood by Walter T. Brown, Jr. 1995. Sixth Edition. Center for Scientific Creation. Phoenix, AZ. 230 pages. Softcover \$17.95.

Reviewed by Carl R. Froede Jr.*

Dr. Brown presents an excellent work which he has wisely divided into three totally independent sections. In part one the reader is presented with a multi-disciplinary approach in defense of Creation. This section

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relates the latest information in support of the creation model gathered from the life sciences, astronomy, physical sciences, and the earth sciences.

In the second part of his book, Dr. Brown presents what he views as evidences which support his Hydroplate Theory. In this theory Dr. Brown ties scripture to geologic processes in an attempt to understand the physical events which occurred with the creation of Earth and its modification during the Flood of Genesis. This section also contains Dr. Brown's theories regarding frozen mammoths in relation to the Genesis Flood, and his concepts on the formation of strata by means of liquefaction.

In part three of his book Dr. Brown presents answers to questions which arise when presenting his information at public gatherings. Many different subjects are covered in various levels of detail. Some controversial topics are also included which have major implications for destroying some of the key paleontological evidences currently cited as defending evolutionary biology.

My biggest negative issue with the book deals directly with the Hydroplate Theory and it alone. Dr. Brown attempts to define several Antediluvian conditions which then altered with the advent of the Flood. He suggests that many of the physical evidences we observe today can then be used to verify many of his Antediluvian postulates. My greatest problem with this model is that Dr. Brown attempts to encompass too much with his Hydroplate Theory without enough physical evidence to support its many tenets. Simply put, the Hydroplate theory attempts to link too many widely divergent concepts into a single model in attempting to satisfy Occam's Razor (i.e., parsimony). While I am not totally against the theory, I believe that Dr. Brown will need to further develop and refine many of his concepts in attempting to create a unified theory for global tectonics and sedimentation. Many of his ideas do not directly link in a cause/effect relationship and this is where the Hydroplate Theory fails to provide the parsimony claimed.

Overall I found the book to be easy to read and very informative. The book provides a wealth of information and is very much up-to-date. It contains numerous illustrations and photographs and is well referenced. In many cases Dr. Brown has added explanatory text to the individual references in order to aid the reader in more fully understanding the concept(s) which he is attempting to convey. There is much new information presented within this work. Additionally, several tables and charts within the book provide information which has been presented elsewhere, but Dr. Brown has served to update and add new information, thus providing new and relevant data to some of the older information. I highly recommend this book to all those interested in the latest information about creation science, for its comprehensive treatment of the physical sciences in support of creation science, and for the extensive reference base from which specific topics could be further pursued. This work is an excellent summary of creation science and should serve as a valuable reference for many years to come. I would suggest this work for the high school to college level reader.

VIDEO REVIEW

Creation or Evolution? 1995. Video. Ambassador Television Production. Pasadena, CA. 76 pages. \$25 donation.

Reviewed by Robert E. Gentet*

The rapidly changing Worldwide Church of God has in the past several years systematically abandoned many previously held doctrines which set it apart from mainline Christianity. It has now offered its first video and booklet combination on the controversial subject of creation/evolution. Some changes from its previously held origin beliefs are to be found in this newly released material (the "Gap Theory" is now rejected, for example), but three basic themes remain the same: 1) the Earth and hence most of its fossils are indeed very old, (2) macroevolution is not borne out by scientific data, and (3) Genesis One reveals God as the Creator of all things.

The material does not challenge the scientist's claim that radiometric dating and the geologic column mandates millions or indeed, billions, of years of geologic time. In fact, such claims are used as evidence that the Bible should not be interpreted to say otherwise. While acknowledging that the Bible *seems* to be saying that the Earth is young, the simple solution to this apparent contradiction is that Scripture is not a textbook on science. Scripture is concerned with the "why" of creation and not the "when" and "how" which is normally best left to scientific investigations.

While God is acknowledged as the Creator, He is conceived as spreading out His creative activities over geologic time. By the time Adam and Eve are created, much of the creation has already come and gone. In short, the material espouses successive creations over millions of years. The Creation Week is seen only as an instructive means that God uses to tell the ancient Israelites and future mankind the basic point that He is the One behind all creation. It is left to scientific investigations, in our time, to begin to discover the "how" and "when" of His creations.

Successive creation material such as this can only be answered by young earth adherents using the dual track of proper Biblical exegesis and plausible scientific possibilities for the apparent/real time elements found within the geologic record and the universe. Both groups of believers say the Word of God and works of God compliment each other. A reconciliation between the two schools of belief might be bridged when a better "fit" between Scripture and the physical data is found. Until then, the Christian witness to the general public is dulled and fails to give a coherent picture to those still caught in the evolutionary web.

The material is graphically well done and the video, while mainly shot in Southern California, holds ones interest. The producers are to be commended for rejecting macroevolution; however, no Biblical reason is given for this rejection since the first chapter of Genesis is not viewed as an actual, historic reality of "how" God created all things. Ironically, it is here that God most plainly tells us that life from the beginning only reproduces "after its kind."

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A SUFFICIENT REASON FOR FALSE RB-SR ISOCHRONS

G. HERBERT GILL*

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Abstract

A mathematical answer is presented for the frequent occurrence of false or 'fictitious' Rb-Sr isochrons. The reason for these inconsistencies is that a simple linear regression procedure is mathematically invalid if two or more independent variables influence a single dependent variable. In many data sets for the "isochron" procedure, there are two independent variables involved. First, there is the desired radioactive relation between the amount of the rubidium parent and the strontium daughter. Second, since the atomic strontium concentration in the samples is a variable, then the isotopic Sr-87 content of the atom is also a variable. In such a situation, the "isochron" regression is mathematically invalid, so both its slope and intercept are erroneous.

Introduction

The geological literature is filled with references to Rb-Sr isochron ages that are questionable, and even impossible. Woodmorappe (1979, pp. 125-129) cites about 65 references to the problem. Faure (1977, pp. 97-105) devotes his chapter seven to possible causes for "fictitious" isochrons. Zheng (1989, pp. 15-16) also cites 42 references.

Zheng (pp. 2-3,5) also discusses the frequent occurrence of a variable Sr-86 (another non-radioactive isotope of strontium) that is critical to the situation. He comes closest to recognizing the fact that the Sr-86 concentration is a third or confounding variable in the isochron simple linear regression. Austin (1994, 1992, 1988), Butler (1982), and Dodson (1982) also discuss the discordant and long ages given by the Rb/Sr isochron. Snelling (1994) discusses numerous false ages in the U-Pb system where isochrons are also used. However, the U-Th-Pb method uses a different procedure that I have not examined and for which I have no data. Many of the above authors attempt to explain these "fictitious" ages by resorting to the mixing of several sources of magma containing different amounts of Rb-87, Sr-87, and Sr-86 immediately before the formation hardens. Akridge (1982), Armstrong (1983), Arndts (1983), Brown (1986, 1994), Helmick and Baumann (1989) all discuss this factor in detail. I do not discuss mixing in this paper; because if my premise is valid that the error is in the isochron procedure itself, then mixing is moot as far as ages are concerned. If the inputs to the mixing equation are data composed of ratios where the divisor is a variable, then the output is invalid.

All the Rb-Sr ages are in the millions to billions of years range, hence they are all completely at variance with the Biblical, literal six days of creation less than 10,000 years ago. Brown goes into considerable detail on this controversy. If the isochron ages are invalid, then a review of his analysis is in order.

Many theories have been advanced in the geological, mineralogical and similar fields to explain the "fictitious" ages, and how to, if possible, "correct" the false ages or to determine the correct age. This paper does not address the geological aspects of the problem. Zheng (1980, p. 3) comes closest to the answer presented here in his analysis of several sets of data containing variable Sr-86 values. However, he misses the true mathematical error in the isochron process, then

proceeds to attempt (p. 7) a correction procedure for the variable Sr-86.

The Simple Linear Regression Line

My answer to the problem is a little recognized mathematical law of the simple linear regression line (SLRL): the procedure applies *ONLY* to the case where *ONE* independent variable influences *ONE* dependent variable. If another variable, called the "third" variable by Johnson (1980, par. 3, p. 477) and the "confounding" variable by Moore (1985, p. 218), also affects the single dependent variable then the procedure is invalid. Figure 1 shows what happens under these circumstances, especially when the third variable affects both radioactive variables as is the case with the isochron procedure.

A simple data set, plotted in Figure 1, is:

X	Y	Variable Z divisor
1	5	4
2	6	4
3	7	2
4	8	2

The data have a simple linear regression line of $Y = 4 + 1 \cdot X$ with a correlation coefficient r of 1.00. The slope is one (45 degrees) and the intercept is four.

If the data set is divided by a variable Z (a purely arbitrary sequence in this sample), and a SLRL is computed for the quotients, then the equation is:

$$Y = .786 + 1.67X. \quad (1)$$

Note that the slope and intercept are quite different from the original regression, and the points are now scattered, so the correlation coefficient is now 0.993, the slope is 167% of the original, the intercept is 22%, the X mean 42.5%, and the Y mean 39.4% of the original line. Both terms of the deviation from the mean ($x - \bar{X}$) and ($y - \bar{Y}$), an important factor for computing the slope, are modified.

The SLRL slope no longer represents the relation between the variables in the original set in any respect. It also does not represent the relation between the variable Z and the dependent variable Y. The results are quite incoherent.

In contrast, when the original data are divided by a constant of 3 (the mean of the variable divisor), as is also shown in Figure 1, the slope, the fundamental relationship between the variables is unchanged. The intercept is 1/3 of the original, and the range is 1/3 of the original. No such simple relationship exists when the divisor is a variable. The reason is that the basic

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equation for the slope is a complex, nonlinear relation between the variables, their means, and deviations:

$$m = \frac{\sum(x - \bar{X})(y - \bar{Y})}{\sum(x - \bar{X})^2} \quad (2)$$

(Johnson, 1980, p. 106, eq. 4-3).

Once the division by a variable is done for the input to the regression, the error is unpredictable and irrevocable. Note that this sample is somewhat different than the normal third variable situation. Both variables are affected, rather than just the dependent one, as Moore (1985, p. 118) illustrates. The confounding is compounded.

The Rb-Sr Isochron Procedure as Normally Applied

The Rb-Sr isochron involves two key processes. First is the division of the radioactive parent (independent variable) by the so-called "constant Sr-86 isotope" and the division of the radioactive daughter (dependent variable) by the same Sr-86 value. Faure (1977, p. 77) states, just above his equation 6.3,

... we can modify Equation 6.2 by dividing ... by the number of Sr-86 atoms which is constant because this isotope is stable and is not produced by the decay of another element.

This is true; the isotope Sr-86 itself is invariable, and is nominally a constant percentage of the strontium atom concentration. However, Faure does not say that the amount of Sr-86 must be the same in every sample used in the simple linear regression equation. Austin (1994, pp. 111-131) does not address the division at all; he simply uses the Sr-87/Sr-86 and Sr-87/Sr-86 ratios in his illustrations of the isochrons. He does say (p. 118): "The isochron method ... is used most frequently with isotope ratios ...". There is again no reference to the fact that the divisor must be a constant amount for all samples in the regression. None of the cited references except Johnson (1980) and Moore (1985) note this fact.

The second step is to compute a simple linear regression with the ratio quotients. The slope of this "isochron" is supposed to yield the age of the formation, and the zero X-intercept is supposed to yield the original daughter content of the formation as it hardened. However, the SLRL is mathematically invalid, because there is a third variable involved: the variable non-radioactive Sr-87 isotope in the atomic strontium present.

Figure 2, using data from Austin (1994, p. 125, Table 6.5) copied in Appendix I, shows that the amount of the Sr-86 isotope is very closely related to the variable amount of atomic strontium. Also, the Sr-86 column in the table confirms that Sr-86 is a variable.

The atomic strontium is, of course, combined with other elements to form the rock minerals, and the isotopes cannot be isolated chemically. They can only be separated in the mass spectrometer and evaluated against a chemical standard "spike." This is actually where the ratios are evaluated as a division quotient.

When the parent Rb-87 is divided by the variable Sr-86, the variable itself, its mean and deviation are changed as in the example above. When the Sr-87 data are divided by the Sr-86 variable, the same thing happens, but in a more important and unusual way.

Figure 3 is a regression between the Sr-87 and Sr-86. It shows that they are very nearly collinear (parallel), with a small constant offset at the X = 0 intercept. The SLRL is:

$$\text{Sr-87} = 0.0586 + 0.6973 \cdot \text{Sr-86}. \quad (3)$$

This SLRL relation can be substituted for the Sr-87 in the ratio:

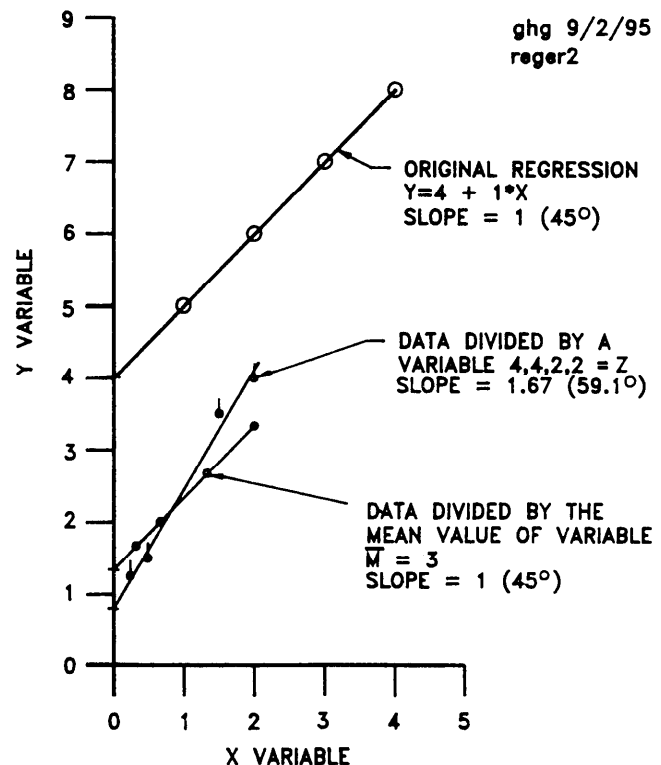


Figure 1. Simple linear regression line when data is divided by a constant and a variable.

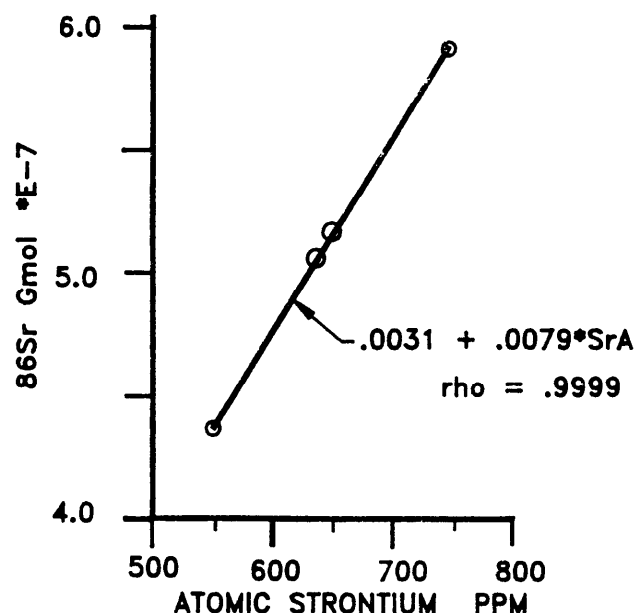


Figure 2. Relation of atomic strontium to isotope 86Sr; they vary together.

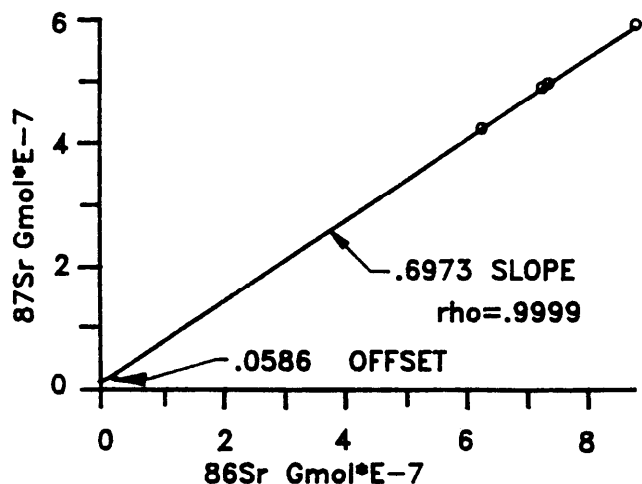


Figure 3. ^{86}Sr and ^{87}Sr are nearly collinear variables.

$$\frac{\text{Sr-87}}{\text{Sr-86}} = \frac{0.0568 + 0.6973 \cdot \text{Sr-86}}{\text{Sr-86}} = \frac{0.0568}{\text{Sr-86}} + 0.6973. \quad (4)$$

Thus, the division results in the constant 0.6973 plus a new variable: $0.0568/\text{Sr-86}$. This new variable is what determines the Y vertical component of the isochron line. The X horizontal component is the substantially modified mean of the $\text{Rb-87}/\text{Sr-86}$ division noted above. The slope or ratio between the Sr-86 and Sr-87 becomes a constant that, when the Y component of the slope is added to it, is the Y axis locus of the line's center of moment.

The composition of the offset 0.0586 is worthy of note. It does have some radioactive daughter, but only in the sense of the one on one conversion of the parent Rb-87 to the daughter Sr-87 . It has no information on when the conversion occurred (no time data). Also, it has some Sr-87 from any other nonradioactive sources that contribute up until the time when the samples are analyzed. The important point is that the sources cannot be identified, let alone be quantified from the existing data. Also, the third variable invalidity of the isochron D^∞ intercept removes any time information. Therefore, the isochron assumption that the slope represents a radioactive time is invalid as long as the division by the third or confounding variable Sr-86 , the internal atomic strontium component, exists.

Summary

When a sample set of Rb-Sr data contains a variable amount of atomic strontium in the rock or minerals, the isotope Sr-86 is also a variable. So when the radioactive parent isotope Rb-87 and the isotope Sr-87 (containing some radioactive daughter) is divided by the variable Sr-86 , a "third" or "confounding" variable is introduced into the quotients. When these quotients are used in the isochron simple linear regression, this regression is mathematically invalidated by the presence of the third variable Sr-86 .

The regression does not signal an error; it simply reports an invalid answer. The slope and intercept are both invalid.

In the case where the $\text{Sr-87}/\text{Sr-86}$ regression has an extremely small offset, a condition known as "Ill Conditioned Data" may result. In this situation, another

tive to Pearson's correlation coefficient r will report an error as the coefficient will exceed one. This is the case with the Uinkaret Lavas data. In Butler (1982) and Dodson (1982), their high correlation between the Sr-87 and Sr-86 is the result of the collinearity of the two isotopes.

In the SLRL, the near zero slope of the line is also caused by the near collinearity. In the event there is exact collinearity, the two column vectors of the data matrix are proportional and the matrix is singular; a regression of these data would have a slope of zero—no correlation at all. This subject is beyond the subject of this paper. The reader is referred to Anton (1981, pp. 315-320). It is difficult mathematics!

Conclusions

When a variable atomic strontium content exists in a Rb-Sr data set, an isochron computed data set, an isochron computed from the ratios data is erroneous because a SLRL is mathematically invalidated when more than one independent variable influences a dependent variable. This is an absolute mathematical law which cannot be violated.

APPENDIX I

A Sufficient Reason for False Rb-Sr Isochrons Uinkaret Lavas Rb-Sr Data

Sample No.	Atomic Strontium ppm	^{87}Rb Gmol x E-7	^{87}Sr Gmol x E-7	^{86}Sr Gmol x 10E-7
QU-1	745	0.305	5.91	8.39
QU2-2	549	1.00	4.37	6.18
QU-5	634	0.371	5.03	7.14
QU-14	649	0.958	5.16	7.31
QU-14S Omitted because of special processing.				

Ratios from original data omitted.

From Table 6.5, p. 125, Steven A. Austin. 1994. Grand Canyon, Monument to Catastrophy. Special study.

The division of the Sr-87 by the near collinear Sr-86 generates a false variable, which may contain daughter products, but which is also influenced by other non-radioactive values. It does not evaluate the radioactive decay rate relationship between the parent and daughter, so the "isochron line" slope does not measure time at all.

Since the slope is erroneous, its extrapolation from the mean locus of the regression line to the $X = 0$ axis is also invalid. Hence, the initial $\text{Sr-87}/\text{Sr-86}$ ratio is also invalid.

If the Sr-87 and Sr-86 data are very nearly collinear (parallel), then an additional substantial error is introduced into the isochron regression because the data are ill conditioned. This near collinearity is an inherent property of the data set, the internal atomic strontium isotope composition.

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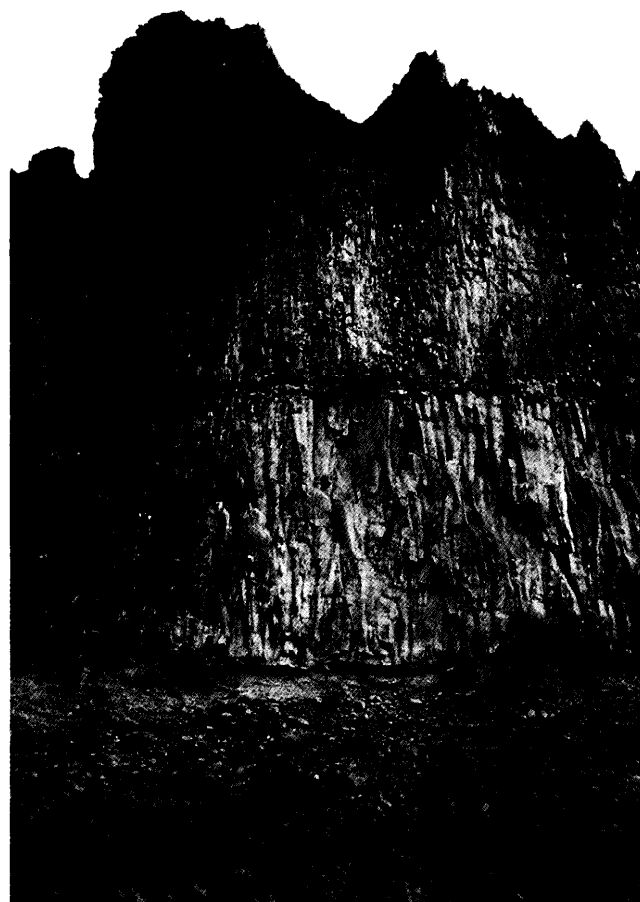
Quote

Which of his titles is hidden under the chapter heading "The Cosmic Christ"? It is the title "Logos" as found in the opening of the Gospel according to John: "In the beginning was the Word, and the Word was with God, and the Word was God. . . . All things were made through Him and without Him nothing was made that was made." Pelikan comments:

Because the speaking of God (which is one way to translate Logos) made the world possible, it was also the speaking of God that made the world intelligible. Jesus Christ as Logos was the *Word of God* revealing the way and will of God to the world. As the medium of divine revelation, he was also the agent of divine revelation, specifically of revelation about the cosmos and its creation. His "credibility" was fundamental to all human understanding.

The Christian fathers drew from this insight far-reaching conclusions: "There was, therefore, an analogy between the Logos of God, which had become incarnate in Jesus, and the logos of humanity, which was incarnate in each person and perceptible to each person from within." After certain starts in false directions (a tendency to glorify the irrational on the one hand and a rash claim that the mind has power to know everything about God on the other), the consensus of the Fathers settled on "the cosmos [that] was reliably knowable and at the same time mysterious, both of these because the Logos was the Mind and Reason of God." We have seen how this deep conviction in the fourteenth century led to corrections of Aristotle by Christian scholars that prefigured some of Newton's principles. These utterly new thoughts were passed on through Leonardo to Galileo, so that the astonishing enterprise of modern science was finally being born in Christian culture after several still births in ancient Egypt, China, and Greece.

Niemeyer, G. 1987. A Christian sheen on a secular world. *Modern Age* 31:358.



Plateau Basalt Overlying Spokane Flood Deposits. Location is west of Yakima, WA along U.S. 12. This particular exposure reveals the rapid manner in which the basalt lava overflowed the area. The lava flow was catastrophic and provides evidence of massive tectonic forces still in operation following the receding of the Flood waters from this area of the continental U.S. (Ice Age Timeframe). Today geologists have nothing to compare it to other than the Hawaiian Islands. Photograph and caption by Carl R. Froede Jr.

Quote

Psalm 93:3-4

The seas have lifted up, O Lord, the seas have lifted up their voice; the seas have lifted up their pounding waves. Mightier than the thunder of the great waters, mightier than the breakers of the sea--the Lord on high is mighty. Holy Bible, New International Version Copyright © 1984. International Bible Society. Used by permission of Zondervan Bible Publishers.

IT'S JUST A MATTER OF TIME

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Abstract

Many people accept what they read as the clear message of Genesis: That the Earth was formed about 10 thousand years ago, on the first day, and that the stars were formed on the fourth day. This has led to disagreement with others who see the hugeness of the perceived distances to most stars and their apparent ages as a compelling argument against this reading. From discussions in which this writer has participated, the argument seems to be based on the required travel time of the light arriving from the distant stars and the estimated ages of stars.

However, there is a solution. This paper uses the Theory of Relativity to illustrate the observed phenomenon that the measurement of travel time is a function of the time keeper. Furthermore, this allows for billions-of-years-old stars that were created after the creation of the few-thousand-year old Earth. The preceding statement is not self-contradicting. One could take the viewpoint that time-keeping processes, such as radioactive decay rates, occurring out in the universe proceeded at a rapid rate as measure by Earth time. Thus, old Earthers should recognize that the perceived size and age of the universe is no bar to a young Earth and universe, at least from the view-of Earth time.

Introduction

The hugeness of the perceived distances to most stars has been considered by some, Christians and non-Christians alike, to be a powerful argument against a young Earth. The logic goes like this: "It is known that stars lie billions of light years from us. Light from those stars that we now see left them billions of years ago." They also derive estimates of the ages of stars based on models of the progression rate of physical processes which affect stellar radiation characteristics and on the observed radiation of stars.

Many others simply accept what they perceive as the clear message of Genesis that the Earth was formed on the order of ten thousand years ago and that the stars were formed on the fourth day, after the Earth. Many non-Christians, and many young-Earth Christians, including this writer, also testify that the wording of the Bible could not even allow for a significantly older Earth. Many young-Earth Christians believe that God placed the stars in the heavens with light from those stars already in place between them and the Earth.

Some who believe in the infallibility of the Bible also believe in an old Earth. Some, but not all of these Christians admit that the plain reading of Genesis implies a several-thousand year old Earth. However, they argue that revelation through the creation itself (i.e. scientific observation and theories) requires another interpretation, which they believe is not precluded by the wording in the Bible. Some also argue that placing the light en route would have been deception on God's part because the light would imply a history that was not real.

The two sides in this disagreement could just agree to disagree. On the one side are Bible believing young-Earthers, while on the other side are old-Earthers, some Bible believing Christians and others not believers. Still, there are those searching non-Christians, and there are some believers, who are troubled by the discrepancy between what they read in the Bible and what they interpret from scientific data or hear from the scientific community. Thus, it seems worthwhile to address the concerns of those people. At the same time, it also seems valuable to attempt to widen the

areas of agreement between young-Earth and old-Earth Christians.

Stated assumptions for the old-Earth argument usually include the constancy of the speed of light in a vacuum and that physical objects, including light which consists of photons, cannot travel faster than this speed. A proper understanding of this assumption, however, shows that it has been incorrectly applied in the old-Earth argument.

It is also seen that the immediate presence of light in the path between the distant stars and the several-thousand year-old Earth is a natural consequence not an unnatural one) of what God describes in the Bible. Therefore, no deception by God is indicated.

The Classic Clock Paradox Story

To begin, consider the so-called "clock paradox," which is based on the theory of relativity. The usual example involves two twins on Earth. One travels to a distant star system. He accelerates to a tremendous speed to reach that point thousands of light years away, and then returns while aging only a few years. However, he finds the Earth is much older.

That this time differential, predicted by relativity theory, can occur may be hard to believe, but there is evidence that supports this theory—see McGraw Hill Encyclopedia (1987). This evidence includes measurements of the decay rate of mesons at high speeds that agree with theoretical predictions. Also, clocks were flown around the world and the clocks "ticked slower" while orbiting. They resumed normal rates when returned to the Earth. The traveling clocks were synchronized with identical Earth-bound clocks before flight, and had, as predicted, time missing (post-flight) when brought back for comparison.

The fact that the traveling twin traveled thousands of light years while aging only a few years may seem to contradict the requirement that one cannot travel faster than the speed of light. However, a violation of that limit by the traveling twin has not occurred, from the perspective (i.e., frame of reference) of either twin. As we will see, the above old-Earth argument misconstrues that same requirement in a similar manner.

From the stationary twin's point of view, the traveling twin traversed a huge distance but took a long time

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(the Earth aged a lot while the traveling twin was gone). From the traveling twin's view, he took a short trip (he only aged a few years) but as his velocity approached the speed of light, his measurement of distance to the distant star system shortened, according to the Fitzgerald contraction (a sample calculation, using the Lorentz transformation, is provided later). The result keeps the ratio of distance covered to elapsed time less than the speed of light. Thus, from both perspectives the velocity of the traveling twin did not exceed the speed of light. Yet, when he reaches the distant star system, he will have traveled the thousands of light years while hardly aging. The ratio of the distance to the star system, before contraction, to the change in age of the traveling twin is not bounded by the speed of light (Bondi, 1964).

This paper resulted from considering the situation if the twin stayed on the distant star system.

A New Clock Paradox Story

Consider a story, where the traveling twin is going to the Earth, instead of leaving it, and he stays there. We want him to stay there because what he sees in the sky is analogous in some ways to what we see when we look to the heavens. The story goes as follows. God creates Planet X, orbiting Star Y. He also creates a pair of twins, A and B (and wives for each), and places them on Planet X. The twins both have accurate clocks, given to them by the Creator, which they synchronize. Immediately, Twin B and his wife enter the spaceship Ark, given to them by God, and they leave on a journey to far-off Earth, which orbits a star called the Sun, about 5000 light-years (in Earth years) from Planet X. Twin A and his wife stay on planet X. Twin B accelerates immediately to a velocity of 0.99999998 of the speed of light.* In his new frame of reference, the initial distance to the Sun contracts to about one light-year (see Appendix I), and his clock rate, as measured by Twin A and his descendants, is reduced by the Lorentz factor:

$$F_c = \sqrt{1 - v^2} \quad (1)$$

where the velocity, v , is normalized to the speed of light and is therefore unitless (See Appendix I). After traveling at this speed for one year, Twin B decelerates instantaneously and lands on Earth. Since Earth is relatively stationary in Planet X's frame of reference, Twin B's clock rate, as observed by descendants of Twin A on Planet X, "speeds up" to the rate of clocks on Planet X, since v , in Equation (1) equals 0.

What are the perceptions of these events from the perspective of Planet X? As prearranged, Twin A uses a light beam provided by God and sends out one light pulse when his twin leaves and a second light pulse at 0.0001 years later. The reflection from the first pulse is seen immediately. The second pulse overtakes Twin B, at the Earth just as he arrives, 5,000 years after leaving Planet X. The light pulse is received and immediately sent (or reflected) back to Twin A. A descendant of Twin A, on Planet X, receives it approximately 10,000 years after Twin B left Planet X, and correctly calcu-

lates the time of reflection, the distance and Twin B's velocity. The time of reflection is the average of the times the pulse was sent and the reflection was received, calculated as 5000.00005 years after Twin B departed (see Appendix II). The distance is calculated as 4999.99995 light-years, based on the $\frac{1}{2}$ of the round-trip travel time of the pulse.

What time has elapsed as far as Twin B is concerned? Upon landing on Earth, the second pulse from Planet X arrives. He looks at his clock and correctly determines that he left Planet X one year earlier. He looks at his wife, and in a mirror, and correctly observes that no significant aging occurred during the journey, and certainly not 5,000 years worth.*

Looking back after he landed, what would Twin B observe about the light from Planet X and Star Y? (Even if he had our best present day technology.) Two significant observations would be that the light would be dim, as it has traveled 5000 light years, and it would have no velocity-induced red shift, since the clock rates are now the same. Yet, the light has traveled those 5,000 light years in less than one year, since they only came into existence a year earlier. Thus, from his vantage point, both he and the light from Star X have violated one of the stated assumptions of the old-Earth argument mentioned earlier.

Twin A sends a third pulse one year after the second pulse was sent, and then one pulse every year thereafter. The third pulse is received by Twin B one year after the second pulse was received, and subsequent pulses every year thereafter.

Just before his death, in the year 50 AC (after creation), Twin B prepared a journal of his creation, his trip and life on Earth. He correctly states that he and his brother and their wives were created, along with Planet X and Star Y, 50 years earlier. In the year 500 AC, after Twin B's death, some of his descendants decide the story in the journal is not true. That they came from a planet circling Star Y, just after its creation, only 500 years earlier, appears to contradict their scientific observations and newly-devised theories. They note that, based on its measured intensity, Star Y is 5000 light-years away. They use an estimate of the star's brightness to calculate the distance, and it correctly seems that the light pulses from Planet X, and the light from Star Y, presently being observed on Earth have been traveling in space for 5000 years. Consequently, they believe that Star Y and the creation, if true, are well over 5000 years old, and Twin B was a liar or insane. One grandson refused to accept that conclusion, so he reasoned that his grandfather, Twin B, was using poetic symbolism, and that the first time the word year was used in the journal, it was symbolic for 5000 years.

For a very similar mathematical treatment of the clock paradox issue, but with considerably more de-

*Admittedly, this acceleration is physically impossible, but it keeps the mathematics simple compared with analysis using finite acceleration, and the qualitative effect is the same. See the clock paradox article in the McGraw Hill Encyclopedia, 1987, which also uses infinite acceleration in their illustration of the so-called clock paradox.

*The time of creation of the Earth and Sun in this story is not relevant to the point of the story. If created at the same time, light from them would not be immediately visible at Planet X and Star Y, and God could place the Ark on autopilot. On arrival, the traveling twin would be a year old and objects on the Earth would be 5,000 years old. In fact, the story could have had the Earth and Sun created near Planet X and Star Y, and Twin B and his wife placed on the Earth as it and the Sun were whisked by God to its new location 5,000 light years away. In this case, all objects on Earth would also be one year old on arrival at the new location.

tail, see the Clock Paradox entry in the McGraw-Hill Encyclopedia of Science and Technology (1987).

Concluding Comments

Conditions existing at the beginning, as described by the Bible are obviously different than those in the new story of the clock paradox. However, just as it is true in the story a decision regarding "how long ago" the stars were created cannot be made even with the best technology. What the story hopefully does accomplish is to establish in the reader's mind the concept that elapsed time can be dependent on conditions of which we are not unaware, and that elapsed time can be different in different places. Once we accept that, the idea of an old, large universe does not conflict with the thought of a young Earth.

Another aspect of the issue is the effect of gravity. Gravity has an effect on clocks similar to that of acceleration. Appendix III shows how the effects of gravitational potentials on clock rates may be computed. Using Equation 9, it may be shown that significant differences in clock rates would exist between clocks on the surfaces of the Earth and Jupiter, for example.

Consider what the Bible says about the making of the heavens. Genesis states that the Sun, Moon and stars were made on Day four and then set in the heavens. [The light present on the first day may have been God's Glory—see Revelation 21:23 and 22:5.] Isaiah 40:22 states that God, who dwells on the circle of the Earth, stretched and spread out the heavens as a dwelling place.

With the stars being formed near the Earth, and then quickly sent to their places in the heavens on Day 4, strong gravitational potentials may have been present at the Earth. If Earth were experiencing a strong gravitational potential until the stars were spread out, then Earth's time measurement would have been very different from other heavenly bodies. Furthermore, once the potential was diminished, there would not necessarily be any observable residual red, or blue shift to the light from the stars.

Earth would have, from the viewpoint of the stars, been almost frozen in time. From Earth's view, the heavens would have developed almost instantly. This is reminiscent of Psalm 90:4 and II Peter 3:8, where it says that with God, one day is as a thousand years and a thousand years is as a day. In fact, one could take the viewpoint that the timekeepers, i.e. physical processes, such as radioactive decay, occurring out in the universe proceeded at a rapid rate as measured by an "absolute" Earth time. Thus, our ability to measure elapsed time from the beginning would be frustrated even more than the descendants of Twin B in the example given above.

Even without a high gravitational potential, God may have miraculously slowed Earth's time clocks (or increased the rate of other clocks). Once we make use of the concept, put forth by relativistic physics many years ago, that time is not the fixed quantity previously thought by many, a young age for the Earth indicated in Genesis should no longer present a problem to those troubled by the apparently huge and old heavens.

Clearly, the old-Earth argument at the beginning of this paper fails to consider all the possibilities. Dr. Russell Humphreys, a physicist with Sandia National

Labs—see Humphreys (1995), applied the field equations of the General Theory of Relativity, taking into account conditions implied by the Bible to have been present at the beginning and arrived at a young Earth, a vast universe, and "old ages" of stars (i.e., according to their "clocks"). (Humphreys' book was an encouragement that ultimately led to this paper.)

This is not to say that we can scientifically determine the answers to all questions about the creation of the universe. On the contrary, this analysis shows that we need to be careful with our pronouncements about what observations prove. However, it seems that if young-Earthers could restrict their position to the age of the Earth, and old-Earthers could restrict their position to an old "heavens," much of the disagreement would disappear. As someone once said, "All time is local." See Bondi (1964).

The theory of general relativity itself may need modification (Peterson, 1994). The US Government is performing experiments this year to determine whether the change is necessary. If it is, the impact will be great, according to its proponents; concepts like black holes will no longer be valid.

Finally, other explanations have been proposed to explain the apparent vastness and age of the universe as being consistent with a young Earth. We obviously cannot determine scientifically the details of the creation, but we can say that any further use of the old-Earth argument stated at the beginning of this paper will be, almost certainly, poorly timed.

Appendix I

The Lorentz Transformation and the Fitzgerald Contraction

The Lorentz transformation is used to relate coordinate systems that are moving with a constant velocity relative to each other. It is used extensively in relativistic computations, and can be used to evaluate the amount of shrinking in the perceived distances (Fitzgerald contraction) according to the two twins, and the difference in perceived clock rates. Equations 2 and 3 give the pertinent relations.

$$d_B = \frac{d_A - vt_A}{\sqrt{1 - v^2}} \quad (2)$$

$$t_B = \frac{t_A - vd_A}{\sqrt{1 - v^2}} \quad (3)$$

where d_A , d_B , t_A and t_B are distances and time measurements in the perspectives of Twins A and B, respectively. Notice that the distance and time are both measured in units of years. The velocity v is normalized to c , and is unitless. The axes coincide when $t_A = t_B = 0$. From the time transformation Equation 3, the apparent clock rates differ by the Lorentz factor:

$$F_c = \sqrt{1 - v^2}. \quad (4)$$

The distance to the Sun in Twin A's frame of reference, d_{A0} , is always 5000.00005 light years. Using this value and the value for v , eliminate t_A by combining Equations 2 and 3 to get the relation between time on Twin B's clock and his perceived distance to the Sun:

$$d_b = d_{A0}\sqrt{1 - v^2} - vt_B. \quad (5)$$

The distance d_b to the Sun seen by Twin B at the start of his journey is 1.0000000041857 light years. The end of his journey occurs when the distance to the Sun is zero, a time of 1.0000000241857 years. Thus the ratio of the distance covered to the time elapsed on his journey is 0.99999998 times the speed of light, the same speed measured by Twin A, but with much greater distance and time. Thus, the concept that the speed of light cannot be exceeded was not violated in the strict sense. Nevertheless, when he reached the Earth, he had traveled the thousands of light years which was his goal before he left, in one light year, a "speed" of 5000 light years per year. Such a measure is termed the proper speed in relativity jargon.

Appendix II

Effect of Velocity on the Periodicity of Light

Assume two objects are receding from each other with constant velocity v , normalized to the speed of light. Light pulses sent, by either one, at intervals Δt will be received by the other object at intervals of k times Δt , with k being a constant.

Bondi (1964) derives the relation between relative velocity and k . When Twin A sends pulses at intervals Δt , Twin B receives the pulses at intervals of $k \Delta t$. According to relativity the effect is the same in both directions and Twin A receives the reflection at intervals of k times $k \Delta t$, or at $k^2 \Delta t$. The time Twin A reckons it took Twin B to get from Planet X to the point of reflection of the second pulse is the average of the times the pulse was sent and the reflection was received, $\Delta t(k^2 + 1)/2$. The distance is calculated as $\frac{1}{2}$ of the round-trip travel time of the pulse, or $\Delta t(k^2 - 1)/2$. Since the velocity is the ratio of distance to time, Bondi derives Equation (6)

$$v = \frac{k^2 - 1}{k^2 + 1}$$

which leads to Equation (7):

$$k = \sqrt{\frac{1+v}{1-v}} \quad (7)$$

Appendix III

Equivalent Effect of Gravitational Fields

Einstein (1961) claimed that the parameter v^2 in Equations 2-4 can be replaced by $-\Phi/c^2$, where Φ is the gravitational potential, given by:

$$\Phi = -\frac{KM}{d}$$

where K is Newton's constant of gravitation. M is the mass of the body generating the potential and d is the distance from the center of mass. A slower clock rate is experienced by objects at a stronger gravitational potential:

$$\nu = \nu_0 \sqrt{1 - \frac{KM}{c^2 d}} \quad (9)$$

where n is the rate of the clock with the gravitational potential, and n_0 is the clock rate at the center of mass, implying a zero potential.

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BOOK REVIEWS

Foundation, Fall and Flood: A Harmonization of Genesis and Science by Glenn R. Morton. 1995. DMD Publishing Co. 16075 Longvista Dr., Dallas, TX 75248. 165 pp. \$15.00 + \$2.00 postage.

Reviewed by R. H. Brown*

The author is a geophysicist who claims to have "once believed in a world-wide flood and a young earth . . ." [p. 52], and has 29 previous publications concerning creationism. Growing doubts led to a nearly 10 year withdrawal from publication. According to his testimony these doubts eventually drove him to the edge of becoming an atheist. He offers this book in hope that it will help others avoid a crisis of faith such as he has experienced [outside back cover].

According to the author's introduction, "The book . . . is . . . a rejection of young-earth creationism. . . . [in] The first part . . . All of the problems with young-earth creationism are discussed. . . . The second part of the book presents a new interpretation of Genesis which has only been seen once before in the creationist literature" [p. 2]. In his opinion "The most contentious issue

in the evolution-creation debate is that concerning the age of the universe" [p. 4].

Part 1 begins with a summary presentation of five interpretations of the Genesis account that have been widely discussed in creationist and theological literature.

(1) Traditional View: Creation of the universe within seven literal and consecutive 24-hour Earth days approximately 6000 years ago, with a subsequent destruction of Earth's surface features by a universal Flood of approximately one year duration.

(2) Gap Theory: Creation of the universe at an unspecified time in the remote past (~18 billion years B.P., according to Morton), with re-creation in seven literal 24-hour days after an unspecified millions-of-years gap in time following a catastrophe that destroyed the original life on Earth.

(3) Day-Age Theory: Evolutionary development of the universe, including life on planet Earth, over seven successive millions-of-years long epochs, following initial beginning of creation possibly ~18 billions years B.P.

(4) Progressive Creation: Six successive millions-of-years long epochs of development, each begin-

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ning with one "24-hour" day of divine creative activity which initiated the evolutionary development that prepared for the following epoch.

(5) Days of Revelation: In the first two chapters of Genesis Moses records revelation concerning the origin of the universe and life on planet Earth that was given to him over seven consecutive days.

In the remaining portion of Part 1 the author gives his rationale for considering *each* of these five classes of interpretation to be inconsistent with both scientific evidence *and* sound exegesis of Scripture. He has written this book to promote a sixth interpretation, the Days of Proclamation theory, as a solution to problems in the development of a Biblical creationism that is in harmony with the conclusions that currently have wide acceptance in the various branches of modern secular science.

The Days of Proclamation theory has an extended history in theological literature. As described by Morton, "Genesis 1 can be read as the proclamations of the Designer as he [sic] mentally visualized what the world would be like. When He saw that it was good, He had not necessarily brought it into existence. God on the first day conceived of light and proclaimed that there would be light in His new universe. On the second day God conceived and proclaimed a separation of waters. He did not necessarily create those objects in successive 24-hour time periods. Only after the seven periods of proclamation did God begin to bring about what He had designed" [p. 104]. In view of statements such as Genesis 1:31 —*And God saw everything that he had made, and, behold it was very good. And the evening and the morning were the sixth day* (KJV), such exegesis strains credulity, and appears to be a last resort for someone who wishes to be identified as a proponent of the Bible as the inspired, authoritative Word of God, but does not want to be constrained by the straightforward grammatical sense of its testimony concerning origins and Earth history.

Morton ranges through cosmology, geophysics, geology, sedimentology, archaeology, biology, and genetics for support of his thesis. For many readers some of his arguments may appear overwhelming, and provide more stressful reading than they are prepared to endure. For others who have a broader scientific background in the topic from which support is proposed, the relation between contention and basic evidence may appear similar to the relation between speculation and sound exegesis noted in the preceding paragraph. An adequate treatment of Morton's appeals to scientific evidence is far beyond the range of a simple book review, and would require a full-sized volume. His general approach is to consider the current core opinions in the various branches of secular science regarding the history of the universe and of life on planet Earth to be basically correct, and then consider the Bible to be a source of truth insofar as its interpretation can be manipulated in agreement.

A perspective on the character of this book can be obtained from the treatment of the origin of man, as given in Part 2 on pp. 125-127:

Assume that God had watched evolution cover the world with plants and animals and was awaiting the evolution of some creature which would serve His purpose for creating a dominating form of life. The great apes look promising, but they

can't communicate complex ideas by vocalizations. They don't have the requisite bent pharynx. Also, their hands are not adept at handling delicate objects. But one ape was pregnant with a significantly mutated offspring. The mutation was extremely rare among primates and would be unlikely to occur twice during the same lifetime. One pair of chromosomes had fused, giving this creature only 46. At birth, the child was still-born. God then took this creature, and miraculously fixed the defects which had killed the fetus. In this way, Adam was born. His body still shows the relationship to his parent species in the form of pseudogenes. He was also a special creation of God. Only in this way can the scientific data be reconciled with the divinely revealed data of the Bible. . . . The rarity of the mutation and its lethality left Adam without any ability to procreate his kind. Nowhere on earth was there a creature like him. After naming all the animals, Adam then realized that there was no one for him. At this point, God produced Eve by that well known surgical technique . . . When did this take place? . . . somewhere around five and a half million years ago.

The book contains extensive discussion of the Flood from Biblical, geological, archaeological, and plausibility viewpoints. The trend of these discussions is illustrated by a few quotations from pp. 134 and 135:

the Scriptures do not require and the geologic data does not support the concept of a worldwide flood. . . .without everything being accomplished by a miracle, a global flood is impossible. . . . we must conclude that the flood was a regional event involving the Mediterranean basin rather than a global occurrence.

In his Conclusions on p. 138 the author states:

"The views presented here concerning the origin of man . . . do accomplish the major objective of this book, to harmonize science with the Scriptural record which leaves the five important doctrines (the six days, the creation of Adam, the creation of Eve, the Fall and the Flood) unharmed historically or theologically."

Students of scientific creationism will find this book valuable for the 522 end-of-chapter references associated with its 12 chapters. Individuals who are involved in dialog or witness concerning Biblical creationism will be benefited by familiarity with the type of rationalization used by the author.

In the Beginning by Walter Brown. Sixth Edition. 1995. Center for Scientific Creation. 5612 N. 20th Place, Phoenix, AZ 85016. 222 pages. \$18.00.

Reviewed by Douglas V. Hulstedt*

Walt Brown is a retired full colonel Air Force, West Point graduate with a Ph.D in mechanical engineering from Massachusetts Institute of Technology. His most recent assignments during his 21 years service were Chief of Science and Technology Studies at the Air War College, associate professor at the U. S. Air Force Academy, and Director of Benet Research Development and Engineering Laboratories in Albany, NY. He retired from the Air Force in 1980 to begin a career in speaking, writing and research in creation science.

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This edition by Brown expounds upon areas most creationists fear to tread. It also has an algorithmic organization in the first of three sections on creation evidences which divides into three major headings: a) life sciences b) astronomical and physical sciences and c) earth sciences. The sections are subdivided into 130 separate subjects. This section alone is worth the book price. The closest format this writer has seen to this is Paul Taylor's *The Illustrated Origins Handbook*. In *The Beginning* however is current and looks in succinct manner at astronomical data inconsistent with slow natural processes.

Part Two of the book is entitled Fountains of the Great Deep. Brown unveils what this writer believes to be the closest model to the actual Genesis Flood that any creationist has ever assembled. He gets a clue from Genesis 7:11 "The same day were all the fountains of the great deep broken up, and the windows of heaven were opened." Brown's Hydroplate Theory is elegant in its parsimony and explanatory power. Brown has been refining this theory or the last 15 years and the theory has gotten little exposure in the creationist literature. It presents itself as the unified field theory of the earth sciences. It also has more predictive power than any model available. Creation scientists have several predictive models including the ice age, floating log mats to name a few; Brown's approach ties them together.

The theory is based on several basic assumptions: first, that at creation the earth had a large mass of subterranean waters; that these waters ruptured and that the rupture areas are seen on the ocean floors as the mid oceanic ridge extending 46,000 miles around the earth. The predictions following from this model are a part of the book's premise. The ocean shelf, plateaus, guyots, and rapid mountain formation in parallel with the mid-oceanic ridge are a few of the predicted results of the Flood catastrophe.

The book may have the definitive source of information on the frozen woolly mammoths. A chapter is dedicated to the subject. Brown has done more cataloging than Rehwinkel's *The Flood* and Velikovsky's *Earth in Upheaval* combined,

Another treasure is the chapter on liquefaction as a sorting mechanism. It may give some of us our first inkling of the stratification of the Flood. The third and last section of the book devotes itself to frequently asked questions regarding creation. The appendices at the end deal with technical notes.

Run, do not walk, to pick up a copy of *In The Beginning*. It is must reading for the informed creationist or evolutionist who wishes to know the cutting edge of earth science knowledge.

Dinotopia a Land Apart from Time by James Gurney, 1992. Turner Publishing Company. Atlanta. \$29.95.

Reviewed by Clifford L. Lillo*

The author, James Gurney, "discovered the sketch-book" of a scientist in a "University Library" while tracking down some information about the spice trade in China. Thus begins this fictional picture book about the co-existence of dinosaurs and men.

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However, this is not a creationist book. The cover overlap begins, "In 1860, when extensive uncharted territories covered a respectable portion of the globe, biologist Arthur Dennison and his young son, Will, set out on a Darwinian voyage of exploration." Other references in the text refer to millions of years and there is no reference to creation by the God of the Bible.

The book may be of interest to creationists because of the customary denial by evolutionists that humans and dinosaurs could co-exist. It depicts dinosaurs as being able to exist under 1860 atmospheric pressure, which some creationists consider impossible because of their limited lung capacity. It also shows pteranodons as being able to fly in an 1860 atmosphere, in spite of the belief of many creationist and evolutionist scientists that a higher atmospheric pressure would have been needed to get the animals' great weight off the ground.

Aside from these scientific reasons for considering the story a fantasy, the author introduces the concept that dinosaurs can talk and that they are every bit as intelligent as humans. Since they have their own language, the author allows the protagonist and his son to meet an obliging dinosaur who is willing to serve as an interpreter. Dinosaur names assigned by scientists in the 19th and 20th centuries are used in this 1860 story. The fossil record of all earlier forms of life on the planet, starting with trilobites, is shown carved on a wall, presumably by the dinosaurs themselves. As a picture book for children this is an excellent book, but its scientific problems and the obvious "proof" of an evolutionary history of life on earth make it unsuitable for creationists.

Quote: Jefferson on the way the judiciary branch can twist the Constitution

"The Constitution . . . is a mere thing of wax in the hands of the judiciary, which they may twist and shape into any form they please. It should be remembered, as an axiom of eternal truth in politics, that whatever power in any government is independent, is absolute also; in theory only, at first, while the spirit of the people is up, but in practice, as fast as it relaxes. Independence can be trusted nowhere but with the people in mass. They are inherently independent of all but moral law."

Jefferson, Thomas. 1819. Letter to Judge Spencer Roane. Reprinted in Jefferson, Thomas. 1903. The writings of Thomas Jefferson, Volume 15. The Thomas Jefferson Memorial Association. Washington, D.C. pp. 213-214.

Quote: Webster on liberty and Bible authority

The principles of all genuine liberty, and of wise laws and administrations are to be drawn from the Bible and sustained by its authority. The man therefore who weakens or destroys the divine authority of that book may be accessory to all the public disorders which society is doomed to suffer.

Webster, Noah. 1833. Preface to The Holy Bible containing the Old and New Testaments, in the common version, with amendments to the language. Quoted in Hall, Verna M. 1976. The Christian history of the American revolution. The Foundation for American Christian Education. San Francisco.

EVIDENCES OF CATASTROPHIC SUBAQUEOUS PROCESSES AT GOAT MOUNTAIN, IN BIG BEND NATIONAL PARK, TEXAS, U.S.A.

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Abstract

Today many geologists are more willing to consider catastrophic physical processes than in the past. However, these catastrophic events are postulated as having occurred over the millions of years necessary to validate the uniformitarian model. One such site where catastrophic physical processes have been proposed is at Goat Mountain in Big Bend National Park, Texas. This site has undergone significant volcanic deposition and erosion. All the volcanic sedimentation is viewed as having occurred rapidly and subaerially, with the intervening erosion being slow and uniformitarian. Tentatively, it appears that the evidence from the stratigraphic section exposed at Goat Mountain fails to support the present uniformitarian interpretation. Rather it appears to better fit subaqueous emplacement and subsequent massive erosion within a short timeframe. The author interprets the Goat Mountain exposure as having formed predominantly during the Flood (i.e., Middle to Upper Flood Event Timeframe).

Introduction

Today the science of geology is at a crossroads. Many geoscientists are starting to embrace the idea that catastrophic physical processes have occurred in earth's past (e.g., Ager, 1993a; 1993b; Fraser, 1989; Einsele, Ricken and Seilacher, 1991; Dott, 1983; Goodwin and Anderson, 1985; Yulsman, 1994). The acceptance of this concept, as simple as it seems on the surface, holds great promise for diluvial geologists (i.e., young-earth catastrophists). In the past, the idea of worldwide catastrophes was scorned and ridiculed. However, today catastrophes are viewed as recurring throughout geologic history. Many of our uniformitarian associates now consider the possibility of global catastrophes (e.g., K/T boundary, Permian crisis, Frasnian-Famennian boundary, etc.). However, the difference for many young-earth catastrophists is that these events are viewed as occurring predominantly during the Flood Event Timeframe and not as multiple events occurring over millions of years.

An outcrop of volcanic rock exposed in cross-section, in Big Bend National Park, provides one such example for a young-earth catastrophist interpretation. The outcrop is exposed at Goat Mountain and is located approximately 14 miles south of the turn-off from the Study Butte/Panther Junction road along the Ross Maxwell Scenic Drive (Figure 1). This exposure provides an opportunity to examine large scale historic geologic events. This paper suggests that the duration of the events which formed and shaped this mountain were brief and occurred during the Flood (i.e., Middle to Upper Flood Event Timeframe [Froede, 1995a]).

Previous Investigations

In their now classic work, Maxwell, Lonsdale, Hazard and Wilson (1967) extensively studied the sediments and stratigraphy which compose the geologic section found at Big Bend National Park in Texas. Various creationist investigators have also reported on aspects of this most interesting park from a catastrophic viewpoint (e.g., Williams and Howe, 1993; Williams, 1993a; 1993b; Williams, Matzko, Howe, White and Stark, 1993; Froede, 1995b).

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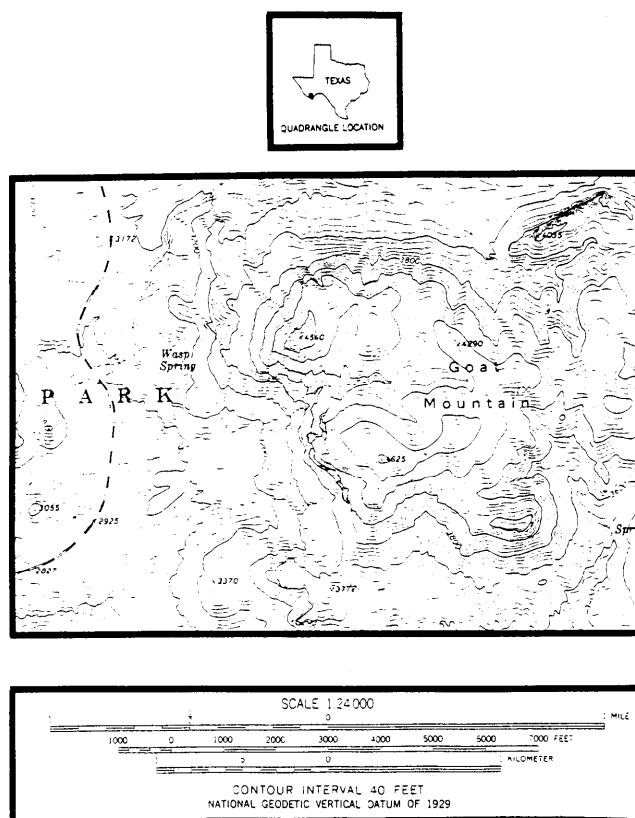


Figure 1. U.S. Geological Survey, 1971. Cerro Castellan, Texas. 7.5 Minute Series. Topographic Quadrangle Sheet. Scale: 1:24,000.

It was Maxwell, et al., (1967, p. 139) who first discussed and interpreted the Goat Mountain exposure. Subsequent investigations of the Goat Mountain outcrop, by various investigators, have served to verify the previous work (e.g., Maxwell, 1968; Pause and Spears, 1986; Henry, Price, Parker, and Wolff, 1989; Dickerson, Stevens and Stevens, 1990; Spearing, 1991).

The formation of the Goat Mountain exposure has been described, within the uniformitarian framework, as starting with subaerial volcanic eruptions from nearby calderas, which resulted in the outpouring of various lavas and the fallout of considerable quantities of ash

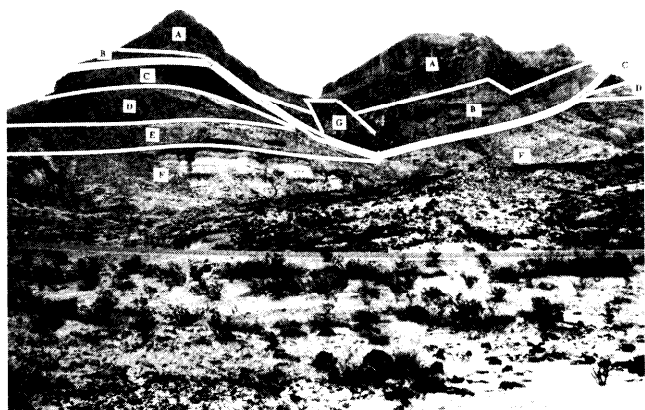


Figure 2a. Cross-section of Goat Mountain exposure with formations and members. A. South Rim Formation-Burro Mesa Riebeckite Rhyolite Member. B. South Rim Formation-Wasp Spring Flow Breccia Member. (Unconformity-double white line) C. Chisos Formation-Tule Mountain Trachyandesite Member. D. Chisos Formation-Tuff beds. E. Chisos Formation-Bee Mountain Basalt Member. F. Chisos Formation-Tuff beds. G. Spine-like intrusion of the Riebeckite rhyolite. The unconformity served as the canyon river channel, according to Maxwell et al., 1967, p. 139. Modified from Maxwell et al., 1967, p. 139, and Pause and Spears, 1986, p. 35: p. 224.

(Upper Eocene). At some later time an ancient stream flowing southwestward toward Castolon, cut a canyon about 900 feet deep (Upper Eocene/Lower Oligocene). This stream is suggested as having flowed for approximately eight million years (abbreviated Ma). Later still, additional subaerial calderan eruptions filled the canyon and surrounding area with additional volcanic deposits [Lower Oligocene] (from Maxwell et al., 1967, pp. 133,137-138; Pause and Spears, 1986, p. 223; Spearling, 1991, p. 316) [Figures 2a and b].

Using the uniformitarian timeframe, all of these formations and their associated events which formed, shaped and eroded them, occurred over millions of years during the Tertiary Period, specifically the Upper Eocene to Lower Oligocene (approximately eight Ma). There has been some difficulty with the radiometric dating of these rocks (Maxwell et al., 1967, p. 137). Additionally, the sparsity of fossils found in the multi-layered volcanics and sedimentary rocks do not aid in determining an age of the volcanic deposits (Maxwell et al., 1967, p. 136). Hence the exact ages of some of the volcanic rocks remains speculative. However, dating of these volcanics has been performed using lateral contacts, superpositions, and the limited fossils found in certain sections of the Park.

Volcanology

Today we know that volcanic eruptions and their associated pyroclastic materials can be deposited and eroded rapidly (e.g., Mount St. Helens). The uniformitarian explanation to account for the occurrence of volcanic deposits is one of sporadic volcanic activity spanning millions of years, resulting in the occurrence of vast sections of volcanic materials. Today, the science of volcanology has advanced to the point where the physical processes and systems are understood well enough to evaluate rates and processes affecting the deposition of pyroclastic rocks and to compare those rates against time. However, Uniformitarians still use



Figure 2b. Cross-section of Goat Mountain exposure without formations and members highlighted.

millions of years when describing the deposition and erosion of volcanics, even when cumulative deposition and erosion could have occurred in much shorter time frames.

Emplacement of Ash-flow Tuffs

Ash-flow tuffs compose much of the extrusive volcanic stratigraphic section found in Big Bend National Park, and several are exposed at Goat Mountain. Much research has been performed on the origins and emplacement of ash-flow tuffs (e.g., Smith, 1960; Ross and Smith, 1961; Chapin and Elston, 1979; Fisher and Schmincke, 1984; Cas and Wright, 1987; Cas and Busby-Spera, 1991; Fisher and Smith, 1991) and while considerable research remains to be done, a clearer picture is emerging regarding its formation. Additional information specifically about ash flow-tuffs can be found in Appendix I.

It has always been accepted that ash-flow tuffs form in a subaerial setting. However, recently it has been suggested that ash-flow tuffs can also form in a subaqueous setting (e.g., Cas, 1978; Fisher and Schmincke, 1984, pp. 293-296; Fisher, 1984, p. 18; Yamada, 1984; Howells, Reedman, and Campbell, 1986; Reedman, Howells, Orton, and Campbell, 1987; Kano, 1990; Ayres, Van Wagoner, Ferreira, 1991, pp. 183-184; Einsele, 1992, pp. 69-71; Lajoie and Stix, 1992). Cas and Wright (1987; 1991) have identified differences between welded subaqueous volcanoclastic (i.e., pyroclastic) deposits and subaqueous consolidated or epiclastic debris (ash-flow tuffs included), and the reader should consult these references to clarify the many dissimilarities between them. Additionally, the depth of subaqueous emplacement is still unresolved for locations suggested as reflecting possible deep water environments (e.g., Orton, 1987). Even as late as January 1995, Gregg and Fink report the current lack of understanding in subaqueous lava flows in terms of both volume and resulting types (i.e., pillow, lobate, or sheets).

The heat generated within a subaerial ash flow is generally accepted as providing enough energy to weld the ash together to form the tuff (Smith, 1960, p. 151; Ross and Smith, 1961, pp. 41-44), although higher temperatures would be required to weld the ash subaqueously (Fisher and Schmincke, 1984, p. 295). Where sufficient heat was not available it would result in an

unwelded or unconsolidated deposit (Fiske, 1963; Fiske and Matsuda, 1964; Niem, 1977; Cas, 1979; Wright and Mutti, 1981; Sparks, Brazier, Huang, and Muerdter, 1983; Heiken and Wohletz, 1985; Stix, 1991). To ensure complete preservation of the entire volcanoclastic deposit the top must be quickly covered or subsequent erosion could remove it (Ross and Smith, 1961, p. 24). Smith (1960, pp. 154-155) identified three zones of welding (i.e., no welding, partial welding, and dense welding) which directly relate to the original emplacement temperature of the ash flow, and which result in the variation of ash flow deposits. His work further revealed that the variables (i.e., temperature, thickness, composition of the ash, amount and composition of volatile constituents, and the ratio of pumice fragments to shards) can result in zonal variations in texture, color, and other features, such that essentially no two ash deposits are alike and a single deposit will show lateral (albeit slight) variation (Smith, 1960, pp. 153-154).

Welded tuffs are reported from many locales. Sidwell and Renfro (1943, p. 17) reference volcanic tuffs, from nearby Chihuahua, Mexico, which they believed were deposited in water; however, they failed to explain how they would have become welded. Other geologists have reported welded tuffs stratified with marine sediments and have proposed that they were deposited subaqueously (see Cas, Allen, Bull, Clifford, and Wright, 1990; Schneider, Fourquin, and Paicheler, 1992; Fritz and Howells, 1991; Orton, 1991; Kokelaar, Bevins, and Roach, 1985; Dolozi and Ayres, 1991; Howells, Reedman, and Campbell, 1986; Fisher, 1984; Yamada, 1984; Fernandez, 1969; Sparks, Sigurdsson, and Carey, 1980a; Howells, Leveridge, and Evans, 1973; Francis and Howells, 1973; Kato, Muroi, Yamazaki, and Abe, 1971; Yamazaki, Kato, Muroi and Abe, 1973). However, not all subaqueously emplaced ash flow deposits contained sufficient heat to result in welding. For example Sparks, Sigurdsson, and Carey (1980b) discuss the formation of subaqueous pyroclastic flows (i.e., epiclastics) which they discovered off the coast of Dominica, Lesser Antilles. Their research revealed unconsolidated pyroclastic rocks which were transported approximately 8.1 miles from Dominica in waters as deep as 1.1 miles (Sparks, Sigurdsson, and Carey, 1980b, pp. 94-95).

Thus the reader now understands that the welding of ash flow deposits can occur underwater. There are special requirements for this type of condition, but evidences supplied by various welded ash flows appear to support their formation in a subaqueous environment.

Goat Mountain Stratigraphic Section

The Tertiary stratigraphic units of interest for this report (i.e., specifically for Goat Mountain) include the Chisos Formation-Upper Eocene/Lower Oligocene (moving from bottom to top-a layer of unnamed tuff beds, the Bee Mountain Basalt Member, the Tule Mountain Member, and the Mule Ear Spring Tuff Member) and South Rim Formation-Lower Oligocene (moving from bottom to top-Wasp Spring Flow Breccia Member and the uppermost Burro Mesa Riebeckite Rhyolite Member) [Pause and Spears, 1986, pp. 34-35; pp. 223-224; Dickerson et al., 1990, pp. 42-43] (Figures 2a and b).

The author suggests that the Chisos Formation was deposited subaqueously. This interpretation is based on the occurrence of fossilized mammal bones, turtle remains, fresh water snails and wood (Maxwell et al., 1967, p. 136) sporadically contained within inter-bedded sedimentary deposits (i.e., clay and mudstone, tuffaceous clay and mudstone, tuffaceous sandstone, coarse massive conglomerate, very thick lenses of fanglomerate, and some freshwater limestones [Maxwell et al., 1967, p. 112]) between the welded and consolidated volcanic strata of the Chisos Formation.

The overlying South Rim Formation contains neither fossils nor significant non-volcanic sedimentary deposits (Maxwell, et al., 1967, pp. 137-151). The author believes that the majority of the South Rim Formation was probably also deposited subaqueously. However, questions remain regarding the uppermost member (i.e., the Burro Mesa Riebeckite Rhyolite) and additional studies are necessary in any attempt to determine the original environment of its emplacement.

The Goat Mountain section described by Dickerson et al. (1990, p. 42), provides information which supports the author's hypothesis of subaqueous deposition of volcanoclastics, due to the inter-bedding of sedimentary deposits between the welded and consolidated volcanic units:

The lower part of Goat Mountain is composed of the Chisos Formation (moving up in section): tilted Goat Mountain Member (informal; Stevens, 1969) constructive volcanic apron sediments (**diluted by some non-volcanic sediments**), now much zeolitized, are overlain by Bee Mountain (basalt), and Mule Ear Spring (welded ash-flow tuff; ignimbrite) members; **these in turn are overlain by a thin unit of sedimentary tuffs**, and Tule Mountain Member (coarsely, sometimes very coarsely porphyritic brown trachyandesite). (emphasis mine)

Dickerson et al., (1990, p. 42) have proposed that the Pine Canyon caldera created conditions (i.e., doming) which resulted in the erosion, via fluvial processes, and formation of the canyon seen exposed at Goat Mountain. However, Henry et al. (1989), interprets the area as being subject to many calderas and they do not provide an explanation as to the origin or cause of the channel exposed at Goat Mountain. The overlying South Rim Formation is described (Dickerson et al., 1990, p. 42) as: "Wasp Spring Member (**poorly welded ash flow breccia and minor sedimentary beds**) overlain by three thick, columnar-jointed cooling units of the Burro Mesa Member." (emphasis mine)

The author interprets the poorly welded Wasp Spring Member (South Rim Formation) as probably also having been deposited in a subaqueous environment. In support of this position, Maxwell et al., (1967, p. 140) state that a paleomagnetic study was performed on the Wasp Spring Member and the results indicated that some differential movement occurred in a "fluid" material at temperatures below the average Curie point temperature for the entire mass. Additionally, as the Wasp Spring Member moves away from the Chisos Mountain source area, the lava component decreases and the flow breccia increases (Maxwell et al., 1967, p. 140). With the loss of sufficient heat to weld the subaqueous flow together, the further away the material

flows from the heat source the less likely that it would be welded together, and the greater the chances of the deposit being eroded. Hence the ash-flow tuff would grade from more "lava" to more "breccia" in direct relationship to the distance from the heat source (see Sparks et al., 1980a).

The Burro Mesa Rhyolite Member caps Goat Mountain as well as many other sections of Big Bend National Park. It is described by Maxwell et al., (1967, pp. 141-142) as:

... a highly siliceous, medium-grained, gray rhyolite with quartz phenocrysts in a riebeckite matrix. The base is finely crystalline to glassy; flow structure is most evident in the basal 50 feet where platy riebeckite crystals form bands parallel to the flow structure.

The lava of the Burro Mesa Riebeckite Rhyolite Member probably came from several vents, but the vent or vents have not been located. The major riebeckite-bearing intrusive masses now exposed in the Chisos Mountains probably came from the same magma source as the extrusive rock in most of the South Rim Formation, but the vent or vents from which the extrusive rocks were erupted were **obliterated by erosion** or by the younger intrusives. (emphasis mine)

It should be clear to the reader that these volcanic deposits provide evidence of a complex original depositional environment. The exposure of these volcanic strata is due to the extensive erosion which has occurred across the Park. Much time (e.g., millions of years) has been postulated as passing between each of these volcanic depositional events.

Subaqueous Caldera Volcaniclastics

The author suggests that the original Trans-Pecos/Big Bend region existed along the western edge of a slowly withdrawing epeiric sea (i.e., receding Flood waters) [Froede 1995c]. This area remained submerged due to the slow rate of accommodation space provided for the epeiric waters as the oceanic crust slowly cooled and sank (see Schopf, 1980, p. 48). Plumes of magma rose to the Earth's surface beneath the Trans-Pecos Region associated with tectonic forces (rifting, uplift, and downwarping) in effect during this time frame. This tectonic movement coupled with deep-seated rising magma resulted in the subaqueous eruption of calderas throughout the region. The subaqueous caldera eruptions postulated for this region are analogous to those proposed by Busby-Spera (1984; 1986) for the subaqueous caldera eruptions at Mineral King in the southern Sierra Nevada, California. The reader is encouraged to review these two references along with the others cited for further information regarding the subaqueous eruption of calderas and the formation of volcanic strata in that environment.

The author proposes multiple subaqueous eruption events from the various caldera sources across the Trans-Pecos region, including Big Bend. These subaqueous eruptions resulted in the generation of massive volumes of volcaniclastic rock. It is proposed that the calderas would rise and erupt subaqueously releasing various volcaniclastics into the overlying waters (probably very shallow in the immediate area of uplift-see

Orton, 1991) and then collapse back into themselves and be buried in their own extruded volcanic deposits. This would explain why many of the source calderas cannot be found today. The volcaniclastics extruded from the caldera source areas would thin with distance from those sources. This is reflected in the thickness of the volcanic deposits (intracaldera versus extracaldera) seen across the Park (see Busby-Spera, 1984, p. 8421; and her Figure 4, p. 8422).

It is this author's opinion that the majority of the volcaniclastics found in the region (i.e., Trans-Pecos) and specifically at Big Bend National Park represent subaqueously deposited caldera volcaniclastics. Additional discussion is welcome in an attempt to determine any criteria which might further serve to clarify the possible original volcanic (i.e., caldera) environment.

Paleosols

Extensive investigations have been conducted on a number of the Upper Cretaceous (Maastrichtian) and Lower Tertiary formations in Big Bend National Park to determine the number and type of paleosols which have developed (e.g., Lehman, 1989; 1990). The author is unaware of any reported paleosol analysis performed on any of the Chisos or South Rim Formations across the Park. The issue of paleosol analysis is discussed because physical and chemical processes start breaking rock down as soon as it becomes exposed at the surface. Once sufficient soil is developed plant life would attempt to establish itself. This has been clearly demonstrated at Mount St. Helens following the May 18, 1980, eruption (see Tilling, Topinka and Swanson, 1990, p. 51; Austin, 1991). Studies by Smith (1991), showed that overland flow of water would be reduced (up to 30%) following the reestablishment of a full ground cover (requiring approximately 15 to 20 years) on volcanic sediments. Soil scientists have identified the Andisol as a soil which develops in volcanic ejecta (such as volcanic ash, pumice, cinders, and lava) and/or in volcanic materials, with short-range-order minerals (amorphous) or Al-humus complexes dominating the colloidal fraction (Daniels and Hammer, 1992, p. 115). In some cases the Andisol can be used to separate various volcanic layers and serve as a marker and mappable horizon (Campbell, 1986, pp. 222-224; Ward, 1967). If approximately 8 Ma were available for soil development, then there should be some evidence (somewhere in the whole Park!) that the Chisos and South Rim Formations developed vegetation or at minimum a soil capable of sustaining plant life. At this time no paleosol is recognized in the Chisos or South Rim Formations exposed at Goat Mountain.

Fluvial Deposits

Maxwell, et al. (1967, pp. 139-140) proposed that following the deposition of the Tule Mountain Trachyandesite (Chisos Fm.—upper Eocene), a stream cut a canyon that flowed southwest. According to Spearing (1991, p. 316), the ancient stream carved the canyon 900 feet deep as it flowed southwest toward Castolon. Today the evidences for this canyon only exist around the Goat Mountain exposure. While it is postulated to have flowed toward Castolon, no physical evidences of the paleo-river remain to verify this proposal. Following several millions of years of inactivity, the canyon



Figure 3. Rio Grande River flows from the top center to bottom left of this photograph. This is the way that Goat Mountain is suggested to have appeared over the 8 Ma that the stream flowed through the area. The Rio Grande has cut down through volcaniclastics. The author speculates that the original Rio Grande channel might have started with the draining of the Flood waters. Note the wide river canyon. This could represent a period of time when the Rio Grande flowed at much higher-rates with greater water volumes than present.

was subsequently filled with South Rim Formation volcanic deposits (i.e., tuffs, lava, and breccia) which eventually overflowed the top of the canyon (Spearing, 1991, p. 316).

If a stream or river did in fact exist over the millions of years suggested by the previously cited authors, then some evidence should remain in the form of fluvial deposits. However, if the erosion of the Tule Mountain Trachyandesite occurred rapidly, followed by the emplacement of the Wasp Spring Member and Burro Mesa Rhyolite Member there should be little to no record of channel deposits (i.e., fluvial deposits) found at the Goat Mountain outcrop.

An exposure along the present day Rio Grande provides an excellent analogy (Figure 3). This specific locale which is located approximately 13 miles northwest of Lajitas, on Texas Highway 170 along the Rio

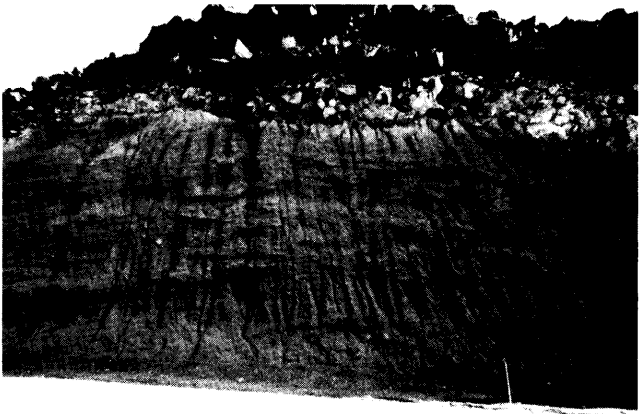


Figure 5. Twenty feet of fluvial deposits exposed approximately 450 feet above the present day Rio Grande, approximately 13 miles northwest of Lajitas on Texas Highway 170. Note rhyolite cap above the fluvial deposits. If the canyon at Goat Mountain once contained a stream or river and if it carved the canyon over the millions of years proposed, then there should be some evidence of its existence (i.e., fluvial deposits). No fluvial deposits have been reported at the Goat Mountain exposure!



Figure 4. Rio Grande River flows toward the left side of the photograph. The side walls of this canyon are composed of rhyolite which has been eroded by the Rio Grande River. This location is approximately 13 miles northwest of Lajitas on Texas Highway 170.

Grande, reveals an exposure created by the incision of the river into a rhyolite (Figure 4). The sidewalls are sheer and do not exhibit any indication of fluvial weathering or deposits. However, the bottom of the canyon contains typical fluvial deposits (i.e., sands, silts and clays). If the Rio Grande were not present, these fluvial deposits would provide evidence that a stream or river once flowed here.

An exposure at the top of this canyon of the Rio Grande reveals fluvial channel deposits (Figures 5 and 6) which are capped by rhyolite. This suggests that the rhyolite was deposited while the paleo-Rio Grande was already in existence and that following the emplacement of the rhyolite, the river subsequently eroded through it. The proof exists that a paleo-Rio Grande existed in the past not only because the river is present today, but fluvial deposits are exposed alongside the river, albeit 450 feet above the present Rio Grande river channel.

The Goat Mountain exposure has been interpreted as having had a river channel cut through 900 feet of volcanic rock. If a stream flowed through this exposure



Figure 6. Fifteen feet of fluvial deposits exposed approximately 450 feet above the present day Rio Grande approximately 13 miles northwest of Lajitas on Texas Highway 170. Note rhyolite cap above the fluvial deposits. These deposits provide physical evidence of a nearby river or stream, in this case the Rio Grande. These fluvial deposits are missing at the Goat Mountain exposure.

for several million years then there should be some indication (i.e., fluvial deposits) which confirm that it did exist. The author has not found any reference which identifies fluvial deposits at Goat Mountain! Additionally, none of the photographs taken by the author reveal fluvial deposits such as are presently observed along the Rio Grande River valley.

Paleontology

The paleontology of any site should be considered when performing paleoecological reconstructions. Certain sections of the Chisos Formation (Tertiary age) have been found to contain vertebrate fossils (See Maxwell et al., 1967, pp. 136-137). The fossiliferous sections are very minor when compared to the entire Chisos Formation, and are reported from the approximate middle of the exposed sections (e.g., West of Round Mountain—19 feet of a 2200 foot section; Western slope of Cerro Castellan—22 feet of a 1500 foot section; Northwest side of Casa Grande—25 feet and 3 feet of a 999 foot section) [data from Maxwell, et al., 1967, pp. 130-136]. These fossils, if they do reflect an actual paleoenvironmental setting, appear to have been transported for some distances due to the conditions (i.e., worn and abraded) in which they have been found. **However, no fossils have been reported from the Chisos at the Goat Mountain exposure.**

Additionally, fossils are also commonly found in the unlithified volcanically derived deposits of the Upper Cretaceous (i.e., Aguja and Javelina Formations) and in surficial alluvial deposits (dated from the Miocene to recent). Most of the fossils found in Big Bend National Park, from these deposits, are disarticulated bits and pieces of bone or teeth from a variety of terrestrial creatures. Very few whole (i.e., articulated) fossilized animals have been found in any of the Tertiary volcanics in the Park.

Currently these Tertiary volcanic deposits are interpreted as being Post-Flood by some creationists (Williams and Howe, 1993; Williams, 1993). It has been proposed that following the Flood, animals dispersed from the Ark and rapidly spread into the North American continent using land bridges created as a result of the accumulation of exotic terranes and uplift associated with the Laramide Orogeny (the last major orogeny to occur on the North American Continent). Flood waters were no longer in the Big Bend area and fresh water lakes are believed to have abounded during this time (see Oard, 1990, pp. 78-80).

While the author generally agrees with this interpretation, further refinement is necessary because fossils are found in at least two different types of strata (i.e., in sedimentary deposits inter-bedded between welded and consolidated volcanic rocks, and also in unlithified re-worked volcanically derived fluvial deposits). The uniformitarian paleoenvironmental reconstruction of these two volcanic paleontological settings as well as others found throughout the Park are open to personal interpretation of the data, and in no way infer a specific setting. For example Maxwell (1968, p. 20) has suggested that the Upper Cretaceous formations (i.e., the Aguja and Javelina Formations) reflect a coastal swamp environment:

. . . associated with dinosaur bones, are fossil stumps of agatized wood, the roots of which are

still emplaced in the sandy lagoon deposits in which they grew **(this is based on finding several trees stumps in this condition; however, the majority of the trees exist as trunks which lie prone and are in various stages of disintegration)**. In some places, groups of fossil logs suggest "log jams" that were covered with mud and preserved. Fossil turtles have been found in the same rocks, and this association of dinosaur bones, wood, and turtles suggests that the ancient environment was similar to the present-day bayou environment of East Texas and Louisiana. (parenthesis and emphasis mine)

Regarding the fossilized dinosaur bone remains found within these same deposits (i.e., the Aguja and Javelina Formations), Maxwell (1968, p. 20) states:

The skeletal remains of the duckbill dinosaur, ceratopsian bones (similar to the familiar Triceratops), and some of the large carnivorous types have been discovered, but only a few bones of the bird-like reptiles have been found. Jawbone fragments and teeth of swimming reptiles are also present.

One can quickly see that any paleoenvironmental reconstruction of the Upper Cretaceous deposits and associated fossils yields many possible interpretations. These Cretaceous deposits were volcanically derived and contain a mixture of both terrestrial and marine fossils. This mixed assemblage should alert the interpreter to seriously question any paleoenvironment reconstruction. Hence, great caution must be exercised by the young-earth Flood modeler in any attempt to recreate a depositional environment. The original information used to reconstruct the suggested environment might be based on only a portion of the facts presented as physical evidence, because the interpreter has a bias toward a specific environmental setting.

Several scientists have proposed a tropical fluvial volcanic environment for the original Goat Mountain area (again based on fossilized pieces of bone, teeth, snails and wood found in the Chisos Fm., collected from various sections of the Park). This environmental setting is interpreted as being violently destroyed in the eruptions of one (Henry and Price, 1984; Barker, Henry and McDowell, 1986; Dickerson et al., 1990, p. 42) or more (Henry et al., 1989) calderas located in the area. These caldera eruptions served to fill and even overtop the former Goat Mountain river valley. It is suggested that the plants and animals, living near these calderas, were also rapidly buried under **hundreds** of feet of volcanic deposits. This is the postulated environment proposed by both Uniformitarians (using millions of years) and some creationists (using several hundreds of years) who cite Nevins (1974) work (see Appendix II) in support of their interpretation.

It should also be noted that uniformitarian paleontologists recognize the concept of climatic zones and many are not willing to speculate as to compare the type of climate and associated flora and fauna found in one area versus another (see Frazier and Schwimmer, 1987, p. 634; Cox and Moore, 1985; Middlemiss, Rawson, and Newall, 1971). It is generally accepted that different types of animals lived in different climatic settings during different times within the Cenozoic. The author suggests that the upper Cenozoic rocks

found across the Park correlate to the young-earth Upper Flood to Ice Age Timeframes when Flood waters continued to recede from the continents and plant and animal life sought to reestablish themselves on the continental landmasses following their migration into new areas. However, any paleoenvironmental reconstruction, within the framework of the young earth Flood model, remains speculative until enough is known about specific species of both plants and animals to determine if migration has occurred or if the fossils represent creatures buried in the Flood.

Creationist Paleoecology of Big Bend and Goat Mountain

As previously stated, the issue of depositional environments, based squarely on the paleontology found in Big Bend, suggests a warm, humid, tropical type of climate. This is true whether examining the fossils contained within the sedimentary deposits inter-bedded in the welded and consolidated volcanic deposits or the fossils within the volcanically derived non-lithified fluvial deposits. The past climatological conditions have been modeled using air flow patterns believed to have been in existence during the Upper Flood through Ice Age Timeframes (see Oard, 1990, pp. 78-91; Vardiman, 1994). The fossilized animal bone, snail shells, and petrified wood found within the sedimentary deposits inter-bedded between welded and consolidated volcanic rocks of the Chisos Formation (Maxwell et al., 1967, p. 136-137) represent species of animals which were believed to have lived in a tropical environment (note the potential for circular reasoning based on the types of fossilized wood and animal remains—one serves to reinforce the other and yet both may be wrong). These fossils along with climatic modeling do not solve the possible paleoenvironment for Big Bend Park, they only suggest a possible interpretation.

Another point of contention is possible based on the amount of time following the Flood event in which the area was repopulated by migrating species of animals. These animals moved from the Ark through Asia, across the Bering Strait land bridge, and into the North American continent, with some species ultimately residing near or in what is now Big Bend (do not forget the freshwater? snails). Eventually these animals met their demise when exploding calderas erupted massive volcanic deposits (i.e., several hundreds of feet of volcanics across hundreds of square miles) which served to bury and preserve them. Oard (1990, p. 84) and Lammerts (1988) have both expressed concern with the animal repopulation of the North American continent following the Flood event. This author agrees! Additional studies need to be performed to determine population dynamics and dispersion as related to the migration and population of the North American continent by animals, following the Flood. However, a rapid population scenario would seem to be required to explain the occurrence of fossils within the sedimentary deposits between the welded and consolidated volcanics of the Chisos Formation.

The animal, snail, and wood fossils found within the welded and consolidated volcanics would appear to suggest that a specific paleoenvironment was in existence when the volcanic eruptions occurred. However, if life were present and the environment was as postu-

lated then evidence of that environment should exist outside the local Big Bend Area in the form of paleosols (both exposed and buried) and buried animal communities. Chronostratigraphically equivalent (i.e., time equivalent) formations, exposed to the east, across the Texas Gulf Coastal Plain, contain sedimentary deposits which reflect a marine environment (Spearing, 1991, pp. 10-11; Renfro, Feray and King, 1973; Plummer, 1932, pp. 803-805). Time equivalent fossils found to the west in the Rocky Mountains are believed (by Uniformitarians) to date to the Laramide Orogeny, and consist of vertebrates and fish (Frazier and Schwimmer, 1987, pp. 634-649). So it would appear that time equivalent rocks associated with the Rocky Mountains more closely compare with those found in the unlithified re-worked volcanic fluvial deposits than they do with the fossils found inter-bedded in the sedimentary deposits between the welded and consolidated volcanic rocks of the Chisos Formation. This interpretation is based solely on paleontology and no creationist work has been performed to date the Laramide Orogeny to a specific period within the creationist timeframe (e.g., Flood Event, Ice Age, or Present Age Timeframes). Again the subject of paleoenvironmental reconstruction, based on limited fossil evidence from two types of settings, remains speculative.

Additional analyses and investigations are necessary to further define and refine the paleosols and fossilized remains found at Big Bend Park within a Creationist Geologic Timescale (Froede, 1995a; Walker, 1994).

Discussion

The Goat Mountain exposure shows that volcanic materials have been deposited, were subsequently eroded, and additional volcanics were deposited again, filling and overflowing the area. The rock record remains unchanged, only the interpretation will vary. The interpretation should be based on the facts as presented by the volcanics exposed at the Goat Mountain outcrop. If millions of years were available for the deposition and erosion of the formations exposed at Goat Mountain, then evidence should be present to support that model. Likewise, if a much shorter timespan were used to explain the rock record then the evidence should exist to support that interpretation also.

Many of the volcanics found at the Goat Mountain exposure were all deposited rapidly, or they would not be welded. This is true whether they were deposited in air or water. If the volcanic materials were deposited in air, they would then be subject to the rigors of chemical and mechanical weathering. This weathering would result in the formation of a soil. With sufficient time plant life would establish itself and further decompose the volcanic rock. If millions of years were available for weathering then at least some, albeit slight, layer of soil should have developed. No soil or paleosol is described or reported at Goat Mountain. Is it possible that every volcanic event destroyed every paleosol horizon before depositing the next layer of volcanic rock? The author believes that to evoke this concept would serve as an ad hoc explanation to justify why no paleosols are found, and this is would not be acceptable within either the uniformitarian or young-earth Flood models.

If the volcanoclastics were deposited rapidly (i.e., subaqueously), and if subsequent erosion occurred due to tectonics and water currents in effect at the time of deposition (i.e., closing stages of the Flood), then no soil would form, there would be abundant missing lateral rock section, and any remaining volcanoclastics would exhibit sharp lithologic contacts. These sharp contacts have been noted at Goat Mountain (Barker et al., 1986, p. 274). The time interval between successive lava flows would be brief and would be limited in lateral extent. If the subaqueous depositional conditions proposed are correct, then the volcanic ash flow tuff deposits would vary with distance and welding would be reduced with distances from the original source area. Each successive layer of welded or consolidated volcanic rock would be rapidly emplaced above the previous layer. The subaqueous environment could have had highly erosive conditions due to possible scouring by water laden volcanoclastics (i.e., epiclastics) coupled with nearby uplift associated with other volcanic features (i.e., the Pine Canyon Caldera and other calderas in the immediate area). The inter-bedded sedimentary deposits could have been washed in from the nearby North American Continent, with the draining of the epeiric sea (i.e., Flood waters) from its surface. The rock sections previously described tend to support this position (i.e., fossil containing sedimentary layers between welded and consolidated volcanic layers, in the Chisos Formation).

However, if the current uniformitarian model is correct in assuming that a stream or river flowed southwest from the Pine Canyon Caldera toward Castolon, carving a channel 900 feet deep, then there should be some physical evidences at the outcrop (e.g., fluvial deposits) which support such an interpretation. None have been described in any of the investigations performed at the Goat Mountain exposure, nor were any observed by the writer. The canyon exposure along the Rio Grande provides a model which should be observed at the Goat Mountain outcrop if a stream or river did in fact flow and carve the canyon seen in cross section.

The sharp contact between the Tule Mountain Trachyandesite (Chisos Formation) and the Wasp Spring Member (South Rim Formation) clearly reflect that nothing developed (e.g., paleosols) or was deposited (e.g., fluvial deposits) between them (Figures 2a and b).

The author proposes that the scouring of the channel possibly resulted as erupting subaqueous calderas generated water-laden volcanics which moved in currents directed by tectonic forces. These water-laden volcanic rock slurries (i.e., volcanic turbidites) served to rapidly erode the 900 feet deep canyon during the Flood Middle to Upper Flood Event Timeframe). An additional possibility could be that the channel was scoured by the Wasp Spring as it flowed subaqueously from its caldera source across the Tule Mountain Trachyandesite. That no fluvial deposits are found can best be explained coupling the erosion with rapid in-filling of the canyon with the Wasp Spring Member (subaqueously) and subsequent Burro Mesa Rhyolite. The rapid erosion, suggested for the subaqueous environment, would not have allowed for the development of typical fluvial deposits. Evidence of the hypothetical river channel (to Castolon) could also have been easily re-

moved along with all the other missing (i.e., eroded) volcanoclastic deposits (e.g., Tule Mountain Trachyandesite, Wasp Spring member, etc.) during this subaqueous period (i.e., Middle to Upper Flood Event).

Fisher (1977) originally proposed a base-surge mechanism for the formation of some U-shaped erosional channels (see also Cas and Wright, 1988, p. 124). The author agrees that the U-shape erosional channel observed at Goat Mountain is a result of erosion. However, it is unknown if this feature formed due to any base-surge mechanism(s). Additional study is required to further investigate this possibility. The U-shaped channels closely resemble typical stream profiles (Fisher, 1977, p. 1295), and the author suggests that the early investigations of the Goat Mountain exposure assumed that the U-shaped cross-section was created by a stream channel. Subsequent investigations have also made the same assumptions, without the physical evidence (i.e., fluvial deposits) to substantiate the original proposal.

While this young-earth Flood model proposal appears to best fit with the evidences seen at this locale, additional investigation of the Goat Mountain outcrop is required to further determine the physical forces and resulting deposits which occurred forming this exposure.

Conclusion

The exposure of the volcanic sequence at Goat Mountain testifies to the power of incredible physical forces in both creating and destroying large amounts of volcanic rock. The defense of either the uniformitarian or young-earth Flood model should fit with the physical evidences observed at the Goat Mountain exposure. The author believes that the Goat Mountain exposure readily lends itself to a catastrophic interpretation and that it can best be explained within the time constraints and physical energy requirements of the young-earth catastrophist Flood model. Deposits necessary to defend the current uniformitarian model and the suggested paleoenvironment (i.e., paleosols, fluvial deposits, and paleontology) are either not present or fail to support the proposed setting.

The author proposes that (within the young-earth Flood model) the Goat Mountain area underwent subaqueous eruption of volcanoclastics which mixed with sedimentary deposits. These deposits were then subject to massive erosion, all of this occurring during the Middle to Upper Flood Event. Volcanoclastics erupted from nearby source areas (i.e., subaqueous calderas) and flowed outward, forming both welded and consolidated deposits. Tectonic forces created water currents which caused massive erosion of the newly deposited volcanoclastics. As a result Big Bend National Park has undergone complex volcanic and sedimentary deposition and massive erosion. The erosion which has occurred across the Park has served to create excellent outcrops of the volcanic deposits (e.g., Williams, 1993b).

The question as to what happened to all the missing volcanic rock remains unanswered. However, the author suggests that it was transported, in whole or in part, toward the Gulf of Mexico with the receding of the Flood waters. Holroyd (1987; 1990; 1994) has pointed to the "missing talus" at other western U.S. sites as being indicators of intense weathering and this author supports that premise and believes that the missing

volcanic rock reinforces the highly erosive conditions (i.e., Middle to Upper Flood Event) under which these volcanic sediments were deposited and subsequently eroded. The present exposures observed across the park are interpreted, by this author, to reflect subaqueous conditions for both emplacement and erosion during the closing stages of the Flood event. Additional erosion occurred throughout the Ice Age Time frame; however, at greatly reduced levels (Froede, 1995b). Only additional research can substantiate this interpretation within the young-earth Flood model. The author welcomes other possible interpretations specifically for the Goat Mountain exposure and for the Big Bend National Park.

APPENDIX I

Ash-Flow Tuff

According to Fisher and Schmincke (1984, p. 91):

Volcanic ash is composed of various proportions of vitric, crystal or lithic particles of juvenile, cognate or accidental origin forming 75 volume percent or more of an aggregate. Tuff is the **consolidated** (i.e., welded-either from the original heat within the mass or subsequent due to diagenesis or tectonic forces) equivalent of ash and is subdivided into fine- and coarse-grained varieties according to the size of component particles. Further classification is made according to environment of deposition (lacustrine tuff, submarine tuff, subaerial tuff) or manner of transport (fallout tuff, ash-flow tuff). Reworked ash is commonly named according to the transport agent (fluvial tuff, aeolian tuff, etc.) [emphasis and parentheses mine].

APPENDIX II

Previous Work by Nevins in a Subaerial Volcanic Terrain

Nevins (1974) has postulated the assemblage of volcanic rock containing mammalian fossils in the John Day Country of Northeast Oregon as dating to the Post-Flood time frame. His justification for this position is presented in "seven points" (Nevins, 1974, pp. 246-248). Some of these points and their relevancy to Big Bend Park, specifically for the Goat Mountain exposure were suggested by reviewers as being appropriate for comparison and are now addressed.

Subaerial Versus Subaqueous Deposition of Basalt

The basalts found in Big Bend, and specifically at Goat Mountain, are for the most part scoriaceous and highly vesicular (see Maxwell et al., 1967, [e.g., Bee Mountain Basalt Member-pp. 132-133]). These physical features would tend to support rapid cooling where escaping gases emitted from the extruded basalts were quick-cooled resulting in vesicular/scoriaceous rocks. The author proposes the possibility of subaqueous deposition for these scoriaceous basalts. No pillow structures have been found; however, the basalts have undergone extensive erosion and these features may not be as readily apparent due to their weathered condition. The author also admits that these basalts could have been extruded into a hypothetical lake (suggested by some) associated with the Post-Flood/Ice Age timeframe; however, the erosion which has oc-

curred in the area is believed to be better explained using the highly erosive conditions associated with the Flood event (Middle to Upper Flood Event).

Subaerial Versus Subaqueous Deposition of Volcanic Ash

Previously cited works (especially Busby-Spera, 1984; 1986) have now firmly established that subaqueous welded ash flows can and do occur. Volcanic ash moving and welding subaqueously involves all fractional sizes, including very fine-grained ash and pumice (see Fiske, 1969; Yamazaki, Kato, Muroi, and Abe, 1973, p. 235; Yamada, 1973).

The author proposes that calderas erupted subaqueously in the Trans-Pecos Area and across the western sections of Big Bend National Park, creating the volcanic strata presently found and interpreted by uniformitarians as being subaerial. The subaqueous setting is believed to be justified based on the types of volcanoclastics found across the Park (and region), and the erosional energy associated with the Flood Event Timeframe. The author does not believe that the Ice Age Timeframe would provide both the volcanic and subsequent erosional energy necessary to explain the hundreds of square miles of volcanic material deposited and then eroded from the Trans-Pecos Region, and more specifically Big Bend National Park.

Local Versus Distant Transport of Volcanic Material

The geochemistry of the volcanic rocks found in the area surrounding Goat Mountain has led scientists to believe that one (Barker, Henry and McDowell, 1986; Dickerson et al., 1990, p. 42) or more (Henry et al., 1999, pp. 259-261) local calderas are responsible for the massive volcanic deposits found at Big Bend. Some of these welded and consolidated volcanic formations contain inter-bedded layers of sedimentary deposits and fossils. This author proposes that these fossils represent creatures which were killed and buried during the Flood. These fossil creatures are NOT paleo-indicators for Big Bend National Park.

Vertebrate fossils are also found in unlithified volcanically derived fluvial deposits in certain areas of the Park. However, these fossil containing formations do **not** consistently yield fossils across the Park, rather the types and amount of fossils found vary from outcrop to outcrop. This author suggests that many of the fossils found in these fluvial deposits represent local fauna, recently migrated into the area (Middle to Upper Ice Age Timeframe), which were probably killed as a result of ongoing but lessening volcanic activity. Hence these fossils were not derived from great distances, but rather locally.

Features Which Suggest a Possible Paleoenvironment

Nevins (1974, pp. 239-240) presents information regarding "upright trees" in the Clarno Formation which he suggests indicate a fossil forest (Post-Flood) which was buried rapidly. However, Austin (1991, pp. 20-23) has shown that upright trees in a volcanic setting might not reflect fossil forests, rather they might reflect water-saturated trees which sank in a vertical orientation and were subsequently buried under additional volcanic sediments. Additionally, Nevins (1974, p. 226, p. 239) cites specific "warm" weather trees, plants and

nuts along with terrestrial vertebrates as indicating a "Mt. Vesuvius" type of eruption which buried and preserved all of this material within one narrow zone of the Clarno Formation. However, Nevins (1974, p. 239) is forced to state that the "mixed" assemblage of fossilized vertebrates do not fit together ecologically. Baldwin (1976, p. 94) stated that the vertebrates found in the Clarno vertebrate locality (near the town of Clarno) represent: ". . . crocodile, fish, horse, tapir, large swamp dwelling rhinoceros, small running rhinoceros, oreodont, and titanotheria, **but practically no small animals.**" (emphasis mine)

If this were a Post-Flood deposit, as has been suggested, and if small plant material such as fruits and nuts were found preserved in those deposits and this was a real ecological setting, then where are the smaller vertebrates which are normally associated with this type of community? Could they have not made the trip across the land-bridge or were they just not preserved? Do these fossils (both plant and animal) really represent a Post-Flood environment? It is interesting to note that Specimen Ridge in Yellowstone National Park also contains a mixture of non-ecologically related trees and that this area is interpreted as reflecting buried upright trees derived from a floating log mat generated during the Flood (Austin, 1991; Morris, 1995).

The overlying John Day Formation also contains an interesting mix of extinct vertebrate and plant fossils, with most of the larger vertebrates identified being grassland inhabitants, living in a temperate and wet climate (Baldwin, 1976, pp. 96-97). The John Day Formation fossils are found in deposits described as "badlands" (Stock, 1946, p. 59). Nevins (1974) provides his interpretation of Post-Flood paleoenvironment based on paleontological assemblage and upright trees; however, a closer examination could suggest other possible interpretations.

Frazier and Schwimmer (1987, p. 634) state that, by the Upper Oligocene, floras found in the John Day Basin resembled those found in the Northwest today. This would appear to confirm the change in climate conditions associated with the closing of the Ice Age, and the beginnings of our modern "uniformitarian" climatic setting. Based on the similarity of past (i.e., Upper Oligocene) to present environments, the author could support the possible interpretation of a Post-Flood setting for the existence and possible burial of the plants and animals found in some of Nevins' John Day Country. However, additional work in the John Day Country could help to resolve these issues, especially in the light of new information gained from the eruptions of Mount St. Helens and volcanic stratigraphy (e.g. Lipman and Mullineaux, 1981; Fisher and Schmincke, 1984; Cas and Wright, 1987; Scott, 1988; Fisher and Smith, 1991).

No upright trees or any other sort of geopetal structures have been identified in the volcanoclastic deposits associated with Goat Mountain, in Big Bend National Park. Nothing found (i.e., fossils) appears to indicate any sort of paleoenvironment. Rather only fossilized broken bits and pieces of bone and wood, along with what are believed to have **been** fresh water snail shells (these snail shells resemble present day species of fresh water snails) are used to reconstruct what the environment might have been like in the Big Bend area.

Fossils found within the unlithified volcanically derived fluvial deposits date to a lower energy environment, which this author suggests would reflect a Middle to Upper Ice Age Timeframe. Volcanic eruptions, associated with the many calderas found both in the region, as well as in the Park, probably continued throughout much if not all of the Ice Age Timeframe. These volcanic releases probably supplied much of the clastics, currently not identified as volcanically derived, on the Gulf Coastal Plain. Additionally, these altered volcanoclastics served to bury and preserve many of the terrestrial environments found in the Cenozoic age deposits.

The author acknowledges that great differences exist between the Nevins (1974) John Day Country strata and its suggested subaerial depositional environment (see Robinson, Brem, and McKee, 1984), and that which is found and suggested as being subaqueously deposited, by this author, at Big Bend National Park (specifically at Goat Mountain). The Trans-Pecos/Big Bend Park region contains hundreds of vertical feet of volcanic deposits spread out over hundreds of square miles, which were subsequently eroded to the point where, in many cases, only buttes and mesas remain. The author suggests that the energy levels necessary to both deposit and subsequently erode all of these volcanoclastic deposits would only be available during the Flood event (i.e., Middle to Upper Flood Event Timeframes).

In recent studies of the various volcanic environments found worldwide, many uniformitarian scientists now recognize and suggest subaqueous eruptive settings. This depositional setting has opened the opportunity to investigate volcanic environments which might have been deposited during the Flood event (e.g., Trans-Pecos, Big Bend, and specifically Goat Mountain). This concept now adds options to the young-earth Flood scientist which allows the possible volcanic site reconstruction within the timeframes and energy levels necessary to support the young-earth Flood model.

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PANORAMA NOTES

Creation Law Debated in Tennessee

In the 1996 session, the General Assembly of the State of Tennessee debated and finally defeated a bill which would have required teachers to treat evolution as a theory rather than a fact. Senate Bill 3229, introduced by Senator Tommy Burks, a Democrat whose home district is 45 miles northwest of Dayton, stated in part:

No teacher or administrator in a local education agency shall teach the theory of evolution except as a scientific theory. Any teacher or administrator

teaching such theory as fact commits insubordination, . . . and shall be dismissed or suspended . . .

When it was debated in early March, the Senate voted 19-13 to send it back to committee for consideration of numerous proposed amendments. The debate also received coverage in the national media. An Associated Press article (Brown, 1996) stated that the bill was originally expected to pass "despite an attorney general's opinion it violates the constitutional separation of church and state."

Historical studies (Barton, 1992) show that the concept of separation of church and state is not in the

Constitution or the Bill of Rights and is an addition by modern, liberal Supreme Court Justices. The first amendment reads:

Congress shall make no law respecting an establishment of religion, or prohibiting the free exercise thereof; or abridging the freedom of speech, or of the press; or the right of the people to peaceably assemble, and to petition the Government for a redress of grievances (Barton, 1992, p. 283).

The language of this amendment does not contain the phrase "separation of church and state." The use of this phrase appears to have originated in 1826 in a letter from Thomas Jefferson to a group of Baptists from Danbury, Connecticut who were concerned about a rumor that the federal government was considering establishing an official state church (Barton, 1992, p. 41). Jefferson was borrowing a phrase from Roger Williams which referred to a wall protecting the church from the "wilderness of the world." Jefferson used the term to refer to a one directional wall which protected the church from government intervention. It obviously did not refer to a wall which prevented discussion of religious concepts in schools, since such instruction was an integral part of education at the time.

Some creationists would not like the Tennessee bill because it would threaten the academic freedom of teachers who happen to think that evolution is a fact. Punishing teachers for using improper terminology will not encourage them to deal with important subjects such as origins. When inadequate curricular materials exist, teachers are not likely to do justice to this subject.

Other creationists point to the responsibility involved in teaching children in public institutions. This responsibility would involve refraining from propaganda, and instead presenting evidence on both sides of controversial issues such as this one (for example, Gish, 1995).

A weakness of the proposed law was that it did not define what is meant by the word "theory." Amendments were considered which would have clarified the definition, but none were adopted. Different disciplines define this word "theory" in different ways. Runes (1960) defined it as:

(1) Hypothesis. More loosely: supposition, whatever is problematic, verifiable but not verified.

(2) (As opposed to practice): systematically organized knowledge of relatively high generality. . .

(3) (As opposed to laws and observations): explanation. The deduction of the axioms and theorems of one system from assertions (not necessarily verified) from another system and of a relatively less problematic and more intelligible nature.

Definition one thus employs the concept of verification. The opposite of this would be falsification, and it might be pointed out that concepts connected to origins are difficult to falsify since they may refer to unrepeatable past events.

When the Senate Education Committee reconsidered the bill it dealt with 16 amendments. Four were adopted, three failed, eight were withdrawn, and one was adopted but later failed. It was adopted to replace the words "shall be dismissed" with "may be dismissed." An amendment was adopted that allowed faulty textbook language to continue to be used until the textbook would otherwise be replaced. Amendment five deleted the phrase about dismissal or suspension altogether. Another amendment specifically declared that no criminal penalties would be allowed under the act. After all of this, the watered-down bill was finally defeated by the Senate and cannot be brought up again until next year.

Some of the amendments, numbers two, six, seven, eight, 12 and 13, tried to define what was meant by the term "evolution." Could the law have been applied to a military maneuver which a teacher referred to as an *evolution*? Should a chemistry teacher avoid the use of the word *evolution* in referring to the evolution of gas in a chemical reaction? Would strict application of the law require the teacher to be fired? The wordings of the various amendments indicated that confusion existed as to just how to define *evolution*.

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Socrates Meets Darwin: A Study in Question Begging

Cf. The Darwin upheaval. One circle of admirers who said: "Of course," and another circle [of enemies-R] who said: "Of course not." Why . . . should a man say 'of course'? (The idea was that of monocellular organisms becoming more and more complicated until they became mammals, men, etc.) Did anyone see this process happening? No. Has anyone seen it happening now? No. The evidence of breeding is just a drop in the bucket. But there were thousands of books in which this was said to be the obvious solution. People were *certain* on grounds which were extremely thin. Could not there have been an attitude which said: "I do not know. It is an interesting hypothesis which may eventually be well confirmed"? This shows how you can be persuaded of a certain thing. In the end you forget entirely every question

of verification, you are just sure it must have been like that.

L. Wittgenstein

Lectures and Conversations on Aesthetics, Psychology and Religious Belief.

The year is 1995. The place is an imaginary after-world from which all aspects of life on earth can be monitored. A gigantic party is underway with all the famous thinkers of history in attendance. Socrates, who is a little more boisterous than usual, weaves his way among the guests, calling out, "Darwin! . . . Darwin! . . . Where is that man?!" Eventually Darwin hears his name being called and answers:

D Socrates! Over here!

S Oh, there you are. Look, I've got to have a talk with you. The matter is serious. I have been following

the development of evolutionary thinking for over 135 years and after listening to the experts I still cannot make head or tail of it.

D What is your problem?

S Well, first of all, I simply do not know what people mean when they say things like “man evolved” or “because of evolution this or that happened.” Now I realize that today even the earthly school children can say the word “evolution” with an air of confidence and understanding. And I also see that the word appears in all manner of magazines and popular books on biology. But do these people really understand what they confidently talk about? I mean, it is possible to fit a supposedly technical word into an informal conversational sentence without making a grammatical mistake, and still not have a fig of a notion as to what one means by it. It seems to me that nothing but the vaguest of ideas is being traded in all this talk about evolution.

D You ought to realize, Socrates, that scientific words have a way of slipping their moorings in the technical disciplines and drifting into the mainstream of everyday conversation. And when they do, not everyone who uses these words has a clear understanding of their meanings. Practically every discipline suffers because untrained people use its jargon vacuously, usually because they want to impress their friends. But for every one hundred people who mindlessly parrot a scientific term like “evolution” there is probably at least one person who can explain its meaning. Also, you must not assume that because a technical term comes tripping off the tongues of individual discussants in a conversation they do not know what the word means. It would be very awkward indeed if a person always had to explain the underlying concepts of such terms in order to speak intelligibly. It is precisely because some words stand for a whole cluster of concepts that they find their usefulness as shorthand notation in scientific discourse.

S Well said, Darwin! You are just the man to explain this whole business to me. Please tell me then what evolution is.

D You suggested that you are familiar with the literature. Surely you do not want me to start with the basics.

S Yes, I do. Be as simple as you can without sacrificing the truth, because I must have missed something at a very rudimentary level.

D The word “evolution” simply means “change”; and the scientific theory of evolution is the theory which states that organisms have gradually changed from the most simple forms into the most complex forms, beginning with unicellular organisms and ending with man—at least ending for the time being. This gradual change took place during the course of millions of years and its basis in fact has been established by the observations of science. The best way to. . .

S But do not scientists today speak of evolution as a fact? You say it is a theory. Which is it?

D Yes, you can say that it is a fact. The theory is based upon observed facts and. . .

S But is the process of change itself observable? I mean that change to which, presumably, the word “evolution” refers.

D Yes! Now will you please stop interrupting and let me continue?

S I’m sorry. Please continue.

D As I started to say, perhaps the best way to see this change is by examining some of the more important explanatory parts of the theory. First, the structural explanations of the theory of evolution explain the similarities of body structure found among organisms of widely diverse species living today. For example, although the whale, the bat, the horse and man are members of quite diverse species, their appendages exhibit marked similarities. The flipper of the whale, the wing of the bat, the leg of the horse, and the arm of man are all structurally alike, even though they are functionally different. Evolution explains the presence of these structural similarities by pointing out that the organisms of these diverse species have an ancestor or ancestors in common from which they have descended. Over many years of descent from a common ancestry these different organisms have changed; though not enough to erase the structural similarity we still observe today. Descent, with change, from a common ancestry also accounts for the presence of vestiges in many different organisms. You must have read that vestiges are remnants of larger and once useful body parts—organs, appendages, etc.—which have atrophied through lack of use as the whole body of the organism descended and changed. For some reason these original parts did not disappear completely although their functional contribution to the organism disappeared. The vermiform appendix in man and the wings of flightless birds are two familiar examples commonly cited.

S All of this sounds disturbingly familiar. You see it is this business about descent and change that bothers me. I asked you what evolution is; you said that it is the change of organisms from one form into another. Further, you said that this change can be seen by looking at the structural similarities between members of diverse species, which presumably illustrate the change in question. But since I have only the vaguest notion as to what this process of change is like, it is hardly enlightening to point to the perceived structural similarity between organisms and to their vestigial organs as evidence of this change. In other words, the idea of descent with change is what I am asking you to explain; but you have presupposed it with your reference to similar structures and vestigial organs. Unless I have missed something, this looks like a subtle species of question begging.

D Look, the evidence is as clear as the nose on your face. How else can we account for these similarities between life forms? Why should these organisms exhibit a similar structure unless in fact they had descended from a common ancestry?

S I can’t see the nose on my face very well and neither can I see very well this vaguely conceived change you speak of. If you are going to start asking “why” questions at the very general level of structural similarities between organisms can you not exercise your imagination and think of something which has greater conceptual definition than “descent, with change, from a common ancestry?”

Of course, I do not know the answer to this biological riddle, but I can think of at least one theory which will account for such similarities. Perhaps the god which sent me on my philosophical mission to the people of Athens devised a good plan by which to make the species of his creation function well. He may have used the same basic structural design in many diverse species, much the same as automobile manufacturers today on earth retain the same basic design for different models. The same design, with modification, can serve many purposes. Just as you asked *your* "why" question, so I can ask *mine*. "Why should a creator throw away a perfectly useful basic design?"

- D You can't be serious! That is a preposterous notion. The scientific community generally rejects such antiquated thought.
- S That may be a true statement about what most scientists believe, but surely you are not suggesting that truth in science is established by counting the beliefs of scientists, are you?
- D Even if I were so backward as to entertain the possibility of such a creation, your theory still would not work. Just because similarities between the structural designs of automobiles can be accounted for in terms of a modification of the ideas of the inventor or manufacturer, it does not necessarily follow that the structural similarities between organisms can be accounted for in the same way by referring to a creator of living organisms. Change in complexity and in apparent design can be accounted for in more than one way.
- S True enough, but this establishes my point. Just as it does not follow necessarily that the developmental changes in automobiles and the developmental changes in organisms are the result of essentially the same kind of process, neither does it follow necessarily that those changes are *not* the result of the same kind of process. They both could be the result of creative planning. And at this level of observation, where you seem to see evidence of evolutionary change I merely point out that there is a good alternative way of explaining the same perceived phenomenon of structural similarity. But more importantly, my idea of creation gives an intelligible account of what the change is and how it is to be conceived: namely, a creative change in the basic plan of the god. Your notion, however, still lacks definition; it presupposes that some kind of change occurred within nature and among different organisms. You have yet to conceptually identify for me what this change is which presumably is at the heart of evolutionary theory.
- D You might be able to conceive of possible alternatives to evolution but you cannot dismiss the facts which evidence evolutionary change.
- S But that is precisely the point of contention. What is factual is not changing, at least not to the degree needed to transform one species into another. All the organisms which you claim have descended from a common ancestry—the whale, the bat, the horse and man—have not changed into different species throughout the thousands of generations of their observed existence. Furthermore, any of the organisms which you may imagine to have been

their ancestors and which are still living today—some of the reptiles, for example—also have not changed throughout successive generations of their offspring. The change which is supposed to distinguish evolution as an important scientific fact is precisely what is lacking when we examine it. And speaking of the facts, as your disciples today are wont to do, the evidence you adduce in support of this vaguely conceived notion of change is highly suspect. In reference to your own example, I have noticed over the years that as the knowledge of animal physiology has increased, the number of vestigial organs so-called has dwindled drastically. Earlier in the history of evolutionary theory some biologists writing on the topic listed more than 180 of these rudimentary structures. The human body alone became a veritable museum of evolutionary remnants. But today I see that most textbooks which treat the subject at all list only about six vestigial organs, with of course the vermiform appendix in man still being given the most prominent place. Unfortunately the category of "chief vestigial, organ" has itself become vestigial; because immunologists now do not think that the appendix is a useless remnant. The role of the appendix in human immunology is well established.

- D So, what are you ultimately saying Socrates: that with a few examples like those you can overturn the scientific theory of evolution? I suppose the next thing you will tell me is that the entire fossil record is also not a fact! What do you propose we do with the countless fossils laid down in the strata of the earth's crust in such a fashion that only the most obtuse observer could fail to get their message?
- S I have always been slow to understand popular concepts. Will you please tell me what that unmistakable message is that you get from the earth?
- D Come now, my friend! You must know that fossils have been laid down in the earth's strata in a clearly discernible pattern. The pattern I refer to—as I think you already know—is the gradual and progressive change in complexity of the life forms which have been fossilized. Beginning with very simple organisms fossilized in the Cambrian layers, you can see, as you move up through successive layers, a graduated complexity in the forms of life, until you reach the most complex organisms in the most recent layers at the top. The unmistakable message is that simple organisms have progressively changed or evolved into highly complex organisms.
- S You asked me what I proposed to do with the fossil record. I do not propose to do anything with it except seriously try to give it the most sensible interpretation, and I must say that your interpretation does not strike me as the most sensible one. Your traditional account of the fossil record manifests the same weaknesses as your so-called structural explanations. First, the alleged facts upon which you construct your theory of evolutionary progression—whatever that is precisely—are not nearly so factual once you look carefully at them. Second, given an account of the facts as they really are, there is a better alternative explanation than evolution: as I said, a creative change in the basic plan of the god.

You claim that the fossils evidence a gradual progressive change in the complexity of life forms, beginning with simple organisms in the bottom layers and ending with complex organisms in the top layers. But unfortunately the evidence cannot be made to conform to such a simple account. In actual fact the change one observes is neither gradual, nor progressive, nor does it begin with simple organisms.

Whatever you wish to say about those life forms at the bottom of the evolutionary ladder, organisms such as sponges and protozoa, you ought not to say that they are simple. Contrary to public opinion the story of evolution does not begin with simple organisms, but with very complex ones. Even single-celled organisms exhibit a degree of complexity which is awe-inspiring. It seems to me that accounting for the composition, structure and sophisticated functions of such allegedly primitive organisms is a major problem for the theory of evolution. As well, among the oldest fossils one can find evidence of prehistoric animals which seem to have been at least as complex as modern animals; perhaps more so. Therefore, because the organisms whose remains are found in the deepest strata are not "simple" in any ordinary sense of the term, and because the remains of highly complex animals are found where they should not be found if evolution is true, it is a misrepresentation of the facts to simply say that the change which fossils exhibit begins with simple organisms or that it always progresses from simple organisms to complex ones.

But worse still, the changes from one organism to another which the fossils are supposed to exhibit cannot consistently be called gradual. Within many important sections of the geological column where you find a succession of fossils, from less complex in the bottom layers to more complex in the top layers, the succession is not gradual! At many junctures within these sections there are tremendously large jumps in the complexity of organisms, with no trace of a series of graduated intermediate forms to account for the alleged evolutionary change. Doesn't evolution here become a kind of "god of the gaps?" Where, for example, are all the intermediate forms between birds and reptiles? I can see no way that such leaps in complexity can be accounted for by a theory which relies so heavily upon the "long - long - ago - over - a - long - long - time" theme in its scenario. Even 100 million years of sedimentary deposition cannot begin to account for the colossal jumps in the complexity of these life forms. Is evolution consistent with its own canons? Don't you see . . .

- D Now hold on just a minute! You talk so simplistically, as though evolutionary development were a simple linear progression laid out like beads on a string. You will do much better if you think of it as a progression, using the model of a tree. Granted, several of the branches are missing, which we shall probably be able to draw in some day, but the main outline is there. Evolution has been a very complex process which we do not completely understand, but I am confident that eventually we shall understand it and thereby clear up the major problems that remain.

S I wondered when you were going to use that old ploy. You appeal to scientific ignorance of the workings of this allegedly complex evolutionary process, but at the same time assert the existence of that process by emphasizing its inscrutability—when all the while the very existence of *the process itself* is precisely what is in question! It is in question because there is neither a clear referent for the phrase "evolutionary change" nor unambiguous evidence to support the evolutionary ideas of change even supposing the referent for "change" were clearly given. How is it that although you do not have the requisite fossil evidence to support evolutionary theory you still know that evolution occurred? And how does its occurrence gain existential status in the deep recess of your ignorance? My response to your claim that there is so much about the workings of evolution that we don't understand, is: how do you know that it is evolution that *has* been working?

D Obviously because we can see clearly the broad outlines of its work.

S You are still begging the question. The vital evidence you need to support the claim that it is evolution's work which is broadly outlined, and not the work of some other force, is missing. Do you not see that by the same kind of reasoning you could say that a few different colored dots on a canvas are, without further evidence, the broad outlines of a Rembrandt. There is no disanalogy here because, contrary to popular belief, it is not in fact the case that just a few branches are missing from the tree of evolution—whole sections of the main trunk are missing! The onus is not upon me to see how much I can exercise my imagination by filling the blanks; the onus is upon you to provide evidence which will support such an imaginative theory. It is your responsibility to produce the important missing pieces: not mine to trail after your flights of imagination.

D Socrates, I now think I see your problem. You fail to make a distinction between the results of evolutionary change and the process of change itself. Obviously we cannot observe the change which modified all those species in the past; but we can infer the existence of such a change from the fossil remains.

S Be careful now. You are wandering in a circle. We have already discussed the gappy fossil record. Let us not wander back to the fossil remains and what we are *supposed* to be able to infer from them; for we have seen large problems along that path. You seem not to be grasping the main point of my criticism. When you say "results of evolutionary change," notice: you assume that the "change" has taken place; when in fact it is precisely this change that I am asking you to substantiate. What you desire to call the "results" of change I have argued are really the deficient beginnings of your case for evolution. Logically you cannot call these weak beginnings "the results." Furthermore, it is not only that the fossil record is lacking in evidence—it presents contradictory evidence. Not only are many fossils missing which should be present; there are many fossils present where they should be missing.

Let me illustrate the point. Suppose that an earthling walks into his dining room in the morning and

sees a beautiful vase on a table. Later that afternoon he returns to the dining room, but this time he sees the vase smashed in pieces on the floor. There has been a change all right, but the "how" of that change may not at all be clear. Was it the cat, an earth tremor, a human hand, gravity, the wind, or something else? Unless he has more evidence than just the memory of the unbroken vase in the morning, together with the spectacle of smashed pieces in the afternoon, it is presumptuous of him to single out any one of those agents as being responsible for the destruction. Notice, however, that he can bridge the gap between his remembrance of the vase intact and his perception of the broken pieces before him, by using his imagination. But if *all* that he uses to bridge the gap is his imagination, then the change which he proposes—for example, the movement of the cat's tail against the vase—is merely a conceptual change, with no basis in fact. He needs more than a jumping imagination to account for change in the world around him. The need for evidence of a specific kind of change is much more acute in the case of evolution; because there you want to argue not only that a change took place in nature itself, but that simpler organisms changed into more complex organisms, by chance. Unlike the change in the vase, the notion of evolutionary change is counter-intuitive; it is especially important to fill in the gaps with something more than the imagination. I am not denying, for example, that reptiles are different from mammals. And there is of course a *conceptual* change which one must make in moving from his thoughts about fossils of reptiles to his thoughts about fossils of mammals. But unless one has something more to offer than the catch phrase "because of evolutionary change," his ideas remain groundless. The "how" of evolutionary change is not, as many scientists seem to think, a non-essential extra to be filled in at some later date. It is the very heart of this putative process. If the "how" of evolutionary theory cannot be identified and coherently described, and if clear non-contradictory evidence at the crucial points cannot be given in support of the theory, then, to speak of "evolutionary change" as a distinctive occurrence within nature is to speak vacuously.

- D You keep harping on this business of change, as though evolution had been discovered yesterday. You said that you have been reading the literature. Have you not read anything about natural selection and genetic variation?
- S Yes, I have—and you would have done as well if you had read Mendel instead of leaving him alone on your library shelf—he is, after all, the father of your theory, is he not? But never mind, like the rest of evolutionary theory, I cannot make head or tail of natural selection and genetic variation. Now, I will stop harping if you change your tune.
- D Speaking of "old ploys," that one of playing the dummy is wearing rather thin. I remember your tricks. Let me guess: now you want me to give you a basic lesson in the mechanics of evolutionary change?
- S Yes, indeed I do! And let me assure you that my ignorance is not feigned—I really do not understand

all this business. That is why I have come to you, the expert.

- D Well, when I first conceived of the theory of evolution I accepted the Lamarckian assumption that hereditary changes are produced by the environment. In order to adapt to a particular environmental niche for which it was not viably suited, an organism acquired the characteristics necessary for survival. The environment, so to speak, urged upon the organism the acquisition of these characteristics—or, so we thought. In addition, I also thought that, corresponding to this change in the organism's characteristics, hereditary changes were somehow produced, such that the newly acquired characteristics could be transmitted to succeeding generations. All of this of course was before the advent of genetics. It is now believed by those who still accept my basic evolutionary model that the mechanisms of change are different. Neo-Darwinians hold that hereditary changes are the result of gene mutations. Simply stated, instead of saying that the environment produces adaptive changes which are hereditary, it is now said that hereditary changes make adaptation possible. Changes in the genetic makeup of an organism alter that organism in such a manner as to *prepare* it for an environmental niche into which it can emigrate. This genetic preparation is sometimes called preadaptation. Let me give you a simple illustration. It is often discovered that the inhabitants of caves are blind and possess highly developed tactile sense organs. According to my old view, the darkness forced the would-be cave inhabitants to give up using their eyes and acquire an acute sense of touch. The revised Neo-Darwinian view says that this is putting the cart before the horse. Actually, the would-be inhabitants must be equipped to survive before they emigrate to the caves. That is, they are preadapted by a genetic mutation which results in a heightened tactile sensitivity.
- S Please forgive another simple-minded question, but why would anyone think in the first place that organisms adapt to their environments, either in the manner you first proposed or in the manner proposed by your followers today?
- D Well, obviously, because of the compatibility which exists between organisms and their environments. It must surely be evident even to your critical mind how well organisms and their environments fit together: the environment being suitable to accommodate the organism and the organism being fit to exist in its environment. This harmonious state of affairs can be observed everywhere on earth.
- S But have these adaptations of new organisms to new environments ever been observed? I do not mean just those changes in parts of an organism such as tails getting longer or fur changing color, etc., as a result of cross-breeding within the same species. These confined changes were observed and well known to everyone hundreds of years before the word "evolution" gained any currency. I mean, has anyone ever scientifically observed a radical change in an organism at the specific or even sub-specific level, such that the radically new organism could fit into a radically new environment? Or, has anyone even observed an organism like the bat

losing its sight, then gaining a heightened sense of touch and hearing, and then emigrating to a radically new environment like a cave where it continued to live and reproduce offspring similarly adapted?

D Of course not. Natural selection at the level you are asking about cannot be directly observed. It is a very complex process which has taken a great deal of time.

S But would you not agree that adaptation at that level has got to be established before evolution may be called an explanatory scientific theory about how organisms have radically changed?

D Certainly the changes must have been radical but the . . .

S Well, if small changes such as the variations in the size of an appendage, or in the color of some body part, cannot provide the evidence needed for the appearance of these radically new organisms, upon what basis do you argue that such large scale changes have occurred which enable an organism to adapt to a radically new environment?

D I have already told you; upon the basis of the harmonious interaction of organisms with their environment. The organisms must have changed dramatically in order to fit into new environmental niches.

S Let me understand what you are saying. You say that organisms and their environments fit together?

D Yes, that's right.

S And they fit together because the organism adapts to its environment?

D Correct.

S And when I ask you how you know that the organism does adapt to a radically new environment you say, because the organism and its environment fit together.

D Yes, that's my position.

S Don't you see that you're arguing in a circle? You jump from the observed harmony in nature to the mysterious conclusion that organisms change dramatically and then adapt to a radically new environment, providing no other factual support for this grand inductive inference than the obvious facts about harmony with which you started. It seems that evolutionists use the notion of "fitness" both as a starting observation and as a concluding explanation. The only facts involved in your case for natural selection are those which are obvious and agreeable to everyone before any inferences are drawn. As a description of the way organisms and their environments are suited to one another, part of your account is unobjectionable; but as a putative explanation of how organisms have come into being, natural selection really does not provide an answer. At best we may learn how some existing organisms survive a radical environmental change—such as black moths in sooty trees—but not how they radically change in surviving. I repeat my former criticism of putative "evolutionary change": the change that you need to demonstrate is precisely what you assume throughout your whole account. And, if you are going to take such liberty with inductive inference you should not object to an alternative inference of no greater breadth which is drawn from the same observations about natural harmony.

Why not infer that the delicate balance of nature everywhere observed is the work of a god who . . .

D You might have gotten away with that kind of argument in your time, or even one hundred years ago, but not now. I think that I have already made it plain that the idea of genetic variation forms an integral part of evolutionary theory as it is taught today. No one any longer speaks about natural selection without saying or implying that genetic variations form an integral part of the evolutionary process.

S Well then, are you now admitting that the main support for the belief in evolutionary change is found in genetics? I should soon very much like to get to the foundation of this whole matter.

D Yes, you could say that. The evidence for change you so eagerly seek is found in the fact of gene mutations.

S But is there really any scientific evidence—I mean solid data; not fanciful theorizing—which shows that a mutant form of an organism can change it into anything like what is needed to reproduce a new species?

D Come now, you must surely have read about the mutant forms in plants, animals, and insects. Are you not familiar with the fruitfly experiments? Countless mutants of the *Drosophila* have been observed and written up in the literature.

S It seems that you are not the only one who thinks he is not being heard. I have just asked a question the thrust of which you seem to be completely ignoring. The weakness of the genetic explanation for evolution lies precisely in the alleged evidence you advance in support of it. Even if the highly improbable occurred, that is, even if a thousand of such mutants occurred in one and the same fruitfly, you would still not have an organism whose total change represented anything like a new species actually found in nature. And what is important here of course is that such a large scale change never has been observed.

D I do not know what literature you have been reading, but a mutation which can change an antenna into a leg is quite a powerful piece of evidence for the mechanism of evolutionary change.

S That is a very misleading description my friend. What you are suggesting is the origination of a new complex structure, a leg, is really just the switching of an already genetically encoded structure to a new location, the place of the antenna, where it then develops. What is worse, however, is that this sort of aberrant switching is disadvantageous to the fly, even if, hypothetically speaking, one could say that some new genetic material were being added to the blueprint of the fly, which definitely is not the case. If you are going to gain any distance with the genetic argument you will have to show that an organism can create new genetic material which increases radically the complexity of the structure or function of the organism, thus enabling it to adapt to a radically new environment. If, for instance, we have evolved from protozoa, where did the genes for a nervous system, bones, etc. come from? There is a huge gap here which needs to be filled.

D Even so, the small genetic changes that we do observe provide us with a good working idea of how

- large scale changes in organisms *could* have occurred and thus produced radically new organisms.
- S Has anyone ever observed these grand genetic changes which you imagine *could* have been the impetus for evolutionary advancement?
- D No, of course not, but just because they have not been observed, it does not mean that they did not occur! You have not shown that such changes could not have happened.
- S No it does not—but neither does it mean that they *did* occur. But, since you are the one advancing the theory, the onus is yours to establish its truth. It is not my responsibility to satisfy your impossible request, to show that some imagined events, such as large scale genetic changes which, as purely imagined events, are not logically impossible, could not occur. That kind of demonstration cannot be provided in any world, let alone be provided in evolutionary theory. Nor is it ever a reasonable request that it should be provided. How, for example, would you ever demonstrate that a creator could not possibly exist? You must base your case for evolution on positive available evidence—unless of course you decide to give your ideas, as they now stand, a more suitable title: “a poetic vision” or “a secular faith” or something similar. I am afraid that you have not yet felt how heavy the burden of proof is which rests upon your shoulders.
- D And you seem to have something against speculation in science. In fact, you misrepresent the scientific process. Listen, it would be ridiculous for scientists to formulate only theories for which there was already confirming evidence. Surely it is not necessary to present the confirming evidence for possible advantageous macromutations before I theorize that they have occurred?
- S I have nothing at all against speculation, in science or anywhere else. I only wish that you—and especially your followers—would call it exactly that, instead of making grandiose claims about the evidence for evolution. You give everybody the impression that evolution is firmly grounded on facts. You claim that genetics has the answer to the questions of change which I have just been pursuing. And yet when the truth is told, *either*, the changes which can actually be observed are small, not radical, and most often disadvantageous to an organism, thus providing no relevant evidence for the large scale changes required by evolution; *or*, the changes are large but non-existent, purely products of your imagination, having no basis in fact. So, in either case the foundational support for the claim that evolution has occurred has yet to be established.
- D I grant you that the theory may have some weaknesses in each of its various explanatory parts, but when the explanations are taken altogether, I think you will have to admit, they present a very convincing account.
- S That’s like saying that although one leaky bucket will not hold water, 10 leaky buckets *will*.
- D It depends on how far you want to carry the water!
- S Yes, and how big the holes are! But to carry the progressive development of life forms all the way from *noncellular* organisms to man? That is a very long way, my friend. You began by discussing structural similarities and vestigial organs. When I pointed out that your account not only contained factual mistakes but also presumed without justification the answer to my basic question of evolutionary change, you directed our discussion to the fossil record and the supposedly unmistakable pattern which is exhibited there. When I pointed out further factual errors and emphasized again your persistence in assuming without warrant the very change in question, you then led us into a discussion of what are apparently the dual pillars of evolutionary theory, natural selection and genetic variation. And now after I have once again pointed out that even in the genetic account radical change is being assumed, not evidenced, you still want to go back over this whole business and say that somehow all the missing supports for your theory are able to make it stand. Is that not an odd kind of argument?
- D How else can we account for the existence of complex life forms?
- S Goodness gracious! You are surely not suggesting that a bad theory is better than none at all? Has it never occurred to you to say, “I do not know”? You ought to read Wittgenstein.
- D But no intellectually respectable scientist today could doubt it!
- S That is the problem with you people. You hold your theories with such religious fervour that you cannot detach yourself from them long enough to ask a few basic questions.
- D And the problem with philosophers is that they are always preoccupied with semantics. Clever word play, that’s all!
- S I have never pretended that philosophy is anything but the art of asking uncomfortable questions about fundamental assumptions. Say what you like against philosophers, but that will not remove the serious criticisms which hound your theory.
- D Do you realize what you’re suggesting? Are you asking me to believe that all of these venerable men of science are misguided because they do not have any clear idea of evolutionary change? One should not dignify the suggestion with a response.
- S I do not know this, but let me tell you what I *think* is the main reason for the perpetuation of this conceptual confusion. The pseudo-explanatory force of evolutionary theory derives its psychological power from the fact that anthropomorphic terms within its narrative are readily understood in non-scientific speech contexts.
- D What in thunder does that mean!?
- S Consider the fanciful character of the stories that are spun around the fossil remains. We read about vertebrates who left their aquatic environment and developed limbs by a happy accident. And with their newly developed limbs these amphibians learned to linger about the drying pools. In the story of the descent from the trees we read of men-like, tree-borne primates who became earth-borne creatures. They assumed an erect posture, lengthened and strengthened their lower limbs; and the latter became organs of the mind. A more anthropomorphic story would be difficult to write. It is hardly a step at all to imagine a group of turtles getting together for a conference to make plans for an exploring expedition.

Of course if these action verbs and nouns are read anthropomorphically then the conclusion towards which the evolutionary argument moves is assumed at the outset. Presumably the lower forms of life somehow developed into the complex form called man. Therefore, in the beginning they did not possess, even at the amphibian stage, the motivation and ability to direct their destinies, as man is able to do. To smuggle into the language of explanation the suggestion that they did is to gain a psychological support for the central thesis of evolution which needs to be established legitimately by non-semantic means.

This dramatic-scientific story of evolution is conceived so generally that it can accommodate almost any idea, which in fact it does. Not only does it deposit in its store the scientific jargon of "fossils," "strata," etc., but it also incorporates with ease the anthropomorphic language of epic poetry. The scientist learns to speak in one breath of "carbon dating," "developing limbs" and "happy accidents." His narrative explanation admixes science and saga, with a strong emphasis upon the latter. And the anthropomorphic action terms find ready acceptance in the minds of readers because their minds are accustomed to using such terms daily in ordinary sensible contexts. For example, "the development of limbs" is thought to convey something intelligible because "the development of muscles" or "the development of talent" are perfectly sensible. It is this practice of semantic borrowing which makes popular books on evolution so saleable. People see beautifully colored charts and read in the captions below all about the saga of evolution. Even the children can repeat with confidence the story of "amphibians developing limbs" and "reptiles taking to flight." And all of this is done with an air of clear understanding, as if evolution were really being explained.

- D Socrates, I am afraid that you have now stepped out onto a very long limb from which, sadly, there is no return. Don't you realize that no scientist in his senses would claim that these narrative accounts explain *how* evolution occurred? They serve merely as an heuristic device, that's all.
- S Are you saying that these accounts are used only for teaching purposes and are not intended as explanations of the evolutionary process?
- D Yes, that's right.
- S That leads me to ask two questions. If the narratives are meant to be taken only as a kind of grand mnemonic, then ought not the writers of these accounts say so unequivocally, to make clear the metaphorical nature of their language? For it certainly seems that they intend for the narratives to be taken as explanations. My second question, however, leads me to doubt your easy interpretation of these narratives. In order for the story of evolution to represent the truth it must surely be based upon a knowledge of the mechanisms for evolutionary development—otherwise there is no guarantee that the story corresponds to the actual developmental process which it merely wants to picture. But if that is the case, what are these known mechanisms of progressive radical change in the development of organisms?
- D Natural selection and genetic variation, of course!

- S But you're arguing in a circle again. We have already seen that there is nothing in genetics which can account for the radical changes required by your theory. And now you want to base the epic, "protozoa to man," on this foundationless support.

You know, Darwin, the longer I talk with you the more questions I have. Could it be that the theory of evolution is not only a question-begging argument, but something even more problematic? Is it even empirically significant? I mean to ask, does the key phrase "evolutionary change" have an empirical referent?

If one tries to discover how evolution works he is told that the causal factors involved are not observable, not repeatable, not simple, and not agreeable to all scientists. And if one wants to see this negative qualification on a grand scale he need only look at the history of the subject. When Lamarckism and Darwinism failed, evolution succeeded. When Vitalism and Finalism failed, evolution still succeeded! Even though Neo-Lamarckians and Neo-Darwinians have been at loggerheads about crucial matters, evolution supposedly stands above the confusion and contradictions.² What is this change called "evolution" which survives all the vicissitudes of its vague and contradictory explanations? How does this alleged process, which cannot be repeated or observed or even specified, and whose supporting explanations of natural selection and genetic variation crumble beneath the weight of logical-empirical analysis, differ from no process at all?

- D Enough! I do not want to hear any more of this nonsense. What you are saying is silly! Be gone!

Socrates calmly turned and walked away, and as he cleared a path among the guests he was heard muttering to himself, "I wonder if Freud is here. Perhaps he can help me understand what Darwin said."

Endnotes

1. "A theory may be described as 'vitalistic' if it purports to give a systematic explanation of evolution in terms of some unique non-natural agency" such as "the 'life force,' 'elan vital,' entelechy, etc." (Goudge, p. 80)
 "Just as vitalism is not necessarily finalistic, so finalism is not necessarily vitalistic. For the core of finalism is the contention that a necessary condition of evolution consists of its orientation towards an ultimate goal." The goal may be reached by "mechanically determined processes." (Goudge, p. 81)
2. Neo-Lamarckism holds "... that the effects of use and disuse [of parts of an organism], together with other environmentally induced changes, can become fixed in the hereditary equipment of species . . ." (Goudge, pp. 85,86)
 Neo-Darwinism, simply stated, is Darwinism *without* the Lamarckian assumption that hereditary changes are produced by the environment, and *with* the assumption that heredity changes stem from genetic variation in the organism. A complete account would be much more complicated than this and would reveal that Neo-Darwinians differ significantly in their evolutionary views according to the theory of mechanism for genetic variation and natural selection which they hold.

Disclaimer and Acknowledgement

Over the past 12 years or so we have seen published a spate of books which challenge Neo-Darwinism. Authors who come to mind are P. E. Johnson, D. Davis and D. H. Kenyon. Spirited defenses of Neo-Darwinism have been mounted by many authors, two of the most prominent of them being S. J. Gould and M. Ruse.

Neither in writing this dialogue nor in revising it have I borrowed from these more recent authors, its main thesis having been written well before the relevant works of these authors appeared.

I must, however, thank Jon Buell for reading the unrevised dialogue and making several helpful suggestions for its improvement.

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This dialogue descended from an unpublished paper of 57 pages written long ago, titled "The Language, Truth and Logic of Evolutionary Theory." That paper in turn derived some of its nourishment from the following works.

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BOOK REVIEW

After the Flood by Bill Cooper. 1995. New Wine Press. Chichester, West Sussex, England. 256 pages. \$14.95
 Reviewed by John Kaplan*

Readers who have followed Bill Cooper's series on the early history of man in *Creation Ex Nihilo Technical Journal* will want to own this book. *After the Flood* fills in many of the blanks concerning early post-Flood history. The chronicles include king-lists of the ancient Britons, Anglo-Saxons, Danes and Norwegians, and Irish Celts. By its very nature a book of this type is very challenging to assemble into a readable format but the author has succeeded in producing an enjoyable book.

God was known by the early pagan peoples after the Flood and atheism did not originate until later. Quotations taken from the Taoist Lao-tzu, from Heliopolis in Egypt, and Xenophanes in Greece all note the existence of a transcendent Creator. For example, a statement from China in the sixth century BC reads:

Before time, and throughout time, there has been a self-existing being, eternal, infinite, complete, omnipresent . . . Outside this being, before the beginning, there was nothing (p. 16).

Materialist philosophy is credited by Cooper as being first recorded by Anaximander (c. 610-540 BC), a pupil of Thales of Miletus. Arguments favoring a creator from design by the Roman Cicero are almost identical to those of today.

Brutus, the first king of the Britons reigned during the time Eli judged Israel (1115-1075 BC). His lineage is traced back all the way through Javan to Japheth to Noah. He discusses the origins of royalty (pp. 112-113) noting the well-known fact that all the royal families of Europe are interrelated and suggests that they can all be found to be descended from Javan through Iobaath. This Iobaath possibly came to be deified as Father Jove. Various names in the royal line are easily recognized such as King Leir (Llyr) of Shakespeare fame who ruled for 60 years (c. 861-801 BC), Coel (Old King Cole) founded the city of Colchester and ruled c. AD 306-309, and of course King Arthur (c. AD 521-542).

Some of the source materials used are the early works *Historia Brittonum* by Nennius and *Historia*

Regum Britanniae by Geoffrey of Monmouth. The author defends these writings from allegations of forgery and lying by modernist scholars seeking to dismiss any genealogy which discloses the young age of the earth. In comparing ancient sources of the record from Japheth to Brutus five diverse sources are used including Virgil's *Aeneid* and Livy's *Early History of Rome* (pp. 241, 242).

Very interesting quotes concerning dinosaur-like creatures are presented, the author pointing out that nearly 200 places in the British Isles are the sites of such activity. Reports of winged serpents, "monsters," dragons and giant reptiles are documented until comparatively recent times. An encounter from Suffolk in 1405 reads

Close to the town of Ures, near Sudbury, there has lately appeared, to the great hurt of the countryside, a dragon, vast in body, with a crested head, teeth like a saw, and a tail extending to an enormous length. Having slaughtered the shepherd of a flock, it devoured many sheep (p. 133).

Local archers were unable to penetrate the hide of the beast but eventually drove it away.

The book contains 14 appendices, all worth reading. The nations descended from Shem, Ham and Japheth are examined from several secular sources together with the locations of their settlements in the first three appendices. A number of these early ancestors were deified and worshiped. Japheth became known as Jupiter. Nimrod was known as Nimurda, the Assyrian god of war and Morduk the king of the gods of Babylon. He was worshipped by the Romans as Bacchus which was derived from the Semitic bar-Cush. Tiras was worshiped by his descendants as Thuras or Thor.

Receding ice sheets may have been observed by early colonists of Ireland (pp. 251-252). These settlers coming from the warm Mediterranean were unfamiliar with ice at sea and some of their boats were wrecked by it. New rivers and lakes also developed during the second colonization of Ireland, presumably from melting ice-sheets.

Cooper has arranged numerous records together into a readable text which is both interesting and a good reference to have at hand.

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OPPORTUNITIES FOR CREATIONIST STUDIES AT THE HANSON RANCH, ROXSON, WYOMING

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Abstract

The Hanson ranch at Roxson, Wyoming, has been made available to a limited number of investigators interested in documenting its deposit of Late Cretaceous dinosaur bones in the Lance Formation. A preliminary description of the site and some possible research topics are suggested.

Introduction

The Lance Formation of Eastern Wyoming has been the source for numerous dinosaur bone excavations. In the region of the Hanson Ranch, the common types unearthed have been *Hadrosaurs* (duck-billed), *Triceratops*, *Tyrannosaurus rex*, and *Pachycephalosaurus* (thick-head). Representative fossils are in several museums located around the world. The Hanson family (especially Glenn and Phyllis, Carolyn and Vern Johnson, Al and Brenda Bolwerk) wish that future recoveries from this ranch remain in the local vicinity, including Newcastle, Wyoming, to the north. They also wish that the bones be used to promote a creationist viewpoint, bringing glory to the God of the Bible, rather than an evolutionist viewpoint.

The Hansons have invited a new organization, Foundation Advancing Creation Truth (FACT), headed by Dennis Petersen, to develop the site according to their wishes. In return, FACT reciprocates by inviting interested individuals and families to work through their organization to maximize the scientific productivity of the Hanson Ranch. All people seeking access to the ranch must apply through FACT (P.O. Box 570, El Dorado, CA 95623). Participation fees will be charged. The normal operations of the working cattle ranch are not to be disturbed.

Two expeditions were held in July and August, 1995, the first for an extended weekend and the second for about 10 days. The invited participants were mostly involved in planning for the site and in the process excavated some large leg bones and many bags of nearby bone fragments.

The site, mentioned by Oard (1995a, p. 53) as near Newcastle, is in The Cheyenne River watershed and in the eastern part of the geologic structure known as the Powder River Basin. It is near the rounded coordinates of latitude/longitude 43° 29'N, 104° 28'W and Universal Transverse Mercator (UTM) zone 13 coordinates of 4,815,000 m N, 544,000 m E. The applicable 7.5' topographic quadrangles for the ranch are Threemile Butte, WY (1981) and Morrissey, WY (1982). Orthophotoquad maps showing 1979 aerial images, correctly positioned, have the same names. The 27 June 1994 frames of the National Aerial Photography Program (NAPP) are 7766-24 for the most-centered view and 7766-23 for the stereo pair to the south. Figure 1 shows a portion of frame 24 around the site area. These basic resources



Figure 1. A NAPP aerial photograph of part of the Hanson Ranch shows a gully system formed by headward erosion in soft shales and sandstones of the Lance Formation. All of the other photographs, except for Figure 7, were taken within this view.

can be ordered from appropriate outlets within the Geologic Survey (USGS).

The NAPP aerial photographs, available in only monochrome for this part of Wyoming, can be scanned by a computer to resolutions of better than 3 meters/pixel. This makes them superior to presently available satellite images in terms of resolution. Landsat color images are 15 m/pixel and SPOT panchromatic images are 10 m/pixel. Future satellite images will have resolutions near one m/pixel, but aerial photography with scanned resolutions better than five cm/pixel can be flown with present technology.

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The USGS computers do not recognize any geologic maps with those quadrangle names. The 1:500,000 scale Geologic Map of Wyoming shows all exposed strata in the area as "K1" for the Lance Formation. The key describes the Lance Formation as "Brown and gray sandstone and shale; thin coal and carbonaceous shale beds." A tour of the area shows numerous oil wells with reported depths of about 6000 feet. The Powder River Basin is also known for major coal deposits, with some in the Fort Union Formation (above the Lance Formation) more than 100 feet thick.

Workers from the University of New Orleans have been excavating a small site on the land for the past five years and have finished their field work. Some field notes and fossils have been made available for study.

Site Description

That part of the ranch which is presently being examined is in a mature gully system with continuing headward erosion into otherwise undulating terrain. The area relief ranges from an elevation of 1174 m (3850 ft) to 1308 m (4290 ft). Within this range the Lance Formation has numerous lithologic units. Sandstones range in color through white, gray, tan, brown, and red. Sandstone beds can be thick or thin, cross-bedded or planar, and continuous to intermittent lenses. Consolidation is variable. Shales are light to dark gray and brown. Bentonite may be present. Some peat-like deposits and carbonaceous shales occur in limited areas. Some lenses of sandstone are of breccia of previous sandstones, bones, and other materials. The various colors and rock textures tend to repeat throughout the exposed vertical lithological section, making it challenging to trace particular layers. Structural geologic patterns have not yet been mapped by us but appear to be minor.

The durable sandstone lenses are usually tan to reddish-brown, sometimes with the colors grading into each other at the same elevation. Cross-bedding is sometimes present. Sometimes the layers are undulating with a large amplitude. Major portions of the durable sandstone layers are organized into parallel ridges, some finger-like, with separations of a few meters. The orientations of the ridges vary with depth. The top layers are generally north-south. Some lower layers can be east-west. Some finger-like ridges are disconnected from their neighbors to the extent of having elliptical cross-sections, like those shown in Figure 2. Within each ridge the joint direction is usually perpendicular to the ridge axis. The bedding is almost always horizontal with little undulation, though one series indicated a transport in a northward direction and another in a southward direction. In Figure 3 the bedding has a large vertical amplitude. The top layer on some ridges is reddish, contrasting with the light gray below. The butte in the rear is of dark gray shale, possibly including bentonite, and has slumped to the left.

There are thicker layers of fine, less durable sandstone, generally white and highly cross-bedded, that underlie the durable layers. Some bedding planes continue into the tan or reddish hard sandstone layers above.

The gray and dark gray shale layers tend to degrade to highly cracked and easily erodible mud. It is sus-



Figure 2. A view along an elliptical ridge of durable sandstone. The sandstone has fractured along joints into segments.

pected that such layers will interfere with transportation by vehicle or foot during and after rain events. Such properties are typical of bentonite clays.

Plant fossils appear in numerous layers. In some, including the shales, petrified wood is found. Some sandstone layers contain impressions of broken plant matter with dimensions of several centimeters. A *Metasequoia* cone was discovered close to the main dinosaur graveyard.

Most of the dinosaur bones, like those shown in Figures 4 and 5, are or were in the soft sandstone. The bones in Figure 4 are still in place across the middle of the view. The large bone (mostly in shadow) being excavated in Figure 5 was originally from the same layer a few meters away but was then in eroded and slumped soils. A few bones (Figure 6) are found in a hard sandstone "bone breccia" that may offer important clues on the paleoenvironment when the dinosaurs were buried. The Hanson ranch area, called the Dragon's Graveyard, has been estimated to contain anywhere from several hundred to several thousand individual duck-billed dinosaurs. A newspaper report on the dinosaur graveyard erroneously reported 8,000 dinosaurs. Some bone fragments were examined with a scintillation counter and were not found to be radioactive, unlike those at Dinosaur Ridge near Denver (Holroyd, 1992).



Figure 3. The parallel ridges of sandstone in the foreground have undulating bedding with two colors, tan and light gray.



Figure 5. A photograph of a large bone being excavated at the Hanson Ranch.

A set of five dinosaur tracks (Figure 7) discovered about 15 km southwest of the Hanson ranch may also contain clues to the paleoenvironment (Oard, 1995a). The site appears to be in the Lance Formation, but it is not yet known if the tracks are stratigraphically above or below the bone layers of the Hanson Ranch.

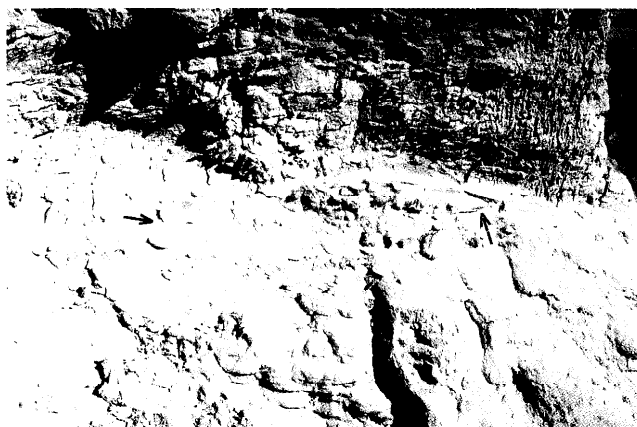


Figure 4. Dinosaur bones are still in place in soft sandstone across the center of this view.

The grid system designed for the 1995 recovery of bone pieces is in UTM coordinates, a metric system which appears on all topographic quadrangle maps. The July layouts were done with crude surveying having mostly angular errors. Future surveying will refine the positions. Using the UTM system starts the project in a scientifically acceptable frame of reference that can be related to bone recoveries in neighboring states. It will allow measurements to be incorporated into three-dimensional geographic information systems (GIS).

Conclusion: Possible Research Topics

There are numerous scientific topics that offer research opportunities at the Hanson site. We suggest a few here to show a range of possibilities. Many can be done without travel to Wyoming. Samples from the Hanson site can be provided for study. Bone castings are being offered for sale, to cover their cost of production and to help finance the research.

The orientations, spacings, and internal structures of the parallel sandstone ridges and "fingers" can be mapped. They are likely to give indications of fluid movement directions, speeds, and depths which are important for understanding the depositional conditions for this part of the Lance Formation. The continuity of cross-bedding into some of these harder sandstone lenses from the weaker fine white sandstones below and some of the color changes in the lenses needs to be explained. Are any of these orientations related to the orientations of large bones?

Color aerial photographs at a much higher resolution (1:5000 scale) would help in mapping the various strata, particularly the orientation of sandstone ridges. Special flights could cost a few thousand dollars if contracted. Perhaps someone might have access to groups (military?) who need to practice flying aerial photography. We could suggest the Hanson ranch as a target, similar to what was done for a Civil Air Patrol practice mission by Holroyd (1994). We started our aerial photography program over the Hanson ranch by acquiring more than 32 black and white stereo frames (9x9 inches) at about 1:8000 scale, flown 28 October 1995 by Donahue Aerial Survey of Parker, Colorado.

The several oil companies that have drilled exploratory and production wells in the area undoubtedly

**6A****6B**

Figure 6. a and b. About 46 meters from Figure 4, and at nearly the same level, hard sandstone encases a large collection of broken bones.

have data on the geologic structure and stratigraphy. Some data are proprietary, but perhaps other data may be released upon inquiry. That would speed our understanding of the region. The USGS has a large collection of rock cores and drilling cuttings at the Core Research Center in Denver. They have no cores of the Lance Formation within about 10 miles of the Hanson ranch. A few nearby drill sites are represented by cuttings in the collection, but most samples are from very deep layers near the oil bearing strata. The Lance Formation cuttings may still be useful for analysis.

Rock samples from the numerous layers can be examined for mineral and grain size distributions, cementing agents, pollen content, mineral alterations, trace elements, and other properties. Concretions are common. What and where are the sources of the materials? Are any, such as the clays, of volcanic origin or are they all erosional products? What plant types are represented? Are they likely to have grown in the area or have floated in from elsewhere (see Oard, 1995b)? What were the ground water properties that may have provided cements and altered the materials? How did these affect the fossilization of bone and plant fragments (see Williams, et al., 1993)? According to Mallory (1972) the Lance Formation in Wyoming is similar in content and stratigraphic location to the Hell Creek

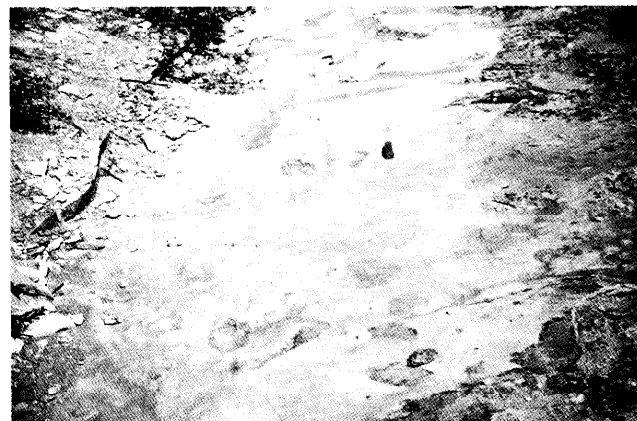
**7A****7B**

Figure 7. a and b. These dinosaur tracks are in the Lance Formation about 15 km southwest of the Hanson ranch. The knife gives a scale in the two views.

formation in Montana, which is also known for its dinosaur fossils. Table II of Williams and Howe (1993) indicates that the Javelina Formation of the Big Bend area of Texas is correlated with the Hell Creek Formation. Therefore, a comparison of these three formations is appropriate.

Thin section analyses of the bone and plant fossils should be made for the replacement mineralogy and cell structure. The peat-like layers can be examined chemically and microscopically. Perhaps some organic matter remains in the fossils. A simple pH mapping of the weathered rock units may provide some useful data.

There are artifacts to be examined that are more recent than the dinosaur fossils. Some Quaternary deposits have bones (Holroyd found a skull with teeth, a spine of 11 vertebrae, and a leg bone in various locations), though not as frequently as in the dinosaur bone layers. On at least one gentle ridge top are stones in a ring, apparently for supports for teepees (Figure 8). Looking down on a grassy area from a nearby butte (locally called Pike's Peak one can see a large circular structure (Figure 9) with other designs that appears to be a medicine wheel drawn by former native Americans.

Research is needed to tie this region, including the dinosaur remains, into a non-evolutionary, Biblical



Figure 8. This ring of white stones suggests that a tepee was placed here.

Flood model. Was the Lance Formation, being late Cretaceous, deposited in the last stages of the Flood as the water receded from the Plains region? If so, then it would be labeled Upper Flood Event, according to the framework proposed by Froede (1995b). Alternatively, the Lance Formation may have been deposited in the Zenithic or Abative Phases of the Flood, according to a new Biblical geological model developed by Tasman Walker (1994). The present geologic interpretation according to the evolutionary time scale is that the region was at the west side of a receding marine inland sea stretching from the Gulf of Mexico to the Arctic Ocean (Froede, 1995a). The extensive coal deposits nearby suggest rafted debris like that suggested by Woodmorappe (1978), Coffin and Brown (1983), and Austin (1986). The studies suggested here and others that readers may propose should help increase our understanding of the depositional conditions and Biblical time frame of the Lance Formation and its associated fossil remains.

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Figure 9. A large circular pattern, just above the center right of light-colored grass suggests that former native Americans made a medicine wheel at the site. The van at the left gives a scale. A design in the grass between the van and the circle may be related.

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Quote from Robert Boyle: Chaos Cannot Create a World

... they discerned and acknowledged the necessity of a wise and powerful agent to dispose and fashion this rude matter, and contrive it into so goodly a structure, as we behold, without imagining with Epicurus, that chance should turn chaos into a world. And really it is much more unlikely, that so many admirable creatures that constitute this one exquisite and stupendous fabric of the world should be made by the casual confluence of falling atoms, justling [sic] or knocking one another in the immense vacuity, than that in a printers working house a multitude of small letters, being thrown upon the ground, should fall disposed into such an order, as clearly to exhibit the history of the creation of the world, described in the 3 or 4 first chapters of Genesis, of which history, it may be doubted whether chance may ever be able to dispose the fallen letters into the words of one line.

Boyle, Robert. 1664. Some considerations touching the usefulness of experimental natural philosophy, 2nd edition. R. Davis. Oxford. p. 77. Some words have been converted to modern spellings.

Quote

Psalm 95:4-5

In his hand are the depths of the earth, and the mountain peaks belong to him. The sea is his, for he made it, and his hands formed the dry land.

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CONFIRMATION FROM A DEBRIS FLOW AT A FOREST FIRE SITE

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Abstract

The previously reported plant fossils at Dinosaur Ridge, Morrison, Colorado, are a mixture of broken charcoal pieces and their impressions, silt and sand. Normal sedimentation processes at a forest fire site indicated that buoyancy differences should strongly limit the mixing of sand and charcoal. Catastrophic mud or debris flows were suggested as the appropriate mechanism for much of the Dinosaur Ridge plant fossil deposit.

The contents of a catastrophic debris flow from the Storm King Mountain forest fire site at Glenwood Springs, Colorado, were examined to determine any similarities with the Dinosaur Ridge site. Charcoal fragments were found mixed throughout two cores taken from the mud flow component of the deposit. Two cores from other areas which experienced normal sedimentation conditions showed no mixing of sand and charcoal. These differing depositional frameworks are suggested as a basis for distinguishing between slow and catastrophic sedimentation rates.

Introduction

Holroyd (1992) described the plant fossil deposits in the Dakota Formation at Dinosaur Ridge, a hogback between Morrison and Golden, Colorado. He interpreted them as impressions of broken pieces of charcoal mixed with sand in a thick cross-bedded deposit. Nearly all plant material is fragmented beyond recognition.

He also examined the Sugarloaf Mountain forest fire site two years after the 1989 fire. Charcoal and sand were still accumulating in the creek bed of Black Tiger Gulch. Small trenches were dug in numerous sandbars formed since the fire, searching for a charcoal and sand mixture similar to that found at Dinosaur Ridge. All sand deposits examined were free from charcoal except scattered pieces on the surface. Buoyancy differences between the sand (quartz grain density 2.65) and plant matter (density 0.2 to 1.1, depending on waterlogging) indicate that in a normal depositional environment with abundant water and agitation the two materials would be strongly separated.

He suggested that the mixing of sand and charcoal at the Dinosaur Ridge plant fossil deposit indicated a catastrophic mud flow. Within a debris or mud flow there may be enough water to move the material but not enough water to completely separate the various composing materials by buoyancy. Such a flow deposit would occur in several minutes. The lack of disruptive biological activity in the fossil deposit in the form of large plant roots, animal burrows, or soil formation, limits the time for the formation of the entire deposit (tens of meters) to a fraction of a year up to decades at most.

Combining the necessary deposition rates indicated by the charcoal mixture with those needed for burial of dinosaurs and preservation of their footprints at Dinosaur Ridge, Holroyd (1992) suggested minimum rates of meters per year. Conventional geology assigns 50 million years for the 200 meters of rock in the combined Morrison and Dakota Formations at Dinosaur Ridge. Strict uniformitarianism would thus give an average net deposition rate of four micrometers per year.

An opportunity to confirm the scenario of a catastrophic deposit within the upper Dakota Formation at Dinosaur Ridge arose during the Summer of 1994. A

major forest fire occurred on July 6 on Storm King Mountain, west of Glenwood Springs in central Colorado. The fire made national news by killing 14 fire fighters when a sudden wind shift blew the flames over them. During the evening of September 1 a thunderstorm initiated a debris flow on the southern slopes of the mountain. The mud and debris crossed both lanes of Interstate-70 (I-70) on its way to the Colorado River, blocking travel until the evening of September 4. The author visited the site, taking photographs and core samples of the mud (still damp but exhibiting shrinkage cracks) on the afternoon of September 4. Aerial photography of the scene was obtained on the morning of September 6.

Core Analyses

Cores of the deposits at Sugarloaf and Storm King Mountains were obtained by pressing jars and cans into the mud and sand. Fingers were forced under the containers before removal to retain the sample within. The three Storm King Mountain cores were gently baked at approximately 90 °C for 2.5 hours to kill bacteria. A limited growth of white mold occurred thereafter on the exposed surface of one core during the 3.5 months before analysis. A small core (#1) in a metal can was carefully rewetted and moved to a glass jar in December, causing a slight contamination of the charcoal layer with sand. The single Sugarloaf Mountain core was analyzed immediately.

The Storm King cores, two still in their original containers, each had a nail taped to the container walls with the point of the nail indicating the downward direction. A medical X-ray unit was used to provide images of the cores along three mutually perpendicular axes.

A set of soil sieves was borrowed for sorting the various sizes of particles within the cores. Table I gives the characteristics of the sieve set. Intermediate sieve sizes exist but were not available in this set. The sieve number indicates the number of wires per inch. The sequence numbers will be used for referencing in the text and figures to follow.

Samples before and after sieving were weighed on a beam balance with a resolution of 0.01 g. Most samples were weighed together with a previously weighed container or sheet of paper. Wet sieving samples were drained of excess water on sheets of typing paper in an

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Table I. The characteristics of the sieves used for sample sorting.

Sequence number	Sieve number	Opening		Size retained
		inch	mm	
1	4	.187	4.76	pebble
2	10	.0787	2.00	granule
3	40	.0165	.420	coarse sand
4	200	.0029	.074	fine, medium sand
5	270	.0021	.053	coarse silt
6	pan	none	none	silt, mud
7	-	-	-	rinse water contents

attempt to return to near initial dampness before weighing. The smooth paper surface permitted the removal with a putty knife of the damp sample with only small losses. A few samples were completely air dried. The procedures introduced measurement errors depending mostly on the amount of draining and drying. Core #3 had a slight excess of water and the others a deficit resulting from drying of some of the original moisture. Muddy rinse water carried away some of the finest sediments, contributing to a weight deficit.

Samples were moved through and around the sieves during wet sieving by water from a spray bottle. They were then removed from the rim of the sieves with a putty knife. That process minimized mechanical actions that might fragment the organic contents of the cores. Dry samples were moved through the sieves by shaking, tapping, and limited stirring. Dry samples were poured into weighing media and sometimes onto an intermediate sheet of paper. During these processes there was always some loss of damp sample material to drainage papers. Unrecoverable material from one sieve was washed into the next to minimize losses during wet sieving.

A portion of each core was analyzed using the sieves. The X-ray images were used to guide a knife away from major stones. Those parts were subdivided vertically so that variations with depth at about centimeter resolution could be determined. The Storm King cores had been kept moist, so no grinding was necessary for breakup. They were washed through the sieves after initial weighing. A deficit from moisture evaporation occurred with the Sugarloaf samples even though no water was used during the sieving.

For comparison, two Dinosaur Ridge fallen stones having indistinct plant impressions were crushed between a hammer and a steel plate to break them into grains. The resulting powder was then sieved for a size distribution. As a check on the possible destruction of original rock grains, a sample of the Sugarloaf quartz sand was crushed with comparable vigor. Sizes were indeed reduced by about a half to one sieve size interval.

Sugarloaf Mountain Sample

By utilizing a 12.5 cm diameter plastic can, a 14 cm deep core was taken from Black Tiger Gulch at Sugarloaf Mountain on December 24, 1994, 5.5 years after the fire. The location was probably within a meter of the site of Figure 7 in Holroyd (1992). Its lower layers contained fine living rootlets from nearby herbs and grasses. Charred bark and twigs were gathered from the surface within 2 meters of the core. The nearby

perennial stream was about 2 meters away and about 10 cm lower than the surface. The surface was therefore highly vulnerable to stream overflow. The surface characteristics indicated a depositional environment during overflow rather than erosional. The sand was unconsolidated and coarse. Its cohesion was provided by residual moisture rather than by mud or silt.

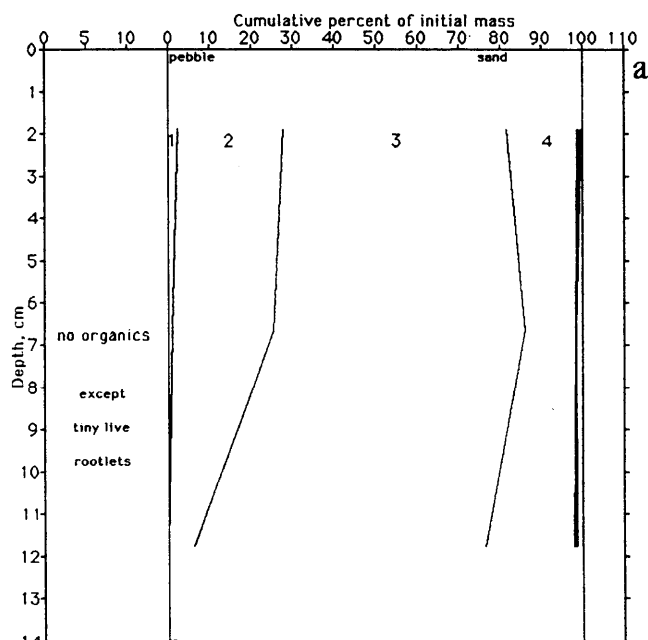


Figure 1. The size distribution, with depth, of the Sugarloaf Mountain core. It shows essentially pure, coarse sand and no charcoal.

The initial core was resampled by forcing a thin-walled steel tube of 2.8 cm internal diameter vertically through the sample. The general uniformity of the core prompted its division into only three vertical layers as it was extruded from the tube. The size distribution is shown in Figure 1 in a format nearly identical with subsequent figures for other cores. The vertical axis is depth from the surface. The horizontal axis is cumulative percent of the initial mass. The scale extends to 110 percent because some samples (particularly core #3) contained extra water from the wet sieving. The left portion of the figure has an expanded scale for the two largest sizes further partitioned into organic matter and rock detritus. No organic matter, other than new living rootlets, was found in the sieved samples from the Sugarloaf Mountain site, in agreement with the previous report by Holroyd (1992). The numbers 1 to 4 in the main part of the figure indicate the sieve sequence number containing the sample subset. The nearly vertical lines connect the vertical midpoints of the three sample partitions. The core actually extends from the surface through 14 cm. The Sugarloaf core contained mostly fine to coarse sand and larger granules. There was very little silt. Losses of residual soil moisture were minor (light shading at the right).

The products of sieving were placed in a partitioned display tray shown in Figure 2. The scale and the horizontal Plexiglas partitions indicate the vertical boundaries of the core subsamples. The vertical partitions separate the various sizes, from 4 to 1. The bins

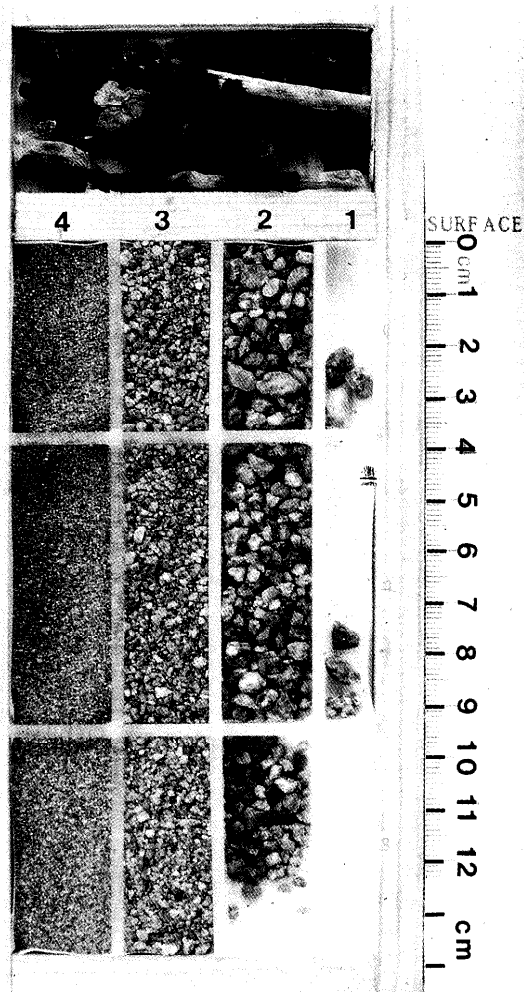


Figure 2. A tray containing the sieved samples of the Sugarloaf core, for sieves 4 to 1. At the top are samples of charred bark and twigs that were still present only on the surface within 2 meters of the core, 5.5 years after the fire.

were loaded with as much of the sieved material as possible. Some bins are therefore full. Others contain everything available. A few bins at the largest sizes in similar figures may not exhibit particles that were too big to fit. At the top of Figure 2 are some of the pieces of charred bark and twigs that were, lying on the surface nearby the core location. They emphasize that the fire products are still available for mixing but buoyancy keeps them out of the sand.

Storm King Mountain Samples

Figure 3 shows an aerial view of the debris flow site on the south side of Storm King Mountain. North is at the top. The drainage, which crosses the westbound lane of Interstate-70 at $39^{\circ} 33' 39''$ N, $107^{\circ} 23' 11''$ W, is not named on the topographic map. The extent of the contrasting reddish mud is evident in the original color image. It is traced in part b, labeled with "M" symbols, and annotated with observation sites, "P" for photographs and "C" for cores. Chronic (1980, p. 203) indicates that the source rocks are of the Permian Maroon Formation and that mud slides are common in the Glenwood Springs area.

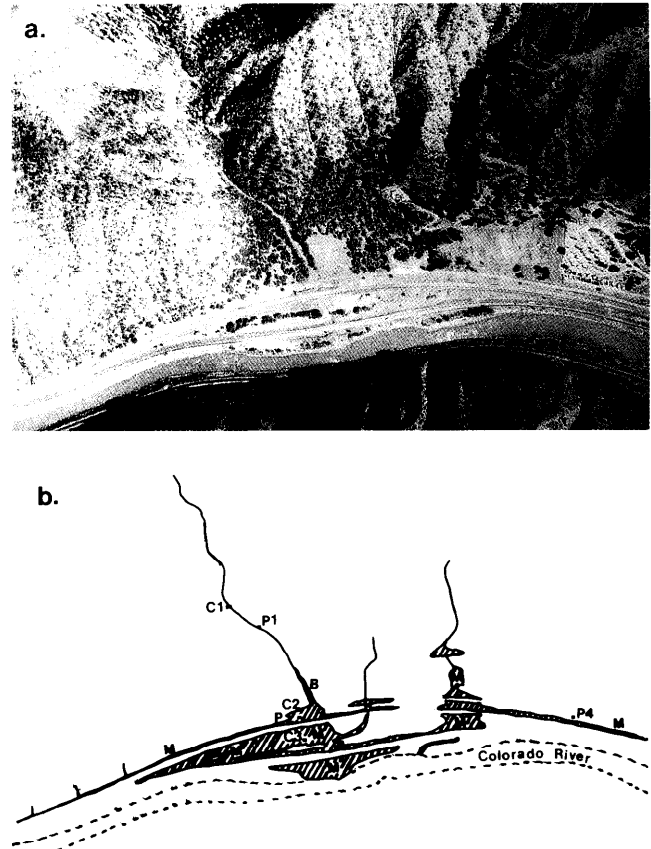


Figure 3. a. An aerial view of the Storm King Mountain debris flow site about 4.5 days after the flow. The dark conifer trees and the Interstate highway lanes indicate the scale. b. A tracing showing the extent of the mud flow (M) and indicating the positions of core samples (C) and photographs (P).

The residual mud and scour patterns in the creek bed north of the highway, as shown in Figure 4 and taken looking upstream from "P1" in Figure 3b, indicated that the flow was about 2 meters deep there. It climbed higher on the outside edges of turns and lower on the inside edges from flow dynamics. From such elevation differences and the radius of curvature of the turns a flow speed could be calculated using energy conservation equations. Data for such estimates were not gathered during the site visit.

Core #1—Core #1 was obtained by pressing a steel can of 7.0 cm internal diameter, 10 cm depth, into a drained settling pool in the scoured creek bed. The core was taken near point "C1" in Figure 3b, a location in the rear of Figure 4. Figure 5 shows before and after views of the core site. The ruler, which appears in the before picture, has a width of 3.2 m. The surface was covered with charcoal debris. Only 5.3 cm of the deposit could be penetrated by the can. A plastic lid was then placed on the can to retain the contents and moisture. Essentially all moisture escaped before analysis, making the clays powdery. Water was added to the contents in mid-December. A thin mylar sheet was forced along the can edges and extracted with the core during transfer to a glass jar for X-ray analysis. The top mat (about 5 mm deep) of wet charcoal debris did not come out of the bottom of the can with the core. It was

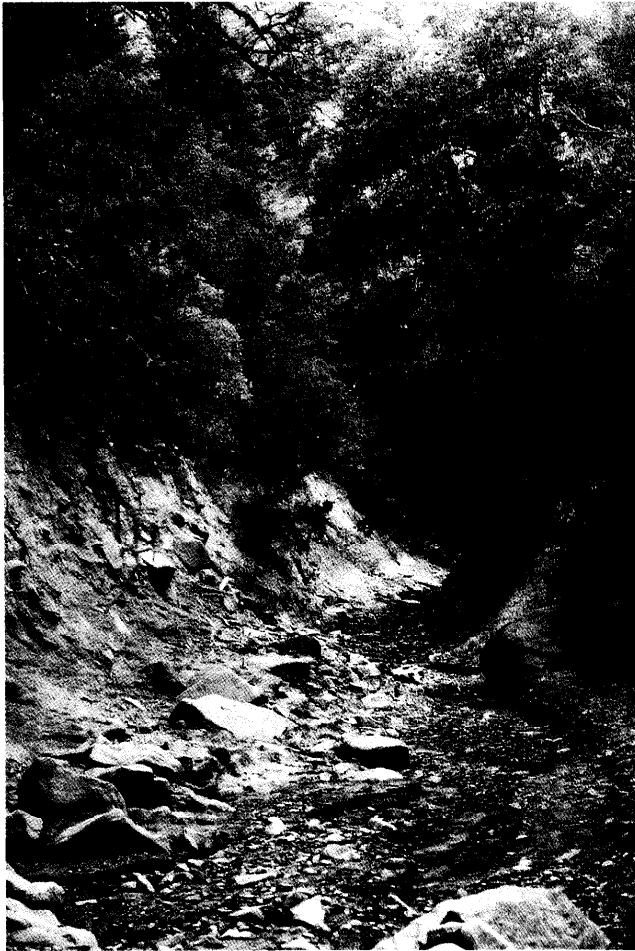


Figure 4. A view looking upstream at the channel scoured by the 2 meter high debris flow. Figure 5 and core #1 were taken somewhere in the left side of the creek bed towards the rear of the view.

scraped out and pasted on the core end. During sieve analysis it again had to be scraped out of the container. The rewetting and extraction processes thereby contaminated this nearly pure vegetative layer with silt and sand.

The X-ray images of core #1 are shown in Figure 6 along with a scale. The glass container and nail are also visible. The top of the core shows black in the image because it is nearly transparent to the X rays. The core becomes progressively lighter towards the bottom and brightest at a large pebble. This results from a great amount of stratification of material with the densest material of the settling pool on the bottom of the core. Buoyancy kept the plant matter at the top of the core. This stratification is confirmed in the size distribution graph of Figure 7. The largest rock detritus sizes are at the bottom of the core with fine sand and silt in the middle. The top of the core was nearly all organic debris except for contamination. The second sublayer from the top retained a great amount of water from the sieving operation. It was therefore air dried for about an hour and lost more than half its original mass of apparently rewetting water.

Figure 8 shows the display tray of core #1 materials by depth. From left to right are the unsorted core, then

sieve contents 4, 3, 2v-vegetative matter, and 2s-sand and stones. Organic material dominated all but the smallest sizes at the top of the core. Even the fine sizes are dark compared to the bottom of the core (ignoring the top contamination). Rock granules are present at the bottom where there is no vegetative debris. The loose texture of the top debris may be visible in the unsorted core, while in the lower left is a pebble.

Core #1 is therefore interpreted as the product of normal sedimentation processes after the scouring passage of the debris flow. There was sufficient water and time for buoyancy forces to operate. The most dense materials are at the bottom and the least at the top, in accord with buoyancy expectations.

Core #2-Figure 9 shows the site of core #2, labeled "C2" in Figure 3b. The picture was taken just southwest of the core location at a point labeled "P." It is slightly downstream from where the gradient lessens and where there is a long deposit of boulders, labeled "B" in Figure 3b. Some boulders are visible on the right in Figure 9 above the foreground tire tracks and below the rear grassy field. A bright stone is in the center left of the picture in front of the tree shadow. As shown in Figure 10, core #2 was taken in the adjacent deep mud. A broken log and stick are to the right in the before picture and a 38.1 cm ruler is lying against the rock. In the after picture are the core hole, my footprints, and a drying crack in the mud. The container for the core was a glass jar with 7.5 m internal diameter opening, widening to 8.0 cm diameter inside. The jar was 10 cm deep and was sealed with a metal lid. The contents settled into the jar to a depth of 8.1 cm before analysis. No depth corrections extrapolating back to 10 cm were made, but that does not affect the conclusions.

The X-ray images of core #2 in Figure 11 show a mottled appearance of lights (stones) and darks (organics). There is no general stratification of this texture. The size distribution of Figure 12 shows slight variations with depth and only a minor trend for coarsening downward. The exception is at the enlargement at the left, where the fraction of pebbles from sieve 1 (no shading) has two major lobes while the dark shaded organics of the same size have no strong variation. Shaded zone 7 indicates the weight of initial dampness that was lost during processing. The third layer from the top was subjected to total air drying. As in Figure 1, the vertical lines connect the depth midpoints of the subsamples. The core analysis extended from the surface to 8.1 cm, though it settled from an original thickness of 10 cm.

Figure 13 shows the display tray of the contents of the sieving operation along with a piece of the unsorted core. Though probably not visible in the reproduction, the raw core shows pebbles, charcoal chunks, and needles amongst the sand and silt. In the partitions, the left two columns are from sieves 4 and 3. Sieve 3 contents are an obvious mix of coarse red sand and black charcoal fragments. The black specks in the Sieve 4 contents are less obvious but were visible during wet sieving by tending to float to the top of the fine sand. Muscovite mica was abundant in both core #2 and core #3. Dark biotite mica may have been present but was not obvious. A few mineral grains were dark, challenging visual separation from charcoal grains. A strong magnet passed over the dried samples did not

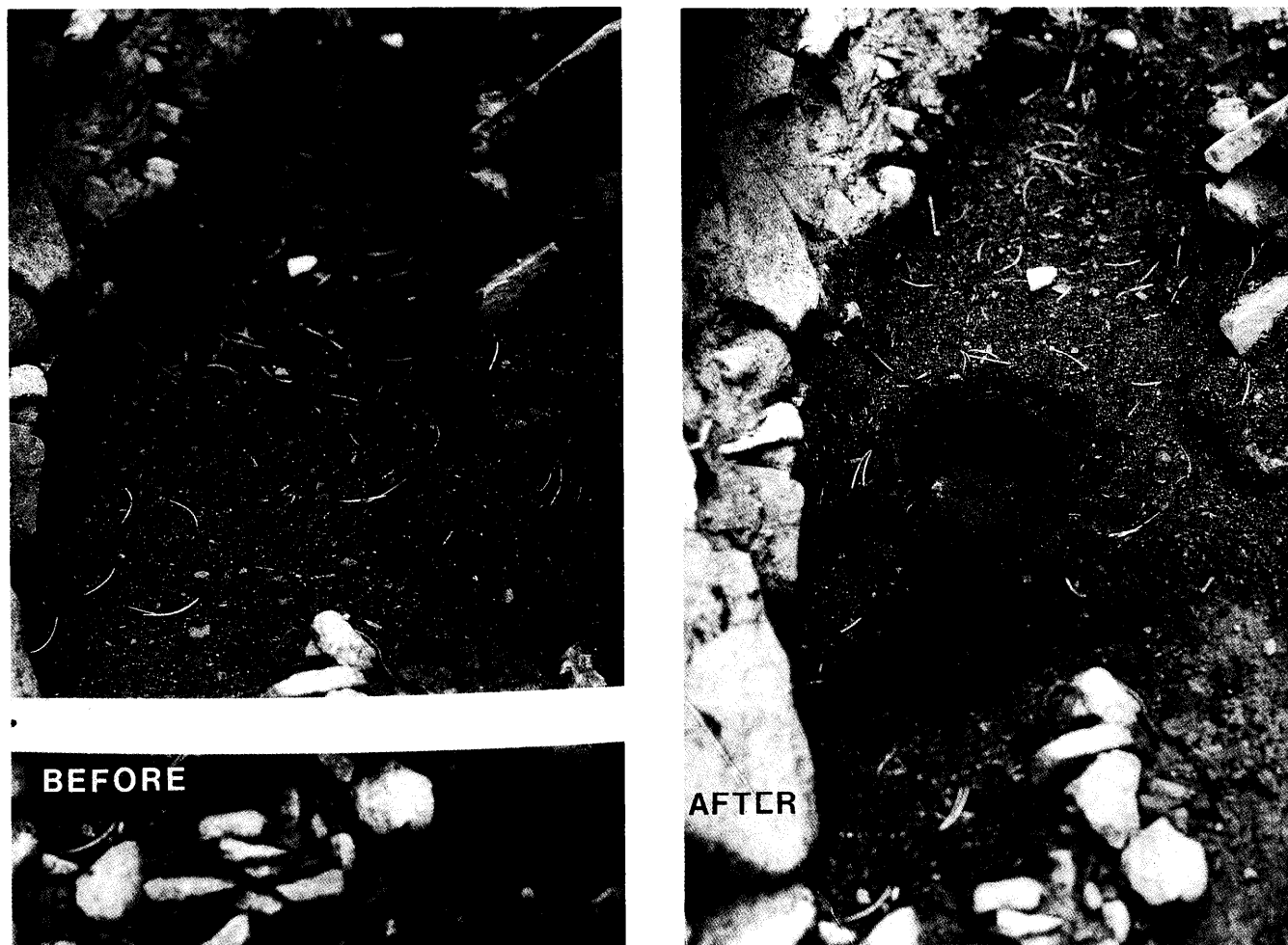


Figure 5. Views before and after a can was pressed into the drained debris of a settling pool. The top surface is essentially all charcoal and other plant fragments.

attract any black magnetite. The middle columns contain the organic (2v) and sand and stone (2s) fractions from sieve 2. The organic contents were essentially uniform with depth but the stone fragments varied with depth. Similar depth variation shows in the right two columns of organics (1v) and stones (1s) from sieve 1. Large charcoal chunks were found at the top, middle, and bottom, with needles and bark throughout.

Core #2 is therefore interpreted as from a turbulent (well-mixed) catastrophic dump from a debris or mud flow. The mud was too thick for buoyancy forces to overcome viscous restraints. Charcoal is therefore found throughout the core at all sizes and depths.

Core #3—The site of core #3 is shown in the photograph of Figure 14, looking across (to the south of) the westbound lanes of Interstate-70 from about the same location ("P" in Figure 3b) as Figure 9. By the time of the photograph the left lane was open but the right lane and shoulder were still being cleaned. Freshly brightened boulders were deposited across the highway to the left of the car. In front of the far trees is a large uprooted tree trunk with broken roots. Core #3 was taken just to the right of it in a deep (estimated at about 0.5 meter) deposit of mud at location "C3" in Figure 3b. There was an abundance of large charred

wood fragments on the surface. Looking the other way (north) in Figure 15 is a view of the coring site before and after disturbance. The view shows several thick branch fragments, some shrinkage cracks, and the 38.1 cm (15 inch) long ruler in the center. The after picture shows a pair of my deep toe prints in the center left with the core hole beyond. The container was a plastic can of the same dimensions as at Sugarloaf Mountain. Though nearly 14 cm of material was gathered into the can, it settled to 11.5 cm before analysis due to loss of water. Again, no correction for shrinkage was calculated.

Figure 16 shows the X-ray images of core #3. The patterns are less distinct because of the core thickness. As with core #2, they do not show any stratification of the mottling with depth. This indicates that the organic material is mixed throughout its depth. Figure 17 shows the size distribution. Shaded area 7 indicates that the processing left excess water in the samples after sieving, except for the bottom layer. There is only a slight tendency for a coarsening of the sand with depth, as in Figure 12. The mass distributions of the two largest sizes are more uniform for both organics and stones than in core #2. The greater uniformity of core #3 may come from larger sample

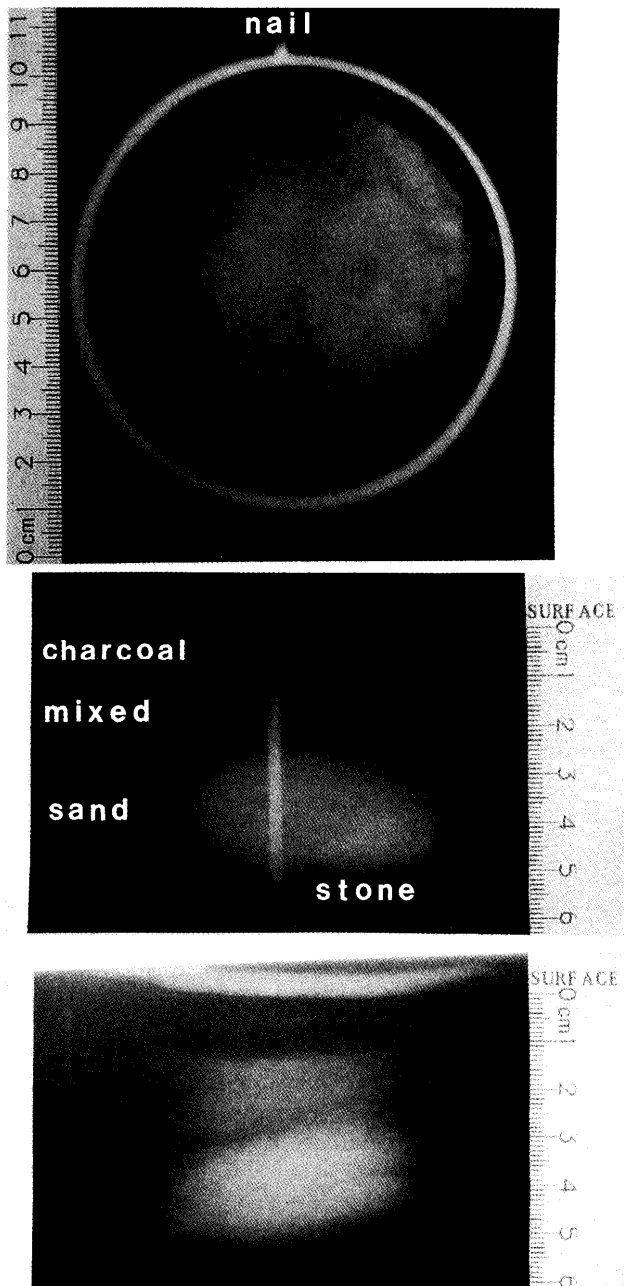


Figure 6. The three mutually perpendicular X-ray images of core #1 show it to be highly stratified, with a large pebble (light) on the bottom, sand and silt in the middle, and less dense (dark) vegetative matter at the top.

sizes. Only quarters of cores #2 and #3 were sieved but core #3 had a larger diameter.

The tray of sieved contents of core #3 is shown in Figure 18 in the same format as Figure 14. Less variation is seen in all columns. Charcoal fragments were found at all sizes and depths. Core #3 is therefore given the same interpretation as core #2.

Other Storm King Mountain Observations

Throughout the wet sieving of cores #2 and #3 there was a distinct tendency for the black component of the sieve contents to remain distinct and on top of the red

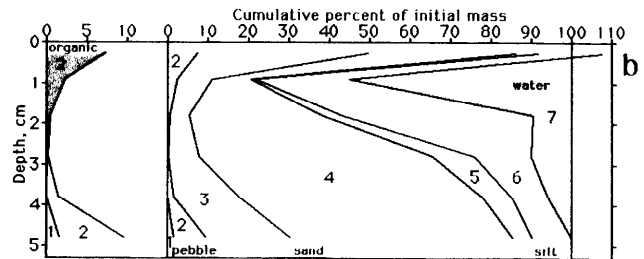


Figure 7. The size distribution of core #1 with depth. The very top layer was contaminated with sand and silt during processing. The next layer down was soggy vegetative matter that lost most of its weight during drying. Sand sizes increase with depth. Buoyancy during settling produced highly stratified material in this core, particularly for sieve size 2, enlarged at the left and shaded for the organic portion.

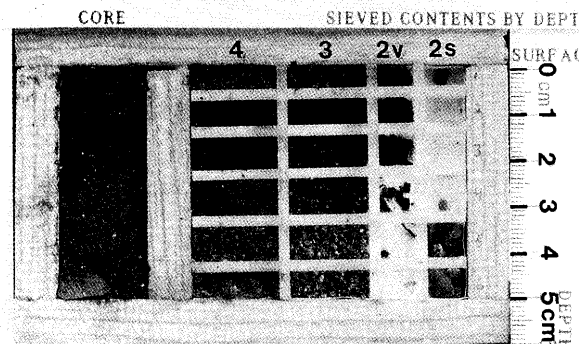


Figure 8. A tray containing a piece of the unsorted core #1 (left) and sieved samples (right partitions) from sieves 4 to 2. Those of sieve 2 are further separated into vegetative matter and rock detritus. The organic matter shades the fine samples dark while the rock materials shade them reddish.



Figure 9. A view of the site of core #2, looking northeast. The debris with boulders flowed toward the right from between the trees. The mud to the left had few boulders.

sand portion. This illustrates the buoyancy separation claimed for the Sugar-loaf site. The sieving operation gave the sample enough extra water and time to perform the separation.

The debris flow showed two directions of movement when it encountered the interstate. The boulder-loaded flow simply crossed the highway and continued to the Colorado River. The interstate gutters, however, filled with the mud component of the debris flow and ex-

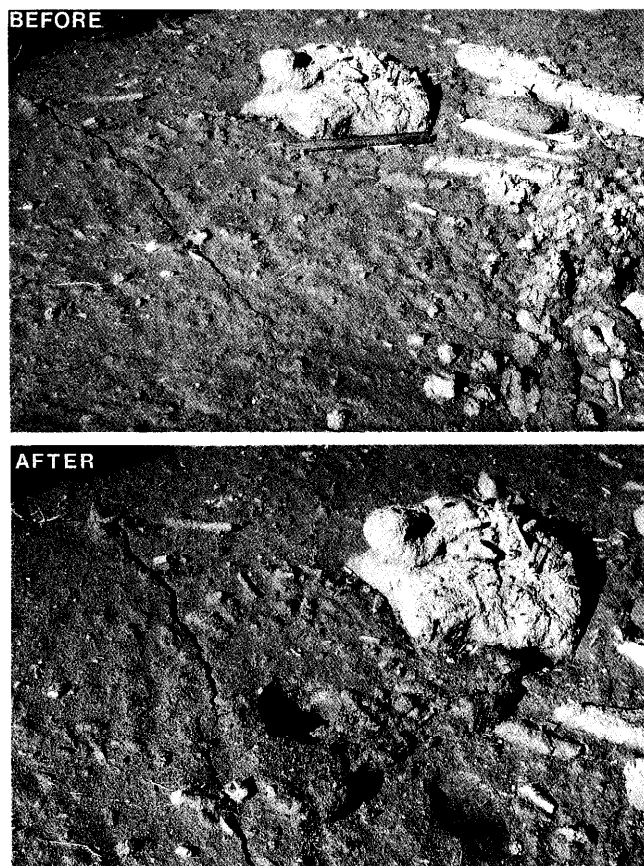


Figure 10. The before picture shows the pool of mud, sticks and stones before coring along with a 38.1 cm (15 inch) ruler. The after picture shows the core hole, footprints and drying crack in the deep mud.

tended parallel to the highway to distances 10 times as great, as shown in Figure 3b. The mud was less viscous and could flow far across a lesser gradient. This gutter flow of mud is illustrated in Figure 19, taken from location "P4" in Figure 3b, and contrasts with the boulder flow in parts of Figures 9 and 14.

When I was walking in the soft mud at the Storm King Mountain debris flow site I was leaving footprints, some of which are visible in Figures 10 and 15. About a week later Dr. Martin Lockley stopped at the site as he was passing by on a trip unsuccessfully looking elsewhere for dinosaur footprints. He told me that he saw footprints of deer and humans (some presumably mine) at the I-70 flow. Though no study was made of those footprints, it might have been an interesting one. How long would the footprints have remained? That would depend on the rates of baking of the mud versus the occurrence of the next showers of rain. Presumably, the best preservation would be for the mud to bake hard and then be overlaid by another mud flow before water had a chance to soften the mud that I walked upon. If rain softened the footprints before preservation then they would be damaged or destroyed. The study likely would have shown that catastrophic processes (rapid deposition) are usually necessary for the preservation of footprints in the geologic record.

The next series of mud flows across I-70 began on 31 May 1995 as a result of snow melt and abundant rains.

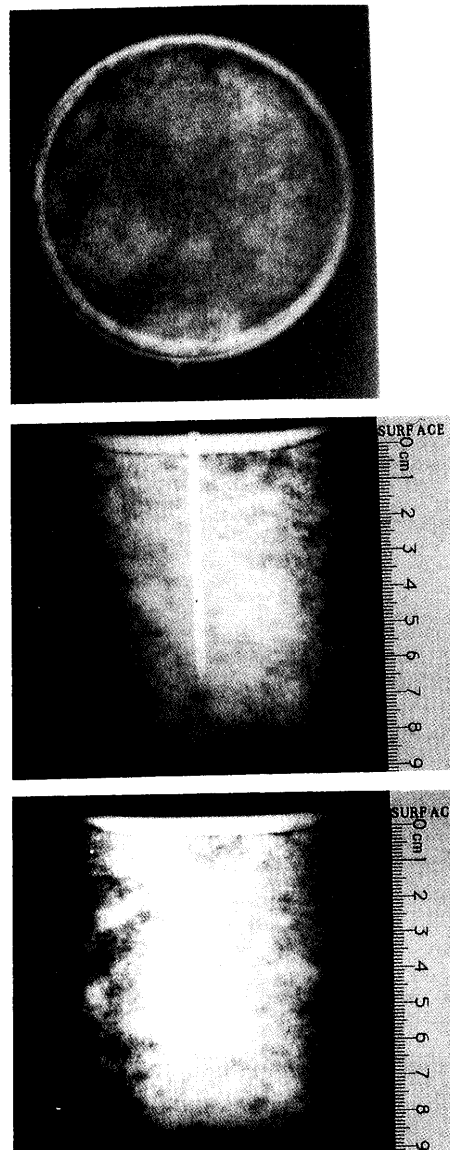


Figure 11. The three mutually perpendicular X-ray images of core #2 show a highly varying texture of brights (stones) and darks (vegetative matter) that are generally well mixed with depth.

Depths of 4 feet were reported. All autumn footprints should have been destroyed by then.

Dinosaur Ridge Sizes

Two small fallen rocks were gathered from the area of the plant fossils at Dinosaur Ridge. One was tan with cavities where the plant material had been. The other was gray with black staining at the cavities and elsewhere within the rock. Both were crushed to reduce them to powder comparable to their original grain sizes. A similar crushing of Sugarloaf site sand showed that the process fractured the original grains to a measurable extent. Figure 20 shows the spectra of the crushed samples along with the original average spectrum of Figure 1. The Sugarloaf sieve 2 granules were all reduced to sieve 3 sizes. Those in turn had half shifted to sieve 4 sizes. So the grinding process is highly likely to have affected the coarser sizes in the

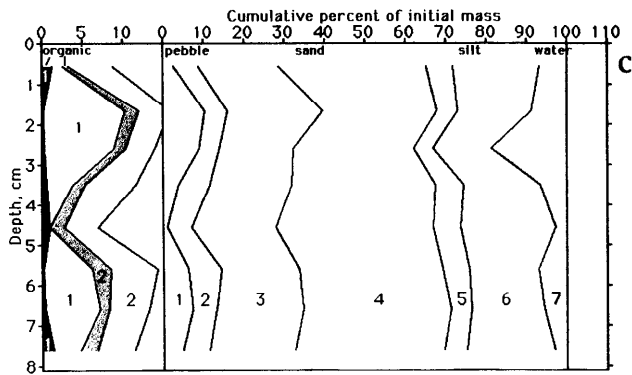


Figure 12. The size distribution of core #2 with depth. Most of the mass is sand with only slight size variations with depth, except for sieve #1 pebbles. The organic content of the largest two sizes extends throughout the core.

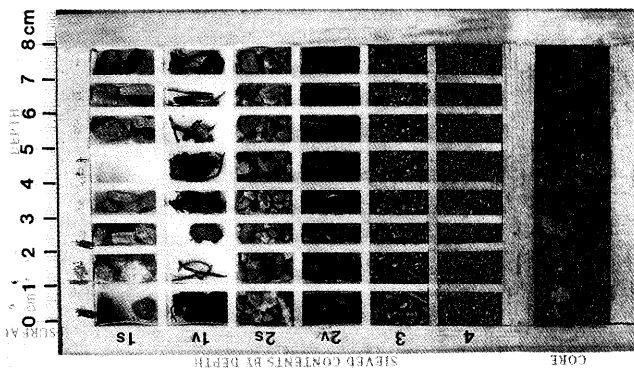


Figure 13. A tray containing a piece of the unsorted core #2 (left) and sieved samples (right partitions) from sieves 4 to 1. The rocky contents of sieves 1 and 2 are in the first and third columns at the right while the organic contents are in the second and fourth columns. The largest size bins show that both stones and organics vary somewhat in concentration with depth but with no general trend in this catastrophic deposit.



Figure 14. A view to the south, across the Interstate-70 westbound lane. Coring site #3 is in the pool of mud in front of the trees just to the right of center.

rock samples. The tan rock spectrum is plotted in the center of Figure 20, bounded with simple vertical lines for visibility. The results of crushing were nearly all of sieve 4 sizes. That range, 74 to 420 micrometers (Table I) generously spans the 200 to 300 micrometers from microscope examinations reported by Holroyd (1992)



Figure 15. The before picture shows the site of core 13, broken branches, mud cracks, and a ruler before disturbance. The after picture shows deep toe prints and the core hole just to the left of center.

for the large grains in a similar tan rock sample. He also found lesser amounts of small sizes. The gray rock (bottom) has considerably finer sand and silt materials. These smaller sizes are less susceptible to further crushing by the crude technique applied and so are likely to represent true sizes of the Dinosaur Ridge grain spectra with reasonable accuracy. The median sizes of the tan rock grains match those of all Storm King cores. The size range of the Dinosaur Ridge tan rock lacks both the larger grains and silt sizes found at Storm King. The grains of the gray rock are smaller than those of both fire sites.

Discussion and Conclusions

The sediments from two forest fire sites were examined in detail and compared with the deposits at Dinosaur Ridge that contain impressions of plant fragments. The Sugarloaf Mountain site showed no mixing of sand and charcoal at either 2 or 5.5 years after the fire. The depositional flows are presumed to have an abundance of water and agitation. Those normal conditions give buoyant forces the opportunity to separate the two materials and keep them from further mixing.

The Storm King Mountain debris flow contained median sand grain sizes nearly identical to those in the tan rocks at Dinosaur Ridge but had a broader range of sizes. Presumably, a greater transport distance for

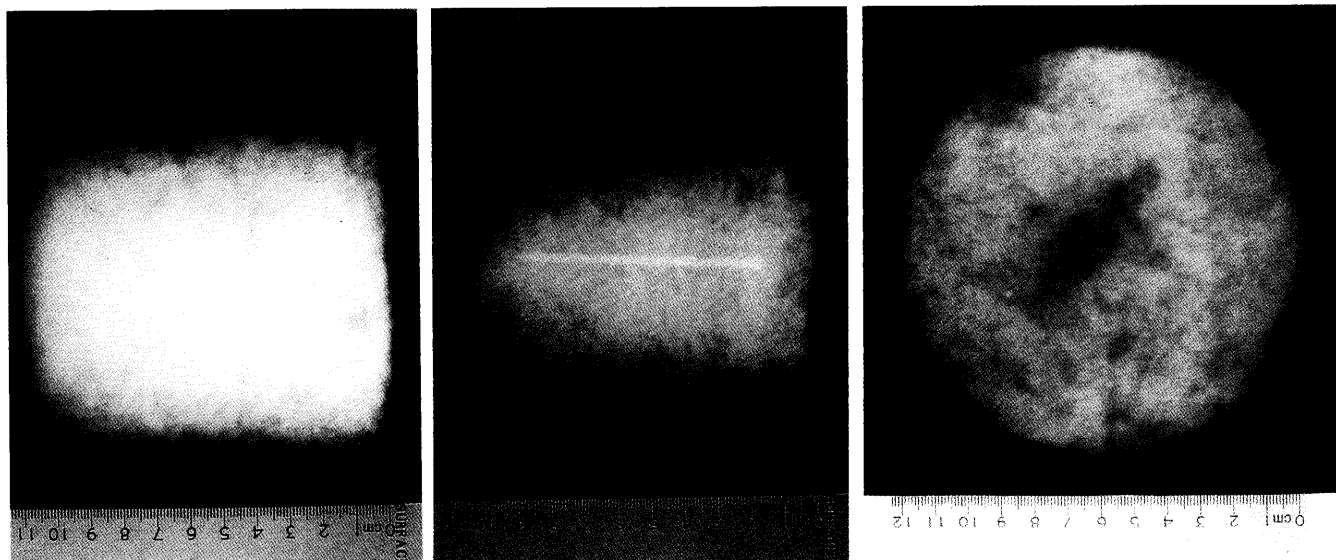


Figure 16. The three mutually perpendicular X-ray images of core #3 show nearly uniform mottling of shades like core #2 but the thickness makes the patterns less distinct. There is no general trend with depth in the images.

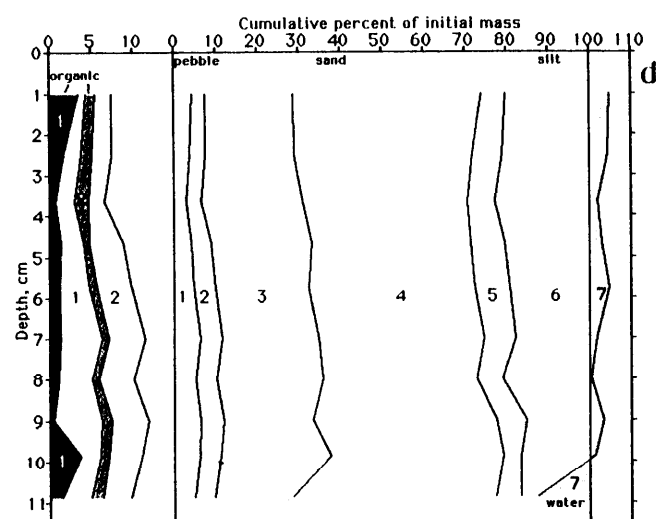


Figure 17. The size distribution of core #3 with depth. The pattern is like that of Figure 12, core #2, except for greater uniformity of the largest sizes (left) and excess water from processing. The large organic pieces are found throughout the core.

the Dinosaur Ridge materials caused a narrowing of the range of sizes.

More importantly, the Storm King cores showed the relative effects of buoyancy and viscosity. In core #1 the materials settled by density after the passage of the catastrophic debris flow. Larger sand grains were therefore on the bottom and nearly pure plant debris was on the top. This, like the Sugarloaf deposit, represents normal sedimentary conditions. Cores #2 and #3, however, contained charcoal and other vegetative fragments throughout their depths and at all resolvable sizes. This matches some of the distributions found at Dinosaur Ridge. There the plant deposits are of two types. In some samples, Holroyd (1996), Figures 2 and 5, the charcoal is mixed throughout the sand similar to cores #2 and #3. In others, like those shown at the left side of

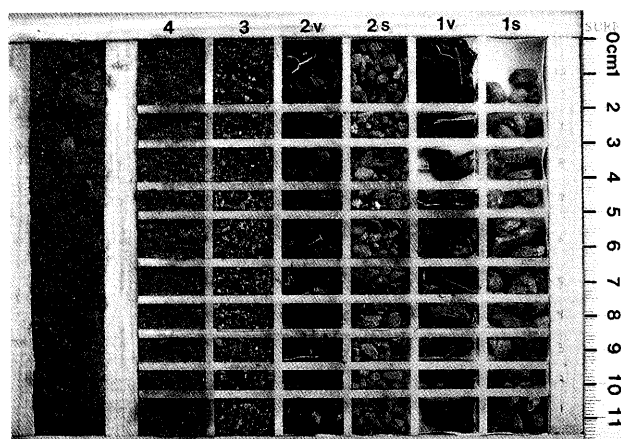


Figure 18. A tray containing a piece of the unsorted core #3 (left) and sieved samples (right partitions) from sieves 4 to 1 in the same sequence as Figure 13. There is less variation of large charcoal pieces with depth in the second column at the right. Charcoal fragments are also at all depths and sizes in core #3.

Holroyd (1992) Figure 4, there is a bedding surface on the cross-stratifications that contains a higher concentration of charcoal fragments. This matches the stratification pattern of core #1 and somewhat at Sugarloaf Mountain.

The different depositional frameworks are interpreted as follows and sketched in Figure 21. Plant deposits along bedding planes usually represent normal depositional processes strongly influenced by buoyancy, as at Sugarloaf Mountain. Materials between the bedding planes that have no inclusions of charcoal might be deposited either from slow or catastrophic processes, depending in part on whether or not charcoal was available for mixing into the strata. For most of the stratigraphic record it was apparently not available. The deposits with charcoal mixed throughout are those from catastrophic flows, whereby there is enough water for transport but not for separation. Those that have a



Figure 19. Much of the mud component diverted to the highway gutters, as shown here, and traveled farther across a lesser gradient than the boulder flow that crossed the Interstate on its way to the Colorado River.

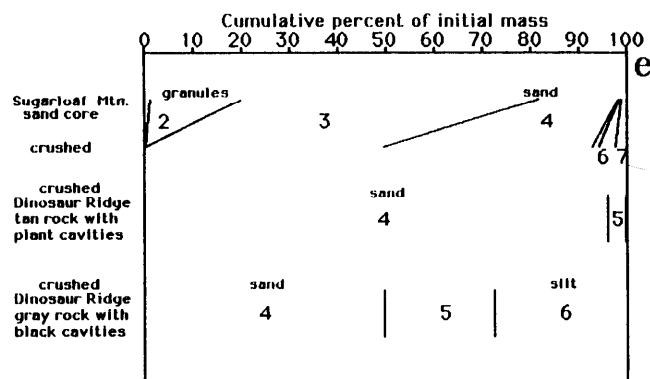


Figure 20. The size spectra of original and crushed Sugarloaf Mountain sand and two crushed rocks from Dinosaur Ridge that contained plant fragment impressions. Crushing reduced the sizes of the Sugarloaf grains but probably had a lesser effect on the finer Dinosaur Ridge grains.

higher concentration of charcoal at bedding surfaces than between them represent the aftermath of a catastrophic mud or debris flow, as in core #1.

Two Depositional Frameworks for charcoal in sand and silt:

1. slow (normal), as at Sugarloaf Mtn. fire site.

none within

along bedding planes only

2. fast (catastrophic), as at Storm King Mtn. fire site.

mixed within

afterwards along bedding planes

Figure 21. A sketch of the deposition frameworks of charcoal in sand and silt.

Just as the surfaces of the Storm King debris and mud flow deposits have a high concentration of large plant matter (as in Figure 10-after), so the bedding planes are the recipients of matter separated by buoyant forces. The concentrated lighter fragments are vulnerable to being swept away by normal stream flow or washed away by rainfall. However, if the deposit can dry sufficiently before the next flow of water or debris, then the fragments might become firmly attached to the bedding surface and less vulnerable to future displacement. The charcoal fragments cannot, however, remain exposed to weathering conditions for periods of hundreds or thousands of years in a uniformitarian scenario. They would oxidize or fragment to dust and become unavailable for preservation.

Therefore, the deposits containing charcoal mixed within them are interpreted as reflecting catastrophic deposits at Dinosaur Ridge. The bedded deposits of charcoal along the top surfaces of the flows reflect brief interludes before the next catastrophic flow. The lack of biological disturbances of the strata (animal burrows, tree roots, soil formation) emphasizes that little time occurred between the catastrophic flows. Some physical processes generated ripple patterns within the upper part of this Dakota series.

The style of study presented here is not difficult. The measurements can presumably be done by students with sieves, scales and some household items. The X-ray and aerial photographs are helpful primarily for illustration but are not critical. This low cost study addresses some important questions. Further research on mixed deposits of sand and charcoal therefore will have important implications for the distinction between catastrophic and uniformitarian depositional environments. More observations on the presence and absence of broken charcoal in recent and in fossil conditions are needed for a meaningful discussion. A discussion of the geographic extents of the charcoal and sand

mixture in the upper Dakota Formation is presented in Holroyd (1996).

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BOOK REVIEW

Genesis and the Big Bang, by Gerald L. Schroeder, Ph.D. 1990. Bantam Doubleday Dell. New York. 212 pages. \$11.95.

Reviewed by Eugene F. Chaffin*

How do you reconcile the findings of modern science with the findings of theology? Readers of the *Creation Research Society Quarterly* are familiar with the paradigms, models, and theories being considered by young-earth creationists. However, in this book we learn about how a physicist, oceanographer, and Jewish scholar views the creation. The author describes how the book resulted, in part, from discussions with his son. The son was educated in some conservative Jewish institutions while the father was educated in liberal western institutions. This led to discussions which resulted in this book.

The book accepts the Standard Model of cosmology, the Big Bang Model, as well as other branches of evolutionism such as punctuated equilibria. Interestingly, Jewish scholars and sources such as Maimonides, Nahmanides, and *The Babylonian Talmud* are quoted extensively. The opinions of these ancient sources are given equal weight to those of modern science, and viewed as having impeccable authority in matters of interpretation of the Pentateuch. For example, Nahmanides, the author of *Commentary on Genesis*, is given credit for referring to mass-energy duality (p. 40). However, Nahmanides lived in 1194 to 1270 A.D., over 600 years before Einstein. The theory of relativity is accepted without question and is referred to as the "law of relativity" (p. 34).

All of this would indicate a boring book, but there are some conclusions in the book which are not common among evolutionists today. The most exciting such conclusion deals with the nature of the first man, Adam.

It is only at the instant when God places in Adam this breath (in Hebrew the *neshamah*),

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that both the created and Creator become inseparably linked . . . In the jargon of relativistic physics, it was at the moment of Adam's appearance that the part of the universe where man dwells started to operate in the same space-time reference frame as its Creator. (p. 52)

The book goes on to postulate that before Adam was created, the literal days of creation were 24-hour days according to God's reference frame. The book accepts 15 billion years for the time elapsed in the Earth's reference frame, following the Standard Model.

Other interesting departures from evolutionary dogma include the statement that the probability that life could arise by chance is negligible even if 15 billion years are available (p. 159). Another concerns recognizing gaps in the fossil record. The Niles Eldredge statement: "The pattern [in the fossil record] that we were told to find for the last one hundred and twenty years does not exist." is quoted three times (pp. 25, 129, and 134). A third concerns acceptance of the extraordinary longevity of the Antediluvian patriarchs (p. 138).

On the negative side, the author accepts human evolution to have occurred starting from stardust and leading to Adam, the solar system evolved from a cloud of gas, dust, and rocks, and the inflationary epoch of the universe occurred within the first fractions of a second after the Big Bang singularity. On p. 28 it is stated that the Genesis Flood was so brief a period that "firm archaeological evidence may never be found."

I find that the book places too much credence in modern radiometric dating methods and other findings of modern science. Also, it is understandable that the Jewish scholars should be venerated, especially by an author who is Jewish, but I again find that too much is read into what they wrote. For instance, on p. 136 we find the statement: "The Talmud describes a swamp-like interface between earth and water as the place of origin of animal life." However, the Talmud does not carry the same weight as Scripture (Isaiah 29:13).

