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Articles

- Particle Physics and Paley's Watch** 73
Jerry Bergman and Don B. DeYoung
- Lichens: A Partnership for Life** 81
George F. Howe and Mark H. Armitage
- Frank Lewis Marsh: His Life and His Legacy** 94
Wayne Frair
- Natural Bridge, Virginia: Origin Speculations** 101
Emmett L. Williams
- The Feasible Same-Site Reappearance of the Tigris-Euphrates River System after the Global Flood** 106
John Woodmorappe
- An Evaluation of the Human Skeletal Remains and Artifacts Found in the Tomb of the Eagles on the Orkney Islands** 120
Lawson L. Schroeder, J.C. Campbell, and George H. Latta

Notes from the Panorama of Science

- Rate of Speleothem Formation: Observations in Country Limestone** 88
Jerry Akridge
- Time Warp I: The Permian-Triassic Boundary in the Texas Panhandle** 116
John K. Reed
- Floral Organs and Fossil Water Lilies** 135
Colin Brown
- Symmetric Variation Limits the Role of Gene Duplication** 159
Colin Brown

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Departments

- Book Reviews**
- The Call of Distant Mammoths* by Peter D. Ward 79
- "Newsnotes" by Alan M. MacRobert 80
- Christian Men of Science* by George Mulfinger and Julia Orozco 100
- Genesis of the Big Bang* by Ralph A. Alpher and Robert Herman 124
- How to Build a Time Machine* by Paul Davies 145
- Author and Title Index for Volume 38: 2001–2002** 127
Lazella M. Lawson
- Keyword Index for Volume 38:2001–2002** 131
Emmett L. Williams
- Minutes of the 2002 Creation Research Society Board of Directors Meeting** 134
David A. Kaufmann
- Letters to the Editor** 136
- Instructions for Authors** 146
- Membership/Subscription Application** 147
- Order Blank for Past Issues** 148

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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

Particle Physics and Paley's Watch

Jerry Bergman and Don B. DeYoung*

Abstract

This review of particle physics illustrates the energy-matter relationship in nature and describes the building blocks of the physical world. Particle physics research reveals that matter is far more complex than scientists imagined just decades ago. This poses a major challenge to naturalistic interpretations of the origin, existence, and maintenance of the universe. Various theories have been developed to account for the living world, including natural selection and genetic drift, but these mechanisms are not applicable to the inorganic

world revealed by particle physics. The failure of naturalism to explain the universe has resulted in a revival of Paley's watch hypothesis. It has also resulted in new attempts by philosophical naturalists to deal with these discoveries. This includes the blind watchmaker hypothesis, an attempt to show how a universe that looks like it was created by intelligence actually came into being spontaneously. However, evidence shows that the universe, and especially the earth, was clearly designed to support human life.

Introduction

The *teleological* argument, often called the argument from design, has always been a major evidence for the Creator's existence. The best known illustration of teleology is Paley's watch analogy, first introduced in his *Natural Theology* in 1802. If a traveler finds a watch beside a path, its specific complexity will convince him that it has an intelligent maker. This analogy has traditionally been used to argue for theism in the biological world, and now is used to argue for theism in the atomic world as well (DeYoung, 1985).

A century ago it was thought that atoms were simple, small, and homogeneous masses of uniform shape, or perhaps a specific set of definite shapes. The last century of research on submicroscopic matter has revealed a new and far more complex watch-like atomic and subatomic structure than anyone earlier imagined, especially in the realm of elementary particles. These research findings eloquently support the Paley's watch hypothesis (see Barrow and Tipler, 1986).

The implications for theology of the level of complexity in the subatomic world has long been recognized by many leading scientists such as Arthur H. Compton:

Who is there who has not asked himself, 'What is this world around me?' Rocks, trees, people—what

are the parts of which they are made, and how are these parts put together? ... When we take apart this infinitely complex mechanism which we call dirt, or perhaps a diamond, or it may be a flower, we find it made up of a myriad of tiny molecules. Each of these molecules is itself complex but is more perfectly formed than the wheels of a watch, and has continued to run . . . without winding and without wear. We find that the molecules which make up matter in all its endless variety of forms are themselves built up of a few hundred kinds of atoms (Compton, 1929, p.110).

Physics research has discovered a whole new world consisting of many elementary particles, but scientists are still unable to explain *why* these particles exist and exactly how they work to produce the world at the macro-molecular level.

A person can take apart a watch to study its intricate movements, can graph its motions and formulate laws that describe the relationships of the hundreds of parts observed, and still not understand *its origin* at the most basic level. Likewise, scientists have observed, measured, charted, analyzed, and graphed the atomic and subatomic world but still do not understand how it works at the most fundamental level nor can they explain its origin.

Attempts have been made to use mutations and natural selection as an explanation for the origin of complexity in the living world. Conversely, analogies to mutations and natural selection—most commonly the “many universes hypothesis”—have failed to explain the order, complexity,

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and design existing in the submicroscopic world researched by particle physics. Electrons, protons, neutrons, and smaller particles undergo rearrangement due to both external and internal forces, but because they do not reproduce or mutate as do genes, evolution by natural selection is not involved in their creation (Lahav, 1999). These particles have maintained their physical properties since the Creation. Like a watch, atomic particles produce an intricate mechanical system which enables life to exist. The most that researchers achieve is a description of the submicroscopic world and a mathematical analysis of it.

Research has produced an enormous body of knowledge that helps scientists to formulate laws and delineate patterns and relationships, but comparatively little understanding exists of the *why* of that which is discovered (Feynman, 1985). Physical laws only summarize what we observe, they do not explain it. Many phenomenon happen in a lawful, probabilistic way, but without a known reason or identifiable cause. The complexity of the building blocks of matter is such that even the long-established law of causality has been questioned by some. Of course, because the cause of something is unknown does not prove that a cause does not exist, only that we have not yet identified it.

The law of gravity is a good example. Scientists can accurately describe gravity but they cannot adequately *explain* how gravity “works.” The four fundamental forces—gravity, electromagnetic, and the strong and weak nuclear forces—are “fundamental” because “they cannot be accounted for in terms of anything else” (Beiser, 1992). Scientists do not know their cause. The original goal of particle physics was to discover the most basic building blocks of the universe by breaking matter into smaller and smaller pieces, eventually arriving at the smallest units possible. However, the results have produced so much data that most particle physicists spend the majority of their time attempting to make sense of the findings.

The Structure of the Atom

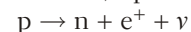
The atom was once believed to be a unit of indivisible mass as the word *ατομος* (Greek for *cannot cut*) implies. Then when the atom was discovered to contain inner “parts” that were emitted during radioactive decay, it was viewed as a container with its parts somewhat randomly joined together. Researchers have now revealed the atom to be an incredibly intricate mechanical structure (see Cox, 1989). Even minor changes in this structure can radically modify the properties of the atomic unit called an element. The formation of isotopes, isomers, and ions are excellent examples. The precision of the total structure, including its mass and energy, is extremely critical. Yet within this precision exists a measure of adaptive ability, a

trait that is also common to living things. One basic example of this plasticity, yielding, or adaptivity ability, is covalent bonding between many kinds of atoms.

Probability is a major design feature of the universe because it can be used to ensure that a system works. The atom’s behavior is fully predictable not because electrons are in a specific place at a specific time as required of a watch, but because given a large number of atoms, enough electrons will be within a certain region to guarantee the system works. Precision follows from probability because only a high probability is required for the system to work properly. The total unit functions only because the atom’s workings as a *whole* are precise.

As watch parts must be machined within certain tolerances to function properly in the assembled unit, in like manner the subatomic particles’ characteristics must be within certain narrow tolerances. The mass of each electron is 9.1094×10^{-31} kg and does not measurably deviate from this value. As far as we are able to determine, every particular subatomic particle is identical, i.e., every proton is perfectly identical to every other proton and every atom is identical to every other one of that isotope. Although *The Handbook of Chemistry and Physics* provides ranges for the characteristics of subatomic particles, these are *measurement errors* and not tolerances of the particles themselves. All subatomic particles are clearly identical to an incredible degree, manifesting clear evidence of unity.

Subatomic particles are not only identical but also carefully selected for their purpose. One example of this precision is the mass of the proton. If the proton mass was *slightly* greater or less, the universe as we know it could not exist (Fritzsche, 1983; DeYoung, 1985). The proton’s mass must be slightly less than the neutron’s mass. If proton mass was larger by just 0.2 percent, it would be unstable, rapidly decaying into a neutron, a positron, and a neutrino:



All hydrogen nuclei (which consist of a single proton) then would decay within minutes. Furthermore, hydrogen is a major component of our bodies, as well as water molecules, the sun, and all the other stars. Hydrogen is, after all, the dominant element in the universe. Therefore the proton’s mass has been wisely chosen to prevent the collapse of the entire universe. Likewise, if the properties of the other stable particles were slightly altered, the biomolecules of life could not exist.

The atom’s nucleus and the electrons revolving around it form a definite structure consisting of complex orbitals and suborbitals. If the nucleus were the size of a tennis ball, the diameter of the atom would be from two to twenty miles, depending upon the particular element. Hydrogen is the smallest atom, and meitnerium (number 109) is currently the largest known and named atom. Fully 99.95 percent of an atom’s mass exists in the nucleus, a structure that is only 0.001 of the entire volume of the atom. This

nucleus is very densely packed together so that a pin-head size piece of pure nuclear matter would weigh about a million tons.

The electrons travel around the nucleus at a speed estimated at about six thousand miles per second (3 percent of light speed). They produce an energy cloud and a force field which totally surrounds the nucleus (Sutton, 1984). The nucleus itself was once believed to be simply a set of parts held together in a spherical shape, but it is now known to be a complex, ordered structure (Flam, 1994). Its components are assembled according to very definite energy levels and the behavior and properties of each chemical element ultimately depends upon this specific structure. To achieve stability and carry out their role, the protons and neutrons likely travel in “orbits” within the nucleus at enormous speeds. Three nuclear models that help us understand how the nucleus behaves will be described here.

1. The nuclear *shell model* focuses on the nucleus as a tiny solar system. The protons and neutrons move in sub-nuclear orbits similar to those of electrons, with paths determined by their energy. The nucleons themselves travel at speeds estimated up to 100,000 miles per second, over 50 percent of light speed (Penrose and Isham, 1986). The shell model is consistent with a hierarchy of similarly *created* patterns of orbital motion: the nucleus, atom, solar system, galaxies, and galaxy clusters.

2. The *optical model* views the nucleus as a *collective unit*. When a stream of bombarding particles collides with a nucleus, a small portion is reflected, some are refracted, and others are absorbed somewhat like the passage of light through a clouded crystal ball. This model is several decades old and is fairly successful in predicting many physical results.

3. The *liquid drop model* was developed by several theorists including Niels Bohr, Lise Meitner, Otto Hahn, J. A. Wheeler, and others in the 1930s to explain the process of nuclear fission. This model focuses on the nucleus as a group of tightly packed spheres. If one is hit, all the others respond and move in a predictable way, as if coupled by springs. The vibration is such that if enough force or a high enough level of instability exists the nuclei can separate in two, much like a liquid drop separating into smaller droplets.

Although the nucleus is tightly packed, its nucleons apparently slide over each other without touching and without friction, meaning that the nucleus as a whole behaves as a superfluid (Bertsch, 1983). This is an “ideal fluid” which exhibits frictionless flow somewhat like superconductivity. Pairs of nucleons also spin in opposite directions as they travel in their defined orbits. If the number of both neutrons and protons is even, the nucleus as a whole has no net unbalanced internal rotational angular momentum.

The entire nucleus generally rotates relatively slowly in contrast to the individual nucleons’ rapid rotation. As with a spinning raw egg, if stopped and then released, the rotational inertial motion of the fluid inside the egg will cause it to again resume spinning. The nucleus shows similar rotational behavior. This description gives a brief glimpse into one frontier of physics concerning the nucleus. On a deeper level, the nuclear force that holds the nucleons tightly together remains poorly understood. Only the Creator knows the ultimate details of the ever smaller components of His created matter.

The Particle Zoo

According to current theory, all known matter is built from two basic kinds of elementary particles, called *quarks* and *leptons*. The quarks are trapped inside larger particles (usually protons and neutrons) and have not been demonstrated to exist in isolation, even in accelerator collisions. Conversely, leptons can travel outside of and commonly exist independently of an atom. Quarks respond to the strong nuclear force while leptons do not (Fritzsch, 1983).

The six kinds of leptons are the electron, electron neutrino, muon, muon neutrino, tau, and tau neutrino. Each also has an antiparticle, bringing the total number of particles in this family to twelve. Of the six leptons, the electron is by far the best known. Except for the neutrino, we do not yet know why the other four leptons exist; they have been called the “vestigial organs” of physics (Maddox, 1991). The term *lepton* is Greek for small or light.

There are six kinds of quarks called *up*, *down*, *strange*, *charmed*, *bottom*, and the *top* or *truth* quark. These six quark variations are sometimes called *flavors*. Each quark further has three varieties or *degrees of freedom*, labeled by the colors red, green and blue to distinguish them. Actual colors do not exist on this level since quarks are much smaller than the wavelength of visible light. Each quark variety also has an antiparticle equivalent, identical except for electrical charge. Altogether then there are 36 distinct quarks (Figure 1). The proton consists of two up and one down quark (uud), and the neutron consists of two down and one up quark (ddu). An anti-proton ($\bar{p}$) consists of two anti-up and one anti-down quarks.

Researchers have probed quarks to distance scales below 10^{-18} meter and find evidence that quarks themselves may consist of still smaller particles. Ferris (1988, p. 295) uses an illustration to show how small this is: “If a single atom was enlarged to the dimension of the earth, any subcomponents of quarks and leptons would have to be smaller than a grapefruit to have escaped detection.” Although this is very small, we still have a long way to go because smallness extends to infinity. However, there is a theoretical conclusion that the Planck-length, or 10^{-35} m,

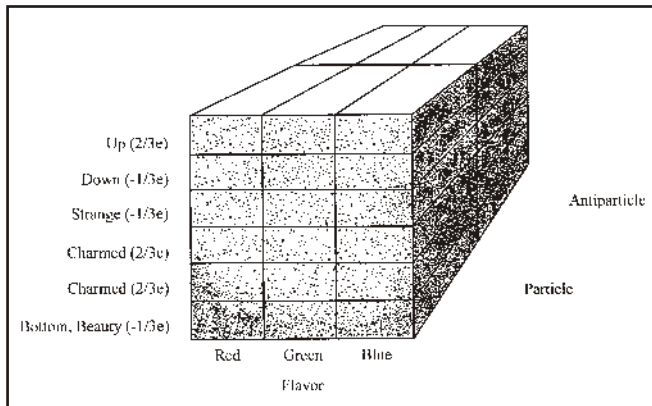


Figure 1. A graphical summary of the 36 distinct types of quarks.

is the ultimate lower limit on detectable, measurable lengths.

Matter and Force Carrying Particles: As another way to categorize particles, the micro-world is composed of two particle types, *fermions* after Enrico Fermi (1901–1954) and *bosons* after Satyendra Nath Bose (1894–1974). The fermions include all matter particles, and the bosons all force-carrying particles (Weinberg, 1996). Fermions include the proton, electron, and neutron. Bosons include the photon and gluon particles.

When traveling through a vacuum, neutrinos and photons move at the speed of light, never slower or faster. When photons travel through matter, they slow down due to absorption and reradiation. But neutrinos do not interact with any of the four forces except the weak nuclear force, and are much more penetrating. Thus the estimated ten-billion neutrinos that zip through every square inch of the earth every second rarely interact with anything (Winter, 1992).

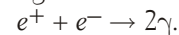
The neutrino was first hypothesized by Pauli to account for the difference between the calculated mass energy from a beta decay reaction and the actual energy level measured (Tayler, 1981). The particle was named *neutrino* (Italian for *little neutral one*) by Fermi in 1934. Three types of neutrinos exist: electron neutrinos, muon neutrinos, and tau neutrinos (Asimov, 1992). The reactions that produce the sun's energy are believed to convert hydrogen to helium, releasing electron neutrinos in the process. This is also the hypothesized origin of neutrinos that come from outer space. Because so many of them exist, if they turn out to have a rest-mass above zero, as now indicated, their collective mass may outweigh the entire mass of visible galaxies.

Anti-Particles: Anti-particles are so named not because they are *against* anything but because each known particle type has a companion particle that is identical but opposite in charge and certain other traits. Matter and anti-matter both have mass, take up space, and can be discerned by the human senses. Anti-matter was first predicted from Paul

Dirac's symmetry theory and later confirmed in the laboratory. Anti-matter is influenced by gravity just as is matter.

The mate of an *electron* (e^-) is a *positron* (e^+), of a *proton* (p^+), an *anti-proton* ($\bar{p}$), and of a *neutron* (n), an *anti-neutron* ($\bar{n}$). A neutron is a *neutral particle* and has no charge. Instead the anti-neutron has a *magnetic moment* sign opposite to that of a neutron. Magnetic moment is the magnetic field that results from the spin of a particle. All of the known subatomic particles have corresponding anti-particles.

As ordinary anti-matter, a positron usually has an extremely short existence because soon after it forms in a reaction it is attracted to an electron and annihilated. Collisions between a positron and an electron result in the conversion of their masses into energy according to the famous $E = mc^2$ relationship. This process produces high energy electromagnetic gamma radiation (γ) shown by:



The inverse reaction, namely *electron-positron* creation or "pair production" ($\gamma \rightarrow e^- + e^+$) is commonly used to produce positrons (Parker, 1988). The existence of anti-matter on the earth is limited primarily to that produced artificially in the laboratory. However, some older versions of the big bang model also predict equal amounts of matter and anti-matter in space. Anti-matter atoms are as stable as matter if they do not collide and react with matter. Some astronomers even hypothesize regions of "anti-universe" that consist of anti-planets, anti-stars, and anti-galaxies. If an *anti-matter* galaxy came in contact with a *matter* galaxy, large scale annihilation would result. No such energetic events are observed in space.

Cosmic Rays: To produce most anti-particles requires high energy collisions of about 30 gigaelectron (10^9) volts, such as is produced at the Brookhaven Synchrotron where much of the research on anti-matter was completed. Another event that naturally produces anti-matter is the collision of cosmic rays with atomic nuclei that regularly occurs in the upper atmosphere. Such collisions can be more energetic than anything produced by accelerators.

Almost all cosmic rays are *charged nuclei* of atoms. About 90 percent are single protons (hydrogen nuclei), and most of the rest are nuclei from stable elements, mostly light elements, but may include elements from helium to lead (Friedlander, 1989). Their energies vary from 10^9 eV to as high as 10^{20} eV or more.

The relatively young Vela supernova is a prime contributor of cosmic rays that strike the earth (Erlykin and Wolfendale, 1997). Cosmic rays themselves rarely make it to the earth's surface unchanged. Our atmosphere is one of several protective shields provided for the earth. When cosmic rays enter the earth's atmosphere they collide with air atoms and the collision produces a shower of secondary particles, often *muons*. These are leptons similar to electrons but 207 times as massive. The secondary particles

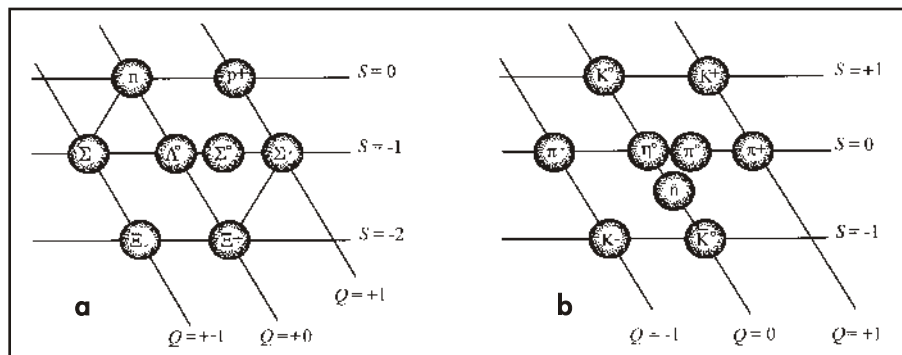


Figure 2. (a) The hexagonal Eightfold Way pattern for the eight spin-1/2 baryons. This strangeness versus charge plot uses a sloping axis for the charge number Q . (b) The Eightfold Way pattern for the nine spin-zero mesons.

collide with an increasing number of air particles as they move toward the earth, producing an ever enlarging cone shaped shower of new particles.

If the primary ray contains enough energy, the cascade effect will reach the earth's surface. The end of the flow is usually around one hundred yards in diameter and can contain up to a billion particles. Many of these particles are electrons, but large numbers are muons. A few muons from cosmic rays pass through every human on Earth every second.

Additional Particle Properties

Mass. Mass is determined by measuring the gravity force acting on an object, or by measuring the object's momentum which is the product of its mass and velocity. The mass of many particles is extremely small and can be given as the ratio of the particle to that of an electron, which may be set at a value of one. A proton has 1,836 times the mass of an electron, and the *omega hyperon* has fully 3,276 times an electron's mass. The mass value is also given in terms of the energy necessary to create the particle, measured in *electron volts* (eV). An eV is the energy needed to move an electron through a potential difference of one volt. Each molecular reaction in a typical flashlight battery produces about 1.5 electron volts of chemical energy.

Electric charge. All particles have either a positive, negative, or neutral electrical charge. Most hadron and lepton particles have a charge of +1, 0, or -1, but particles with a charge of +2, -2, +3, -3 and other multiples are known. Quarks have charges of +1/3, +2/3 and -1/3 and -2/3. Many particles exist in all three basic charge states. An example is a *pion* which can be either a *pion-plus*, *pion-minus*, or *pion-naught* (+1, -1, 0).

Magnetic moment. Magnetic moment describes the magnetic field that is always associated with a spinning charged particle. All spinning charged particles manifest the characteristics of a tiny magnet that allows them to line

up and reorient themselves when placed in a magnetic field. The atom's spin is determined to be either in the direction of the magnetic field or in the opposite direction only, and thus it too is quantized. This conclusion was supported by the famous 1924 Otto Stern-W. Gerlach experiment.

Parity. Parity is a comparison between an object and its mirror image. There are two possibilities. A particle may look the same as its reflection, for example a sphere or cylinder. Or the particle may be obviously reversed, such as many written letters would be.

Symmetric particles which do not change in mirror reflection are assigned the *even parity* number +1. Particles which are reversed are given the odd parity number -1. Parity is a quantum number, and is conserved in interactions when the parity of the products is equal to the parity of the initial reactant. The evidence indicates that parity is conserved in strong nuclear interactions, but in weak nuclear interactions such as beta decay, it is not conserved.

Half life. Half-life refers to the rate of decay or conversion of an unstable particle into other particle combinations. For short decay rates, this value is typically measured by calculating the distance that the particle travels before it decays and then dividing by its velocity (Weinberg, 1996).

Symmetry and Conservation

Several physical quantities in nature including energy, momentum, and electric charge display constancy or conservation. Why these conservation laws exist cannot be explained by natural science alone. Creationists would conclude that they display the profound dependability and predictability planned in the Creation. Conservation rules are multiplied in the realm of elementary particles. Consider two examples. The category of *strange* particles include kaons, lambdas, and sigmas. It is found experimentally that these strange particles are always produced in pairs. This property is called conservation of strangeness. Second, particle interactions usually obey conservation of quantum numbers including spin, baryon number, lepton number, strangeness, and electric charge. Fascinating diagrams result from these properties. For example suppose we plot strangeness (S) against electric charge (Q) for the eight baryon particles that all have a spin of one half. Figure 2a shows the result, a hexagon. Likewise one can group the nine mesons which all have spin zero, and a similar picture results (Figure 2b). These symmetric patterns are called the *eightfold way*, first shown by Murray Gell-Mann in 1961.

Alternate grouping produces other patterns, for example a ten pin bowling pattern. Some researchers even have tried to connect these patterns with New Age concepts or Eastern Mysticism. Instead, however, physicists are actually discovering the partial, poorly understood picture of the elegant symmetry of the created building blocks of matter.

Exotic Matter

The basic building blocks of the universe can be assembled to produce new types of atoms with unusual characteristics. For example, a *negative muon*, since it is similar to an electron, can take the place of an electron and orbit around a deuterium nucleus (Parker, 1988). As a muon orbits two-hundred times more closely to the nucleus than an electron, a pair of deuterium nuclei with an orbiting muon can come so close together that the two nuclei fuse, expelling the muon, which then soon orbits another nucleus, causing another fusion and another expelling (Flam, 1994). The process then continues until the building blocks are exhausted.

Conclusions

The goal of particle research is to understand the universe and to learn how it functions. We have come a long way from the simple conception of a universe consisting only of a few types of solid atoms. The existence of an estimated 500 subatomic particles shows that our attempts to simplify the universe by formulating a few basic laws that explain a large amount of information have been thwarted by a high level of complexity. The purpose or function of most of these particles in the universe is not yet understood, but we maintain that all of these subatomic particles will eventually be found to have a critical function in the universe to support life.

Why are there twelve leptons, when the Universe seems to contain only electrons and electron neutrinos in appreciable numbers? Electron antineutrinos are produced only in radioactive transformations, which are few in number in the Universe as a whole. Positrons are produced in some radioactive transformations, but less often even than electron antineutrinos. The heavier leptons and their neutrinos are produced, as far as we know, only in the laboratory by such things as cosmic-ray bombardment. Why, then, doesn't the Universe get by on just electrons and electron neutrinos? Why needlessly complicate things? (Asimov, 1992, p.251).

Asimov concludes that the complexity discovered by particle physics exist for a reason and are not needless.

The universe is built in such a way that every interaction must play its role. We might not see what possible use the tauon has, for instance, but I have the strong feeling that whatever it is that makes the Universe work as it does requires the tauon's existence; that *without the tauon the Universe would not be the Universe we live in and might not even have the capacity to exist* (Asimov, 1992, p. 252 emphasis ours).

The theory that the entire particle zoo is constructed from complex fundamental particles called quarks and leptons does not explain their source. And both quarks and leptons have shown evidence of having an internal structure below 10^{-18} meters. Will these subquarks also show evidence of yet smaller particles? We now know that the multiple levels of hierarchical structure, from subatomic particles to galaxy clusters, are all integrated and functional because of the other levels (DeYoung, 1987).

All of the particles so far identified have very definite traits which indicate that each one has a watch-like structure. The description of the particle traits show that they are quantized, meaning they exist in discrete units. The conclusion that they were all designed to produce a universe that can support life is a logical deduction. Although we understand the role of only a few of these particles, hundreds more could exist, all of which no-doubt play a role in creation just as all body parts play a role in life (Breuer, 1991). Particle physics research has revealed the fact that properties are such that only slight modifications would not allow stable atoms to exist. According to theorists including particle physicists John Polkinghorne, this new knowledge of particle physics

constitutes a triumphant new natural theology . . . the new natural theology is different from that of Saint Thomas Aquinas and the eighteenth-century English theologian and philosopher William Paley—who argued, famously, that the mechanism of the eye could be understood only as the creation of an intelligent designer. By contrast, the new natural theology, Polkinghorne says bases “its arguments not on particular occurrences (the coming-to-be of the eye or of life itself), but on the character of the physical fabric of the world which is the necessary ground for the possibility of any occurrence.” For Polkinghorne, then, the very existence and nature of the physical universe is testimony both to its divine origin and to its inherent cosmic purposefulness (Wertheim, 1999 p. 40).

Physicists believe that every subparticle of the same species is exactly alike—every electron is exactly like every other electron in the universe, and the same is true of all subatomic particles. Further, their behavior is so orderly we summarize it in statements called laws. Why do patterns, symmetry, and laws exist in nature? Some experts might answer that the task of science is to find out only *how*

nature works, not *why*. But this response reveals the incompleteness of natural science alone. Ultimate truth about the universe must also deal with God's construction and continuing oversight of His creation.

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Book Review

The Call of Distant Mammoths by Peter D. Ward Springer-Verlag, New York. 1997, 241 pages, \$26

Author Ward is a faculty paleontologist living in Seattle. He has written several excellent previous books about natural history. This time he tackles the question of what killed off the mammoths just “10,000 years ago.” There are two competing ideas: a gradual, cold climate change or extinction from human hunting. Ward visits earth locations in the past using an imaginary time machine. There are good descriptions of dinosaur habitat, the hypothesized Chixulub impact event, and early American Clovis people.

Scientist Don Fisher has made careful analysis of mammoth tusks and they provide a “diary” of the animals’ life (p.216). This data reveals mammoth diet, health, and even the birth rate for females. The conclusion is that mammoths lived during a cooler period, but they show little sign of stress or starvation. Ward therefore concludes that mammoths along with 50 other large North American mammal species were hunted to extinction by people over a rapid 1,000 year period. Mammoths may have been slowly *dying out*, but mankind made them *die out* (p.191).

One mammoth fossil was found in Naco, Arizona with 8 imbedded Clovis spear points (p. 128). Some other carcasses show signs of butchering.

Many creationists would suggest that a combination of the post-flood ice age and human hunting finished off the mammoths about 4,000 years ago. The author mentions creationist thinking, but he shows very little understanding (p.46). He suggests that creationists are lazy and that they invoke the miraculous rather than “do the hard work of scientific explanation” (p.90). Ward obviously does not comprehend the Biblical basis for creation.

At the end of the book Ward takes his time machine 1,000 years into the future, and his view is pessimistic. All

remaining large mammals are gone, along with all forests. Genetically-altered crops are grown worldwide. All white-skinned people have been killed off by skin cancer with the demise of the ozone shield. With 100 species going extinct every day since the 1900s, future zoos are greatly impoverished. The only way to avoid this scenario, Ward believes, is to reduce human population. This naturalistic view of the past, present, and future is basically depressing. Not only is the creation worldview a refreshing alternative, it is also much more optimistic.

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“Newsnotes” by Alan M. MacRobert *Sky & Telescope* 104, June 2002, Pp. 19, 28

Two short “Newsnotes” in this *Sky & Telescope* issue demonstrate how the astronomy establishment handles contradictory evidence to the standard interpretation of redshift (greater redshift being equal to greater distance from the earth) and casts doubt on gravitational lensing results. In the first “Newsnote” titled “Binary Quasar Is No Mirage” a binary quasar (Q2345+007A and B) found in the constellation Pisces was originally identified as a candidate for a gravitationally imaged single quasar with redshift of 2.15 (p. 19). The redshift using Hubble’s Law would put it at 11 billion light years from earth and the lensing formation would require the gravity of 100 million Milky Way galaxies somewhere between it and earth. The lensing formation is not visible so conjecture had it that pure concentrated dark matter had been discovered. Recently X-ray photos were obtained of the binary and it was found that these two sources have different X-ray spectra signifying they could not be two images of the same source. Nothing is said about the fact that quasars are not bright enough to be detected at 11 billion light years direct line of sight. This discovery seems to be another example demonstrating Halton Arp’s intrinsic redshift theory and his belief that there is no gravitational lensing (Arp, 1998, p.169–193).

The second “Newsnote” on (p. 28) titled “Lensed Galaxy Sets New Redshift Record” tells of the greatest redshift for a galaxy ever recorded that was found in Cetus and supposedly gravitationally magnified 4.5X by cluster Abell 370 (preprint article Hu, E. M. et al., 2002). It has a redshift of 6.56, which the standard interpretation puts at 13 billion light years distance and at the end of the reionizing epoch. Since this is a single galaxy the test used above to determine whether the object is magnified by a lens or not would not be applicable. But if Arp’s interpretation of redshift being intrinsic to galaxies is correct this gal-

axy may not be magnified by a lens and therefore may be located much closer than calculated. The quandary this leaves us in is who to believe concerning what redshift really means.

Big Bang evolutionists have to believe that redshift is proportional to distance in an ever expanding universe because it is one of the pillars their theory depends on. They also have to believe in gravitational lenses and therefore in most cases lots of dark matter to provide the gravitational potential required to bring the faraway objects close enough to detect. Steady state evolutionists like Arp need to explain redshifts so that they are intrinsic to quasars and galaxies so that the universe never had a beginning. Creationists need to look at both these interpretations of redshift skeptically because both are driven by the evolutionary worldview of the astronomers interpreting the data. Creationists need to find the true interpretation of redshift and of course it needs to be consistent with the revealed worldview provided by the Creator.

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Lichens: A Partnership for Life (A Van Andel Creation Research Center Report)

George F. Howe and Mark H. Armitage*

Abstract

This is the first in a series of papers in which we discuss lichens growing on rocks at the Van Andel Creation Research Center, (VACRC), Chino Valley, Arizona. We introduce lichens in general, dealing with their nature, size, growth rate, mor-

phology, distribution, physiology, taxonomy, reproduction, and laboratory growth in this paper. We also analyze aspects of the origin of lichens from both the creationist and macroevolutionary perspectives.

Characteristics of Lichens

Lichens are plants that consist of a particular fungus growing in close contact with an alga (plural algae). The lichen is a third entity, which results from this partnership:

Lichens are an association of specific fungi and algae so intimate in terms of functional interdependence and so integrated morphologically that a sort of third kind of organism resembling neither of its components is formed. Odum (1983, p. 400). An association between a fungus and an alga that develops into a unique morphological form that is distinct from either partner is termed a lichen. Moore-Landecker (1972, p. 380). When we consider one lichen, we seem to be dealing with three plants: a fungus, an alga, and the composite form... Amadjian (1967, p. 1).

It has been generally assumed that the alga of a lichen supplies food to its fungus while the fungus in turn provides such benefits as water, shade, minerals, and protection for its algal partner (Fuller et al., 1972, p. 380). The alga and fungus supposedly form a mutualistic symbiotic union in which they both benefit. Concerning the algae, however, Bessey (1971, p. 216) wrote that the "...constant tribute levied in the form of food substances diffusing out from the cells must reduce their vigor somewhat."

Using radioactive tracer nuclides, workers have demonstrated that photosynthetic products of the alga do indeed enter the cells of the fungus partner, where they are readily stored (Moore-Landecker, 1971, p. 385). Carbon-14 experiments demonstrated that about 70% of the carbon-14

fixed by *Nostoc* in the *Peltigra* lichen quickly showed up as carbon in mannitol molecules within the nearby fungus cells (Smith, 1973, pp. 11–12).

The fungal strands called hyphae predominate when it comes to the biomass of a lichen (Hale, 1961, p. 3). D.C. Smith (1973, p. 16) indicated that although the alga makes up only about 10–20% or less of the dry weight of a lichen, it supplies all the food. Webster (1980, p. 368) found no evidence that minerals, water, or other substances move from the fungus to the alga, although many authors like Haupt (1956, p. 311) have assumed that the fungus does supply such items to its algal partner. "The benefit gained by the alga from the association is not at all clear," according to D.C. Smith (1973, p. 7).

Stern (1997, p. 338) called the lichen relationship a "controlled parasitism" on the part of the fungus. Daubenmire (1959, p. 313) wrote that the many lichen fungi manifest varying degrees of symbiosis, all the way from a balanced mutualism to a parasitism in which the fungus actually sends hyphae called haustoria into the algal host cells. Delevoryas (1966, p. 34) agreed that the fungus/alga relationship in the lichen is probably parasitic to some extent but "...not severe enough to harm the algal host".

Most Lichens are Epiphytes

Like mosses, many lichens grow upon trees where they are simply epiphytes which means they are plants that live upon other plants but do not parasitize them (Stern, 1997, p. 339). A few lichens, however, are known to attack nearby moss plants which may be destroyed as a result (Bessey, 1971, pp. 217–218). Some tropical lichens have likewise been observed to invade leaves of plants by entering the leaf pores (stomates) and then parasitizing the leaf tissues (Bessey, 1971, p. 217).

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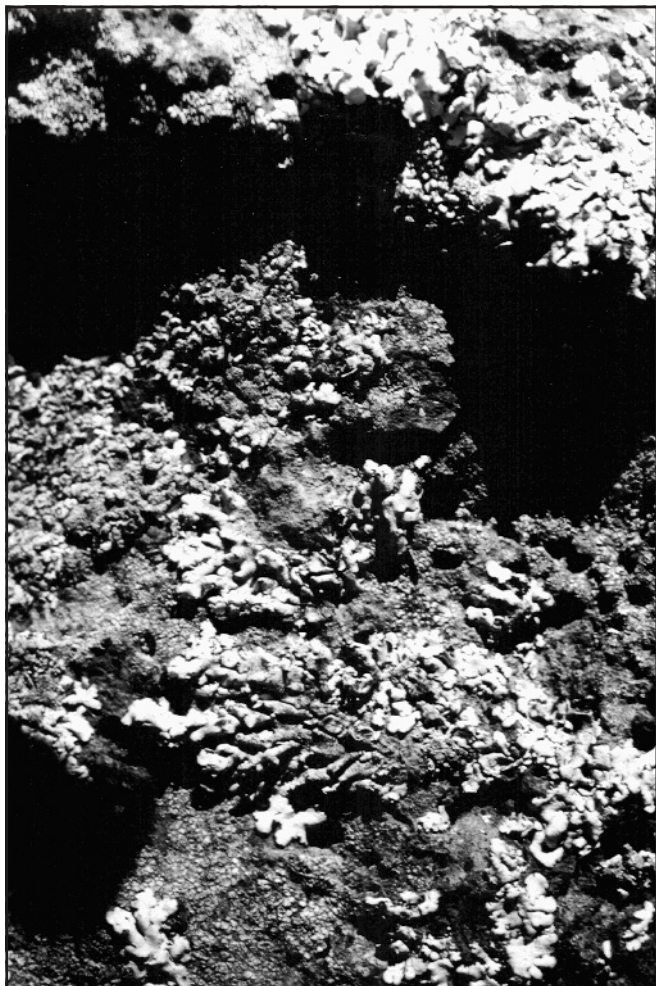


Figure 1. Foliose lichens. The large colonies of foliose lichen seen at the top right and in the lower third of this photograph are *Xanthoparmelia* (States, 1990, pp.208-209; Hale, 1979, p. 159). Although attached to rocks at various points, sections of a foliose lichen curve up from the rock, like miniature leaf-like lobes.

Lichen Growth Rates

Lichens grow very slowly and this is thought to be attributable largely to the slow growth of the algal partner. It has been shown in culture experiments, however, that the lichen fungi also grow quite slowly. The growth rates of three lichens and a moss have been observed at VACRC over a period of 14 years and will be reported in a later paper.

How Big Is a Lichen?

Lichen colonies range widely in size from those which are barely visible (one millimeter in diameter) to some which are up to two meters across (Stern, 1997, p.338). The very large lichen colonies are thought to be quite old.



Figure 2. Crustose lichens. *Acarospora* (visible on the lower rock from center to left) is a lemon-yellow colored lichen classed as being crustose because it adheres closely to the rock surface throughout its thallus (States, 1990, pp.208-209; Hale, 1979, pp.32 and frontice picture). Note the small sections (areoles) separated from each other by cracks. There are no fruticose lichens at VACRC.

The Form of Lichens

The lichen plant body is called a thallus (thalli plural) because it does not have organs like leaves or stems. Morphologically lichen thalli fall into three overall growth forms: crustose, foliose, and fruticose:

If the lichen forms a crustlike growth closely appressed to the substratum, it is termed a crustose lichen ... if a leafy growth projecting from the substratum, a foliose lichen... and if a branching bushy growth mostly free from the substratum, a fruticose...(Fuller *et al.*, 1972, pp. 380–381)

Bessey (1971, p. 217) reported that the term “fruticose” comes from *frutex* which means shrub in Latin. Bessey also indicated that some lichens can change from one type to another as they grow and that in some lichens the distinction between these three morphological phases (crustose, foliose, fruticose) is not clear. We have not found fruticose lichens at VACRC.

In describing the types of lichen plant bodies, Doyle (1965, p. 29) put things quite succinctly: “Thalli are commonly leafy (foliose), encrusting, or shrubby.” Fink (1935, p. 3) reported that crustose lichens often have a “chinky” surface pattern, being divided into small sections known as “areoles” (see Figures 2 and 4a). Both crustose and foliose forms may have rootlike rhizoids on their lower surfaces where they touch the rock or other substrate. We will discuss the internal and cellular anatomy of the lichens at VACRC in a later paper. For illustrations of a foliose lichen, see Figures 1, 4a, and 4b.



Figure 3a. *Grimmea*, a moss. Both lichens and mosses grow on bare rocks throughout the southwestern United States (Marshall, 1910, pp. 178-179). Three or four species of lichens are growing on this exposed rock surface while mats of the moss (*Grimmea apocarpa*) are seen in the shaded crevice below. We will discuss the identifying colors of these lichens in another paper.



Figure 3b. *Grimmea*, a moss, is growing adjacent to a lichen-covered rock surface. While a large share of “soil-building” on bare rocks can be attributed to lichens, Daubenmire (1968, p. 118) has argued that mosses like, *Grimmea*, growing outward from crevices, may “overgrow” lichens that are present and may make an even bigger contribution than lichens to forming soil on a rock substrate.



Figure 4a. Ascocarps. In the lower left and center of this photograph is a large colony of the foliose lichen *Xanthoparmelia* in which cup-like objects with black centers are barely visible, the ascocarp reproductive structures of the lichen fungus. These range from less than one-half inch up to one inch in diameter.

Where Do Lichens Live?

It might be easier to answer the question “where are lichens unable to grow?” because they are known for their very widespread geographic distribution and their ability to survive extremes of climate. Taylor et al. (2000, p. 244) summed it up this way: “...lichens can be found in a wide range of habitats, extending from close to the poles to deserts and rainforests.” They are able to live in deserts and other warm, dry climates because they have an amazing endurance for drought and high temperatures. Although

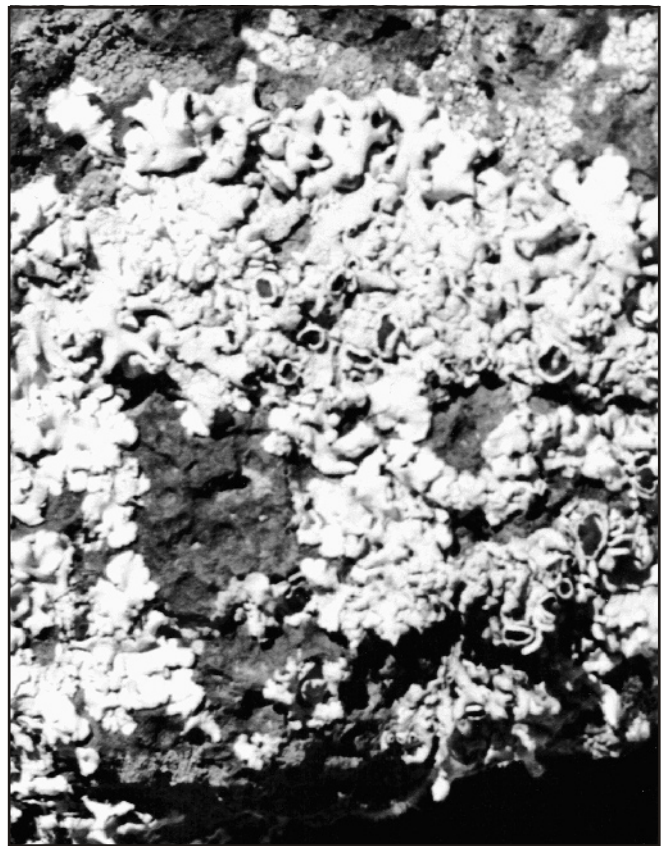


Figure 4b. *Xanthoparmelia* ascocarps enlarged. This is a portion of Figure 4a enlarged. Some cuplike ascocarps are nearly circular while others have variously curved borders. The center of each is black because it is there that the pigmented ascospores are produced inside miniature sacs called asci, visible only with a microscope.

they become dry enough to be brittle, lichens can yet survive. If the water content in the tissues of most other plants goes down to 50% dry weight or lower, they die (Daubenmire, 1968, p. 117). By way of contrast, lichens can survive with a water content as low as 2% during drought (Moore-Landecker 1972, p. 382; Stern 1997, p. 338). Dry lichens, on the other hand, can absorb water up to 300% of their dry weight when water becomes available. Their cellular osmotic pressures can go as high as 1000 atmospheres which enables them to extract water directly from moist air (Daubenmire 1968, p. 117). Stern reported that lichens produce a gelatinous substance which helps them resist desiccation.

It has been found that certain dry lichens can absorb up to 50% of their maximum possible water content during the first 5 seconds after water is added to them and they become almost completely saturated in just 30 seconds. After exposure to solar radiation for as little as one hour, a thallus that was previously fully saturated with water can become fully dry again (Amadjian, 1967, p. 103). Isaac noted that some danger to lichens results if the wetting and drying cycles are too rapid and too frequent:

The loss of carbon on rewetting, together with the rapid rise in temperature (resaturation respiration) are the most potentially damaging effects of dry conditions and extremes of temperature. Lichens recover well from these conditions unless the wetting and drying cycles are very rapid and repeated (Isaac, 1992, p.315).

On the opposite extreme from these lichens that can easily absorb water are certain crustose lichens that are almost unwettable such that they are "... not able to take up liquid water even if they are kept submerged for hours" (Amadjian, 1967, p. 104).

Lichens in The Ocean

While lichens grow in such varying terrestrial regions from dense tropical forests to deserts and even into the arctic tundra, they also thrive on rocks at the shoreline of the ocean where they are often completely submerged (Stern 1997, p. 338). Bands and tar-like patches of blackish crustose lichens are to be found on rocks of the intertidal zone (Sumich, 1976, p. 156; Fox, 1983, p. 233).

Lichens at High Temperatures

The temperature of lichens growing on rocks exposed to the sun's radiation has been recorded to be as high as 50° C (D.C. Smith, 1973, p.4). Amadjian (1967, p. 111) reported that the temperature of exposed lichen thalli on a hot day may reach 50–70° C and possibly even higher. Bessey (1971, p. 216) attributed this resistance of lichens to high temperatures and drought to the fungus member.

Lichens at Low Temperatures

Daubenmire (1968, p. 117) reported that lichens have been found to carry out photosynthesis during winter. They thrive around icecaps (The World Book, 1986, p. 85) and above the "treeline" in Greenland, Iceland, and Alaska (Moore-Landecker, 1972, p. 380). Isaac (1992, p. 315) reported that, "Low temperatures are tolerated by lichens providing that the thalli are dry when the temperature is low." The ability of lichen thalli to survive experimentally induced low temperatures is phenomenal.

Lichens that were:

... frozen in liquid oxygen at –183C [sic] for eighteen hours still respired when thawed and kept at a warmer temperature... A specimen of *Xanthoria parietina* has been reported to have withstood a temperature close to absolute zero...—a characteristic which it shares with some mosses, algae, and insects...—and moreover to have retained vitality after six years in a vacuum (Amadjian, 1967, p. 111).

Lichens, Ecological Succession, and Soil Formation

It has long been assumed that lichens enhance the weathering of rocks and thus contribute to soil formation. They are also thought to be the first step in an ecological succession or series of changes leading from bare rock to a full grown forest (Fuller et al., 1972, p. 382). Daubenmire (1968, p. 118) cogently argued, however, that soil building on bare rock in certain habitats may actually proceed outward from crevices where mosses like *Grimmia* thrive (see Figures 3a and 3b). Soil develops most rapidly in these moss colonies, according to Daubenmire, while the nearby lichen patches simply prepare the way for secondary lichen communities. The clumps of mosses and of flowering plants grow outward from the crevices, in many cases directly "overriding" the patches of lichens. The importance of mosses to the entire ecosystem in general and to the study of intelligent design in origins has been reviewed by Bergman (1998).

Wilson *et al.* (1962, p. 413) and Lee (1999) maintained that lichens contribute to rock weathering largely by way of the back and forth mechanical action which occurs when the lichen undergoes cyclic wetting and drying. The hyphae of lichens can penetrate considerable distance into rocks (Bessey 1978, p. 218). Lee concluded that it is the mechanical effect of hyphae of a particular lichen that caused rocks to weather:

This preliminary work shows that the main weathering effect of *Rhizocarpon geographicum* on granite is by mechanical rather than chemical processes. (Lee, 1999, p. 20).

But lichens may weaken rocks chemically too because they secrete carbonic acid and other acids (Daubenmire, 1968, p. 117). Marshall summarized the role of mosses and lichens as soil-builders:

They work by two methods. The one chemical, the other mechanical. By chemical, action they either construct plant tissue of gases taken in directly from the air or they first free from the rock or wood or earth-mould, the minerals needed and then construct them into plant tissue. By mechanical action they pry off bits of soil from hard rock, arrest dust and debris brought to them by the wind, and constantly add to the mass, such plant tissue as they themselves are continually shedding. (Marshall, 1910, p.12)

The famous writer John Ruskin penned this stirring little note about lichens and their action on rocks:

Meek creatures; the first mercy of the earth, veiling with hushed softness its dustless rocks; creatures full of pity, covering with strange and tender honour the scarred disgrace of time. Marshall (1910, p.4).

Lichen Taxonomy

Most lichen fungi are not extensively free-living but are usually found growing in their lichen partnership. About one-fourth of all the different species of fungi are the fungi found in lichens (D.C. Smith, 1973, p. 3). Each lichen species is given a latin binomial and is classified on the basis of its fungus partner (Amadjian, 1967, p. 3). Commenting on lichen taxonomy, Odum (1983, p. 400) wrote that "Lichens are usually classified as single 'species' even though they are composed of two unrelated species." Each lichen species is thought to have its own unique species of fungus (Stern, 1997, p. 338) except for about 20 tropical lichen species which all have the same fungus. But Doyle (1965, p. 29) maintained that this idea of each lichen species having its own unique fungus "needs verification."

The various lichen fungi fall into three major fungus divisions which are called the Ascomycota, (those fungi that produce sexual spores in little sacs called asci; ascus singular), Basidiomycota (those fungi that produce sexual spores on small club-like projections called basidia; basidium singular), and Deuteromycota (those fungi which have no known sexual reproduction). In some older works the Ascomycota taxon is called the "Discomycetes" (Moore-Landecker, 1972, p. 383) or the Ascomycetes. Most of the lichen fungi are Ascomycota members while some are in the Basidiomycota division and a few in the Deuteromycota. Stern (1997, p. 338) reported that one exceptional lichen had a bacterium growing with its alga rather than a fungus.

The Ascomycota-containing lichens produce spores called ascospores within sac-like cavities called asci. The

asci are in turn produced in cup-like or vase-shaped fruiting structures known as ascocarps (see Figure 4a and 4b). The order within the Ascomycota to which most lichen fungi belong is the Lecanorales (Bessey, 1971, p. 215; Webster, 1980, p. 367). Concerning families and genera, Bessey (1971, p. 223) noted that there are 37 families of lichen fungi containing about 275 genera.

The number of lichen species ranges variously depending on the source consulted: 7,400 (Bessey 1971, p. 223), 15,000 (Fuller *et al.*, 1972, p. 380; Haupt, 1956, p. 309), 16,000 (Sumich, 1976, Table 4.1; Moore-Landecker, 1972, p. 380), 18,000 (D.C. Smith 1973, p. 3) and 25,000 (Stern, 1997). Perhaps the true number of lichen species lies somewhere within this amazing spread of estimates!

Lichen Algae

One lichen species generally consists of one particular fungus associated with one specific alga (Hale 1967, p. 9). A few lichen species, however, are able to use two or more different algae (Bessey, 1971, p. 217). Since there are far more species of lichen fungi than of lichen algae, many lichen species possess the same alga, although they have their own specific type of fungus. Amadjian (1967, p. 79) wrote about one species of lichens that was found to have different algal species when it was collected from different localities. He also indicated that some lichens have different algae in the same plant: in one case both blue-green and green algae. He summed up the pairing as follows:

The lichenization of a single alga by different fungi...or, conversely, the lichenization of different algae by one fungus... is probably very common. (Amadjian, 1967, p. 79)

The unicellular green alga *Trebouxia cladoniae* (G.M. Smith, 1950, p. 224) is the alga most commonly found in lichen species (Hale, 1967, p.31). Another name for *Trebouxia* in certain older books (e.g. Fink, 1935, p. 318) is *Cystococcus*. *Trebouxia* algae are found in over 70% of all lichen species (D.C. Smith, 1973, p. 3). It is found in 83% of the lichen species in Scandinavia (Hale, 1967, p. 8)

The alga found in second highest percentages among lichen species is *Trentepohlia*, another green alga. The third most common autotrophic partner in lichens is *Nostoc*, a nitrogen-fixing blue-green bacterium (a group formerly called "blue-green algae"). Nitrogen fixing is the ability to take molecular nitrogen (N₂) from the atmosphere and to convert it to ammonia (NH₃) or to the nitrogen of amino acid molecules in the cell. Lichens, which contain *Nostoc* (or certain other nitrogen-fixing blue-green bacteria), are themselves able to fix atmospheric nitrogen.

Probably 90% of all lichen species contain one of these "top three" algal partners: *Trebouxia*, *Trentepohlia*, or *Nostoc* (D.C. Smith, 1973, p.3; Stern, 1997, p. 338). The

various algae found in lichens belong in a total of 26 genera. Eight of these genera are actually “blue-green algae”, now classified as bacteria. One genus of lichen algae is a yellow-green alga and the remaining 17 genera of lichen algae are in the green algae division (Moore-Landecker, 1972, p. 383; Amadjian, 1967, p. 12). The anatomy of *Trebouxia* and *Protococcus* cells (two algae present in the lichens at VACRC) will be examined with electron photomicrography in a later paper.

Lichen Reproduction

Many lichens produce asexual reproductive bodies called soredia, which are small dust-like clusters, each of which contains some algal cells together with attached fungus hyphae. These soredia, dispersed by wind or water, are believed to routinely initiate lichen growth on new rocks or trees. Many species of lichens do reproduce asexually by soredia (G.M. Smith, 1950, p. 224).

The fungi in many different lichens are members of the Ascomycota division and, as such, produce ascospores inside the asci of their cup-like ascocarps, as part of their sexual life history (see Figures 4a and 4b). It is believed that new lichens can arise:

... after ascospores carried by the wind come into contact with independently living algae, germinate, and parasitize them (Stern, 1997, p. 340).

Some lichen algae like *Protococcus* and *Trentepohlia* have a widespread distribution independently of their lichen fungus in various natural habitats, e.g. on tree trunks or rock surfaces. It is conceivable in the case of these two and certain other algae that their lichen fungi, growing nearby from germinating ascospores, could routinely make contact with them and grow together to produce a lichen *de novo*, as Stern suggested. But Stern added the curious fact that “No one has yet observed the initiation of a new thallus in nature...” (Stern, 1997, p. 340). Lichen dispersal and establishment has been extensively reviewed by Bailey (1976, p. 215).

In those lichens in which the algal partner is *Trebouxia* (which is most of the lichens), one might imagine that new thalli would also arise when germinating ascospores hook up with the free living alga. *Trebouxia* cells do not grow as widely as *Protococcus* and *Trentepohlia* by themselves, however, which may suggest that lichens which contain *Trebouxia* reproduce mostly by asexual means rather than by ascospores.

Some of the algae in lichens have the genetic capability of forming asexual reproductive cells of their own called zoospores. But this ability to produce self-propelled (motile) algal spores is ordinarily suppressed when the algae are living in the lichen relationship (Bessey, 1971, p. 216). Amadjian (1967, pp. 25–26) noted that *Trebouxia* in

culture by itself can produce such motile spores, but it does not do so when growing in a lichen thallus.

Synthesis of Lichens in the Laboratory

It is possible to grow the algal and fungal partners of many lichens separately in pure culture, and physiological studies of the separate components and intact lichen thalli have been made... Attempts have also been made to synthesize algal thalli *in vitro* from cultures of the two components, but typical lichen thalli have rarely been formed... (Webster, 1980, p. 367).

Here Webster was summarizing the extensive researches on laboratory growth of lichens carried out by Amadjian (1967) and others. Amadjian himself, however, took a much more positive view of lichen synthesis experiments and concluded that:

“Reestablishment of a lichen association can be accomplished under laboratory conditions” (Amadjian, 1967, p. 80).

Amadjian supplied the following valuable summary about culturing lichens in the laboratory:

1. The most important conditions for the establishment of lichen associations are nutrient poor substrates and slow drying...; 2. Spores of a lichen fungus are capable of reestablishing lichen unions in culture; 3. The fungal symbiont can fruit in the absence of its algal partner; 4. A mycobiont in culture loses its ability to fruit but can still form the lichenized state with algae (Amadjian, 1967, p. 87). [Note, the isolated fungus is here called a “symbiont” which means that it ordinarily grows in symbiotic union with an alga. Amadjian also refers to the fungus of the lichen growing by itself as a “mycobiont”.]

The Origin of Lichens

In each of the articles on lichens we will examine certain aspects of their origins. Convincing links and mechanisms showing that one lichen species had a common ancestry with another do not exist. In defense of evolution theories, however, it has been asserted that the lichen fungi evidently differentiated from one another long before each subsequently underwent lichenization separately:

Since there are many varied types of algae and fungi in lichens, it is possible that the symbiosis has arisen on a number of separate occasions in the course of evolution. (Smith, 1973, p.6)

But no one has ever observed a non-lichenized fungus undergoing the changes required to convert it to a fungus equipped to collaborate with a particular alga. In other

words, the origin of a new lichen species has never been observed in nature or the laboratory. Presumably a suite of very selective changes would be needed to convert a free-living saprophytic (feeding on dead or decaying materials) or parasitic fungus into a suitable lichen partner. If lichens themselves do not give rise to new lichens, many (if not all) of them must have arisen by repeated parallel evolution in which numerous unrelated lines of fungi each underwent the prerequisite steps enabling them to become suitable stable partners for the algae. Purvis (2000, p. 46) admits that lichenization had to occur independently at least seven times. He wrote that since the lichen association involves very different fungal groups (Ascomycota versus Basidiomycota or even Deuteromycota members):

It has clearly evolved independently numerous times (polyphyletic)... (Purvis, 2000, p.46).

No evidence exists, however, to support such wholesale convergent evolution (polyphyletic evolution) in the origins of lichens.

In this evolutionary scenario one would predict that for many of the lichenized fungi there would exist the “ancestral”, non-lichenized counterpart of each, living in various saprophytic or parasitic niches. But such is not the case as, Amadjian (1967, p.33) noted: “... lichen fungi must have originated from free-living forms, but there is little evidence to support this view.” Attempts to demonstrate that various lichen fungi are the equivalent of various non-lichenized saprophytic or parasitic fungi have been unsuccessful according to Amadjian (1967, pp. 33–34). It appeared that Amadjian was still hopeful in this regard, however, even though there had been no success in attempts to relate several lichen fungi to free-living molds:

Further isolations of mycobionts from the fifteen to twenty thousand species of lichens undoubtedly will reveal additional relationships between lichen fungi and free-living fungi. (Amadjian, 1967, p. 35)

As an alternative to the evolutionary view of lichen origins, there is the concept that the Creator produced many separate kinds of fungi that were preadapted to unite with various algae, to yield the many kinds of lichens. Although this view carries with it the necessary task of trying to find the limits of various lichen “kinds”, it is more in keeping with scientific evidence than is the macroevolutionary scenario.

A Lesson from Lichens?

We suggest finally that lichens figure effectively in a field called “natural theology.” This is the practice of finding spiritual lessons in nature itself, a discipline which was popular in the eighteenth and nineteenth centuries. Natural theology has been revived recently by Gothard and his associates (Character Studies, 1985, pp. 360–361) who have discussed moral and spiritual lessons which can be

deduced by the study of plants and animals. On pp. 360–361 they actually derive such lessons from lichens and lemmings.

To our surprise it was Odum (1983, p. 401), evolutionist and GAIA advocate, who also drew an important moral lesson from lichens. He noted in lichens a kind of symbolism directing human beings away from wholesale destruction of their habitat back to “... a mutualistic stage in their relationship with nature.” We agree with Odum that wherever possible people ought to live in harmony with the rest of the ecosystem, like a lichen fungus “gently parasitizing” its algae host cells! Hoffberg (1998) has endeavored to show that a balanced ecological ethic is found in Biblical theology.

We further suggest to the “Odum’s” of evolutionary science that moral lessons like these can be found in little plants called lichens and elsewhere in nature because nature itself is the product of a moral and loving Creator. The existence of moral lessons in biology is incomprehensible otherwise.

Acknowledgments

Although we alone take responsibility for the content of this article, we thank the following individuals for valuable suggestions: Eugene Chaffin, Emmett Williams, and John Meyer. We thank John Meyer for help in identifying the VACRC lichens. We gratefully acknowledge the help of Bobbi Blade in manuscript preparation. We thank an anonymous lichenologist who helped us identify these lichens from our photographs. We are thankful likewise to those who have donated to the C.R.S. research fund and to the VanAndel Creation Research Center Fund, interest from which has helped to support various aspects of this study. Finally, we appreciate and gratefully acknowledge the many thousands of hours of intense study on lichens that have been spent by hundreds of workers worldwide, some of whose research we cite here.

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Note from the Panorama of Science

Rate of Speleothem Formation: Observations in Country Limestone

Jerry Akridge*

Speleothems are dripstone features found in subterranean voids resulting from the deposition of calcite into various shapes seen as stalactites, stalagmites, flowstone, rimstone dams, drapery, and curtains (Davies and Morgan, 1984). Uniformitarian doctrine usually indicates that speleothems took great amounts of time to form. However, uniformitarian scientists should rethink the supposed rates of speleothem formation in view of known facts.

This study involves fieldwork on recently formed and ongoing formation of speleothems in country limestone in Huntsville, Alabama. While the determination of exact rates of formation is possible and being studied, the age of the speleothems has been ascertained within a definite time frame. Because the rate of speleothem formation is of

interest to researchers regarding Earth's history, this study not only documents information countering erroneous claims of long ages needed for speleothem growth, but also provides evidence in support of the young-Earth Flood model.

Site Location and Description

This research was done in Three Caves, a feature located at the base of the western slope of Monte Sano Mountain and within the eastern boundary of Huntsville, in Madison County, Alabama (Figure 1). Three Caves is not a natural cave, but a rock quarry that was excavated from 1945 through 1952. The feature has the appearance of a large cave with three entrances in close proximity and a fourth entrance further removed (Figure 2).

*2626 Pine View Drive, Arab, Alabama 35016



Figure 1. The study site is located in Huntsville, Alabama.

Rock excavated from the quarry was used for agricultural and construction purposes when this area was undergoing rapid expansion. The quarry eventually became an unwelcome neighbor in burgeoning Huntsville and closed because of problems associated with blasting, noise, dust, and heavy equipment operating close to nearby housing development.

Initially, the quarry began as an open pit, the limestone being removed by excavating from ground level down and working horizontally toward the increasing slope at the foot of Monte Sano Mountain. In the late 1940s, the “drill-and-shoot” method of quarrying changed from the open pit configuration to excavating straight into the solid limestone (The Land Trust of Huntsville and North Alabama, undated paper).

By excavating horizontally into the side of the limestone deposit, the quarry assumed the configuration of a large mine resembling a natural cave. The mine extends back for hundreds of feet into the limestone. The floor of the mine is essentially level with minor vertical variation. The ceiling is approximately 25 feet above the floor of the mine.

Once the mine reached a certain size inside the limestone formation, “room-and-pillar” construction was begun within the large void that formed. Several huge pillars of strategically located limestone were left for support to prevent collapse of the ceiling (Figure 3). Besides the mine’s length of hundreds of feet, it also extends laterally for a few hundred feet.

The Geology of Three Caves

The site of interest on Monte Sano Mountain is located in the Cumberland Plateau section of the Appalachian Plateaus Province of northeastern Alabama (Dunn, et. al., 1989,

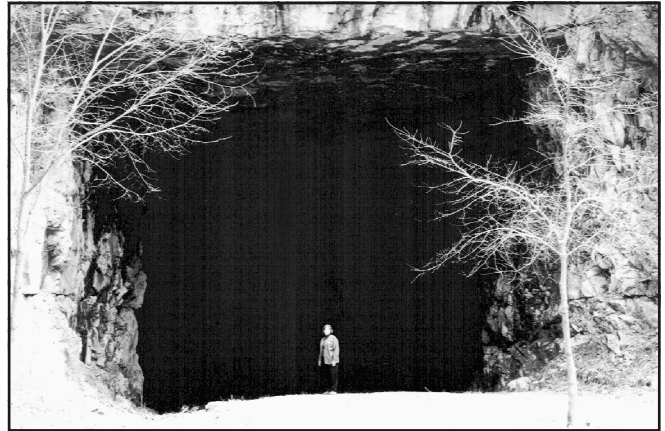


Figure 2. One of the four entrances to Three Caves Quarry. A photograph of more than one entrance is prohibitive due to the physical separation of the four entrances.

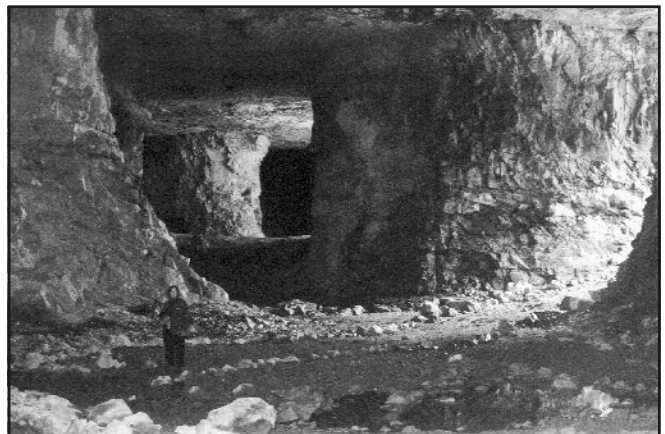


Figure 3. Immediately inside Three Caves Quarry. The huge pillars of limestone remain to prevent collapse of the ceiling. Light can be seen coming into the mine from two separate entrances to the quarry. Note person in lower left for scale.

pp. 23, 24). This mountain is typical of the regional Appalachian stratigraphic structure with a cap of Pottsville Formation sandstone. Below that are conformable strata of conglomerate, shale, dolomite, sandstone, and limestone (Mandel, 1998). Above the site of Three Caves, Monte Sano Mountain has an approximate elevation of 1,600 feet MSL.

Three Caves Quarry is located on the western base of Monte Sano Mountain at an elevation of 719.5 feet MSL (Ground Engineering and Testing Service, Inc., 1990). The mine is located within the Tuscumbia Limestone, identified as Mississippian in age by uniformitarian geologists. The Tuscumbia Limestone rests below the Monteagle Limestone and lies conformably over the Fort Payne Chert. In this area, the Tuscumbia Limestone varies in thickness from 150 to 200 feet. The matrix is composed of thin to thick-bedded, fine to coarse, gray, crystalline, highly fossiliferous limestone including a paucity of gray to white chert nodules and irregular lenses. The Tuscumbia Limestone

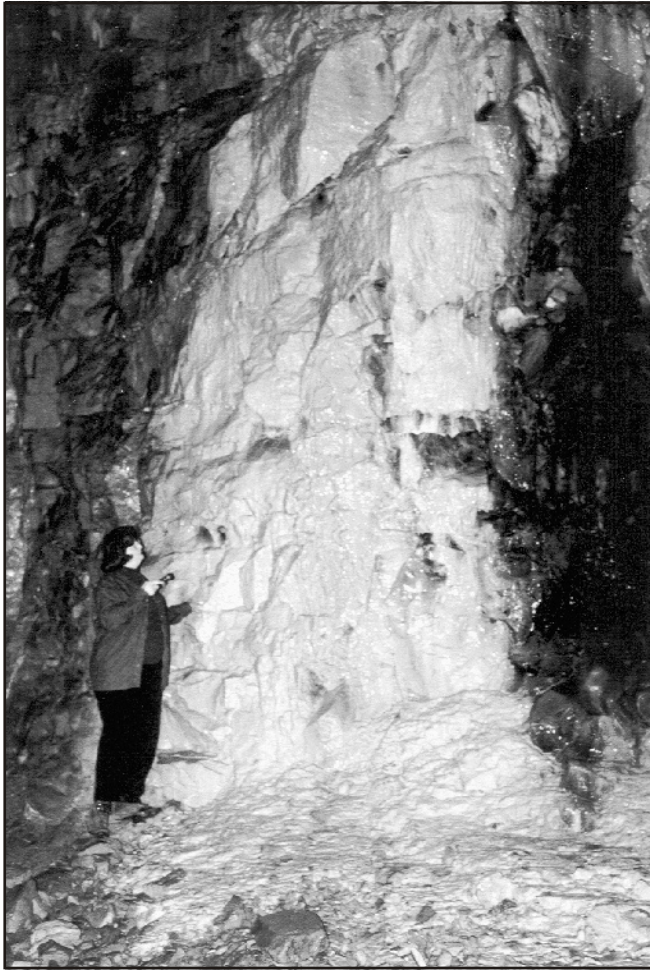


Figure 4. Ground water deposits calcite as it courses down the walls of the quarry.

varies in elevation according to location, but is usually found below 800 feet MSL (Dunn, et. al, 1989, p. 26).

Observations of Speleothem Formation in the Rock Quarry

In examining the interior of Three Caves, we observed evidences of the rapid formation of speleothems. In at least two areas within the feature, water coursed from the ceiling and ran down portions of the walls of the quarry (Figure 4). In these locations are flowstone (Figure 5), drapery formations (Figure 6), calcite dams, and cave pearls (Figure 7).

In these same areas where the quarry walls are wetted, water continues movement horizontally across the floor of the mine after its descent from the ceiling and flows over forming speleothems. At the intersection of the walls and floor are numerous loose pieces of limestone remaining from the original quarrying operation and varying in size from pebbles to boulder-sized specimens. Many of the pieces up to several inches in thickness are cemented together and bonded to the floor. They remain in appear-



Figure 5. Flowstone is formed by calcite deposition on the walls of the quarry. Scale is in inches and centimeters.

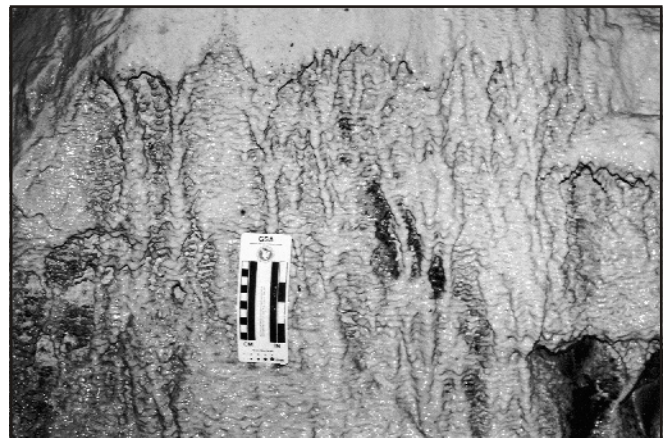


Figure 6. Classic drapery formations are observed in the quarry. Scale is in inches and centimeters.

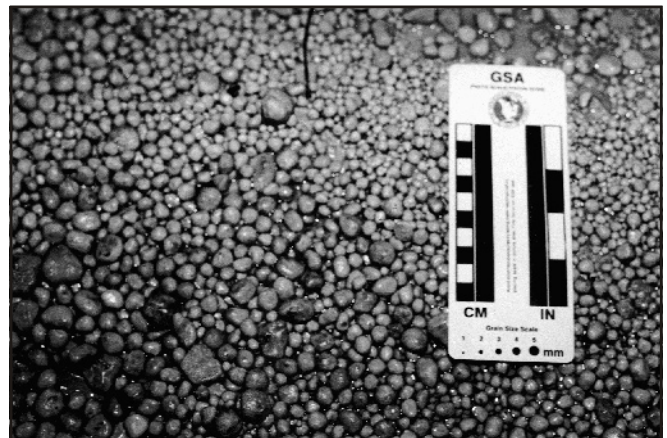


Figure 7. Cave pearls are found on the floor of the quarry. These are smooth rounded concretions formed by calcite precipitation around a nucleus. Scale is in inches and centimeters.

ance as a very coarse abrasive medium with their angular sides jutting upward and being securely cemented to the floor by the calcite. Other rock fragments are completely covered by the calcite, their locations only discernable by



Figure 8. Rocks of varying sizes are welded to the quarry floor by calcite. Some of the rocks are almost completely covered and hidden by the thickness of calcite. Scale is in inches and centimeters.

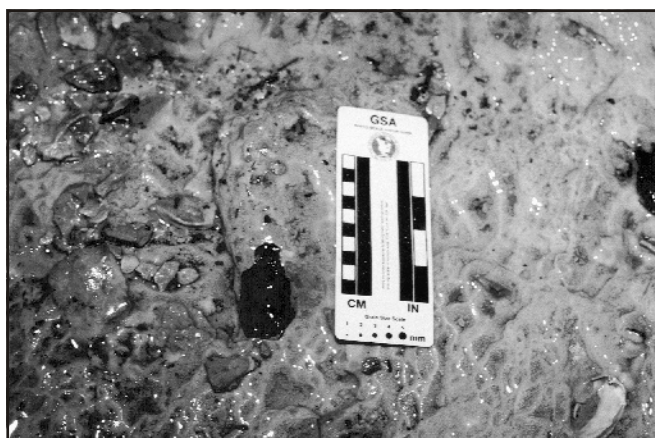


Figure 10. The wood fragment is parallel to the scale and is about the same length of the scale. Most of it is barely visible because of its coating by a thick layer of calcite. Note that the lower end of the fragment has been truncated at an acute angle exposing the charcoal black color of the wood. The white areas on the exposed wood are due to camera flash on the wet surface. Scale is in inches and centimeters.

gentle undulations on the surface of the calcite (Figure 8).

At the wall and floor interface, we also found pieces of wood that were partially and completely encapsulated with calcite and bonded to the floor (Figure 9). These wood fragments include small sticks as well as larger samples several inches in thickness and length. In examples with partially exposed wood, the wood was charcoal black in color and firm in texture (Figure 10).

Another interesting find was a plastic "wine cooler" bottle cap that was partially covered and cemented to the floor by the calcite (Figure 11). In checking with the manufacturer of this brand of wine cooler, I found that it was introduced in 1984 and not distributed in this area after 1994 (Jensen, 2001).



Figure 9. Two wood fragments in near axial alignment. The upper specimen is almost completely covered by calcite. The lower fragment is bonded to the floor but not completely covered. Scale is in inches and centimeters.



Figure 11. The bottle cap just to the upper left side of the scale is bonded to the quarry floor and encrusted with calcite. Note that the rocks in the top and right side of the photograph are almost completely covered by calcite. Scale is in inches and centimeters.

Thickness of Speleothem Material in Three Caves

Permission was granted to ascertain the thickness of the calcite features. Test sites were selected on the flowstone-covered walls and small diameter holes were drilled directly into the calcite. After drilling the first test hole through the calcite into the limestone matrix, the drill bit was removed and measurement of the thickness of the calcite was made. This first measurement indicated 3/8 inch of calcite deposition.

On the second test site at another flowstone structure, I drilled into the calcite the full 2.5 inch exposure of the drill bit and did not reach the limestone matrix. Because of the dulling of the carbide bit and the drill's battery being depleted by the resistance of the hard calcite, only two borings were possible.

Implications of the Rate of Speleothem Formation

Because of teaching in various media that speleothem formation is only possible after vast expanses of time have elapsed, many people believe this to be factual. I attended a recent tour of an Alabama state-owned cave when the cave guide told our group that speleothem growth is about a cubic inch per thousand years. In another cave in a Kentucky federal park, the ranger pointed to a stalactite in a dry area of the cave and told us that he had not seen any growth on that particular feature in his years there. He prefaced his comments with an indication of how slowly the speleothems form.

Speleothem formation has been touted by evolutionists and uniformitarian geologists to lend credence to the idea of an ancient Earth. Several creationist studies have been done on the rate of speleothem formation offering evidences that only short time frames are necessary for this process to occur (Matzko, 2000; Williams, et al, 1976; Williams and Herdtklotz, 1977; 1978; Williams, House, and Herdtklotz, 1981). Both laboratory and field observations conclude that growth rates of speleothems easily fit within the context of the young-Earth Flood model.

Conclusion

Caves were formed in phreatic zones that were temporarily elevated as a result of an abundant source of ground water after the Flood. Eventually, the zone of saturation was reduced below the level of the caves by dewatering of the sedimentary strata deposited by the Flood. Once the ground-water surface dropped below the naturally-formed caves, speleothem formation was then possible in the air-filled chambers.

Speleothem production would have decreased exponentially from a maximum rate during ideal conditions after the Flood to the eventual equilibration of the hydrologic and phreatic cycles. Thus the environment of Three Caves would probably be similar to conditions expected sometime after the major effects of the Flood had subsided and present-day processes began to operate.

Three Caves Quarry offers a study of speleothem formation under natural conditions where water can flow through and over the limestone in a feature of known age. Because of these conditions existing in Three Caves, we can predict that speleothem formation here would parallel that which occurred in naturally formed caves since the Flood. Although speleothem formation is rapid and measurable in Three Caves, the rate of production would not be expected to be as great as that experienced in the time frame of greater hydrologic activity following the Flood.

Three Caves Quarry was developed from solid limestone and mined from 1945 until 1952 when the business

ceased operation. From this study done in March of 2001, the observed speleothems would date no older than about 50 years. The calcite-encrusted bottle cap discovered in this research would have been in Three Caves no longer than 17 and as few as seven years.

From these observations, the rate of speleothem formation is within the time frame necessary to be accommodated by the young-Earth Flood model of Earth history. Obviously, uniformitarian estimates of long ages for speleothem formation require modification to reflect current knowledge of these features.

Further Investigation

Further creationist study is recommended to ascertain the rate of speleothem formation in Three Caves. Ongoing study of this feature would be profitable for evidence in support of the young-Earth Flood model of Earth history. I recommend that certain areas in the quarry be instrumented to aid researchers in gathering data relating to speleothem formation. Scale sticks could be installed in the active flowstone walls and floor to be periodically checked in determining the increasing thicknesses of calcite over time. Charts of local rainfall could be maintained to help determine and compare varying flow rates of water over the formations. Also, recording daily air temperature outside the quarry would be beneficial in the study. Outside ambient conditions could determine how much carbon dioxide would be dissolved in the water eventually reaching the speleothems. A pH reading of the water flowing over the speleothems should be continuously recorded with an instrument. A humidity and temperature recorder with a continuous printout should be installed near the forming flowstone to correlate rainfall data and outside temperature with conditions inside the mine. The rate of formation of the speleothems could be correlated with all the various recorded data. Such a study would require many necessary resources as well as special permission from the organization that holds the quarry in trust for public use.

In addition to facilitating instrumentation and maintaining appropriate records mentioned above, the calcifying wood samples could be periodically analyzed to determine if a petrification process is ongoing. Micro-core samples of the calcifying wood fragments could be taken to determine if a petrification agent such as permineralization or replacement is observed in the wood fragments.

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I heard about Three Caves and its speleothem formations from Mr. William W. (Bill) Varnedoe, Jr., a Christian friend as well as a preeminent speleologist, researcher, explorer, and writer. His encouragement prompted this study. I appreciate the helpful suggestions of Dr. Emmett

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I am indebted to my wife, Lucky, without whose strong and loving support this project would have been nearly impossible. She provided invaluable assistance with the necessary fieldwork in Three Caves, even under far less than desirable conditions. Her encouragement in the various stages of this research provided the impetus to complete the paper. Perhaps not everyone who assisted in this effort would concur with my conclusions, but all were interested in sharing personal expertise to facilitate the study. Any errors that may remain are mine.

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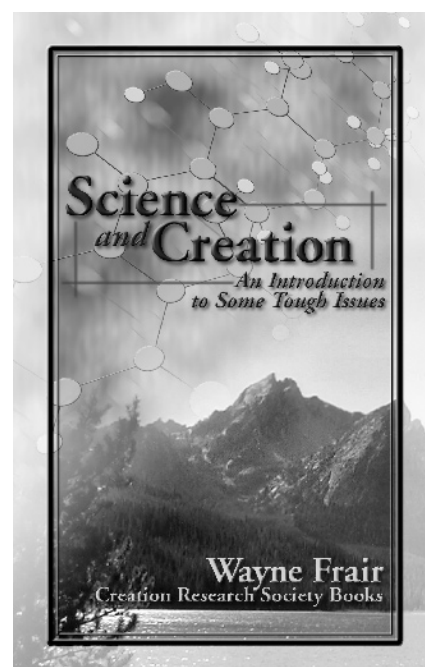
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Author Wayne Frair earned undergraduate science degrees from Houghton and Wheaton Colleges. His MA. is in embryology from the University of Massachusetts, and his Ph.D. in biochemical taxonomy is from Rutgers University. He is a fellow of the American Association for the Advancement of Science and a past president of the Creation Research Society. Having spent more than forty years in research and teaching, his current status is Professor Emeritus of Biology at The King's College in New York City.

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Frank Lewis Marsh: His Life and His Legacy*

Wayne Frair**

Abstract

In early decades of the twentieth century, history was awaiting a new champion in the creationist movement. The call was answered by a hard-working farm boy with a penchant toward science. He obtained a good education and assumed leadership in the creation movement, becoming a science

professor, prolific writer and speaker. He recommended the term *baramin* for the created kind and persistently promoted the concept of discontinuity as contrasted with evolutionary continuity. His scholarship was important inside and outside scientific communities.

Early Years

Frank Marsh was born 18 October 1899 in Aledo which is located on the high prairie of northwestern Illinois. He was the youngest of three children born to Wilson V. and Annabel K. Marsh. They lived on a stock and grain farm where they were familiar with hard work and cooperative efforts. Frank was at home with plants and animals (Figure 1). He did a little hunting and trapping. He even raised skunks for three years in order to obtain pelts. However, Frank's daughter, Sylvia, has informed me that Frank was very soft-hearted toward animals and that he released alive all of the skunks. He loved to collect butterflies and moths. Even as a youngster captivated by the study of various plants, birds and other animals, he longed for the day when he could become a game warden and write nature stories.

The whole Marsh family was active in their local Seventh-Day Adventist (SDA) church and school. Frank attended SDA schools and was accepted at the SDA medical college in Loma Linda, California.

However, because of financial needs he went into medical work and nurses' training, and in 1925 became a registered nurse in the state of Illinois (Figure 2). He married Alice Garrett 22 June 1927, and that same spring graduated from SDA Emmanuel Missionary College (EMC) in Berrien Springs, Michigan. He received a B.A. degree in science and English.

After a year working as a nurse he returned to EMC for what was his first year in a career of teaching. He instructed in physics at the EMC academy, and concurrently earned



Figure 1. Frank Marsh is 6 years old and in first grade. Find him at lower right by the sheep.

30 more hours of college credits in science and Bible at EMC for which he received a B.S. degree in the spring of 1929. During that spring Frank also was editor of the college newspaper and associate editor of the college annual, *The Cardinal*. Throughout this time his writing and teaching skills were being developed.

For the next five years Frank taught science and math courses and also served as Dean of Men at

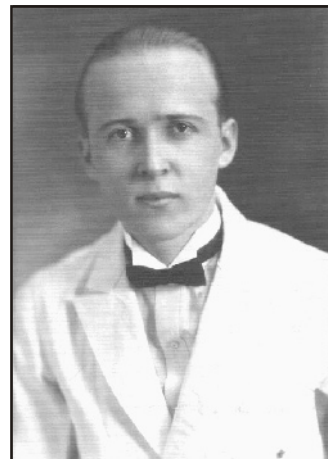


Figure 2. Frank Marsh in 1925 at graduation from nursing school.

*On 15 August 2001 this paper was presented in abbreviated form at the Discontinuity conference at Cedarville University in Ohio.

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Figure 3. Frank Marsh in his office at Union College, 1948.

Hinsdale Academy in Hinsdale, Illinois. Frank recognized his need for more formal training, but most of his denominational leaders frowned upon attendance at non-SDA universities. There were other denominational leaders, however, who did encourage him, and so while continuing at Hinsdale he took courses in chemistry, genetics and field zoology at the nearby University of Chicago in night classes and private meetings with professors.

On his own time and expense he researched local cecropia moths and also their parasites. Because he desired an advisor for a more formal study of the moths, he transferred to Northwestern University's Evanston Illinois campus where he also continued studying additional zoology and botany. During 1934–1935 Frank was supported full-time by the University as he taught there and did research. In the spring of 1935 Northwestern awarded him an M.S. in zoology (see Marsh, 1987). Frank now was prepared to launch into what arguably could be considered the most influential period of his life.

In August 1935 he assumed chairmanship of the biology department of Union College in Lincoln Nebraska where he served for 15 years (Figure 3). He also carried out further graduate studies in ecology, and in 1940 received a



Figure 4. Marsh lecturing on insects especially his lepidopteran moths.

Ph.D. in plant ecology from the University of Nebraska. While living in Nebraska the Marshes had a son, J. Kendall, and daughter, Sylvia.

After completing his graduate studies Frank was constrained to turn from serious empirical research which he loved deeply, and to employ his abilities to forward a cause that was burning in his heart—that of creation.

During his graduate training Frank had sat under an uncounted number of professors in three universities where students were drenched with evolution and creation was derided. So now he, as the first SDA biologist with a Ph.D., was in a position to present to his own denomination and to the world a coherent creationist concept consistent with fields of science and of the Bible. His lifelong experiences of 41 years had included extensive informal and formal training in both of these fields. So he continued with teaching (Figure 4) and other responsibilities while launching into an aggressive career of writing.

His Publications

A. Early works

Frank's published articles first appeared in 1923 with a story about a pet blue jay. During the next decade he had printed 7 short pieces, some of which dealt with scientific topics. These were followed by 8 primarily technical publications. One of these reported a previously unknown parasite which Marsh had discovered.

B. Marsh's First Book

This book, entitled *Fundamental Biology*, (1941) was comprised of 128 mimeographed pages, and the work was

dedicated “to my mother...the guiding star of my aspirations.” Seventh-day Adventists were the specific focus of the text, but author Marsh indicated that his reflections should be of worth for those who honestly and sincerely were concerned about creation and evolution.

Marsh’s understanding was that God had created life during 6 literal 24-hour days during a 7-day week about 6,000 years ago. The creation included kinds of plants and animals which would reproduce only within boundaries set by members of their types or kinds. Marsh’s typological concept of separate kinds was to become a theme that he would elaborate in 50 subsequent years of formal teaching, speaking and writing. The fertility which would permit offspring was a touchstone for assigning a male and a female to a single kind. He referred to this concept as a biological law of creation (the law of reproduction, p.93, or a universal law in nature, p.105) as being just as real as the law of universal gravitation (p.52).

Being a professional biologist Marsh recognized the importance of gene and chromosome changes, hybridization, genetics (segregation, recombination, etc.), natural selection, niches, adaptations, and extinctions. He believed that rather than evolutionary progress there had been degeneration (including behavior contrary to original instincts) since the time of creation.

In this first book Frank Marsh (1941, p.100) revealed his wrestling with what to name the groups which God originally had created. He desired to dissociate the types from the word “species.” Possibilities were “Genesis kind,” “Original kind,” or “Created kind.” But he concluded that a new word was needed, saying:

What could be more appropriate than to build this word from the two Hebrew words “bara” (created) and “min” (kind)? This would give us the single word “baramin” (pronounced ba rä-min) for one Genesis Kind and “baramins” for more than one kind (p.100).

Marsh’s first book apparently has had little influence except possibly within the SDA denomination, but Marsh’s pattern of thinking had been solidified and he was on the way toward publication of the next book which would have a major influence not only within his denomination but also upon others having a variety of religious views.

C. Second Book

The next book, *Evolution Creation and Science (ECS)*, 1944 and revised version 1947, is what I personally would consider Marsh’s most significant book. This text and his subsequent major works emphasized scientific content with some Bible references. *ECS* opened with the following impressive inscription.

This book is dedicated to those who, in their search for truth, ignore unjustified authority in the field of science and keep their sincere minds alert to

the recognition of facts regardless of where these may lead in the matter of conclusions.

In the *ECS* Marsh exhibited a credible familiarity with thinking of leading evolutionists as well as scientific data pertinent in origins discussions. With convincing rigor built upon a wealth of factual information he established his case for discontinuity in nature as contrasted with an evolutionary continuum.

Recently I had a personal letter from Dr. Ariel Roth (2001) who currently is Professor of Biology and member of the Geoscience Research Institute at Loma Linda University in California. At the mid-twentieth century when Roth was a graduate student in the Zoology Department at the University of Michigan “evolution was being offered as the only valid worldview” in what otherwise was “a substantial and excellent academic environment.” Then Roth read *ECS*, and in his letter to me said, “I had not penetrated very far into the book before I realized how weak the case for evolution was.” Frank Marsh’s *ECS* had helped Ariel Roth so much that Roth was inspired to write his own origins book to help students as he had been helped by Marsh (Roth, 1998).

Marsh’s *ECS* was mailed to one of the world’s leading evolutionists and famous geneticist, Theodosius Dobzhansky, who carried on a relatively intense correspondence with Marsh during 1944–1945. In his review “for the American Naturalist, Dobzhansky announced that Marsh had written what he (Dobzhansky) had previously thought to be impossible: a sensibly argued defense of special creation” (Numbers, 1995, p.xvii).

When I was in graduate school at the University of Massachusetts in 1954 I gave a copy of *ECS* to one of my professors who had very adamant evolution beliefs. I recall very clearly his reaction of amazement at the high level and convincing nature of Marsh’s scientific material.

D. Other writings

In his writings Marsh steadfastly promoted the concept of discontinuity.

A point which we are very sure of is that, equal with the fact of diversity, is that of discontinuity. Organisms cannot be found grading gradually one into the other. We recognize men, apes, dogs, horses, oak trees, wheat and roses. There is never any confusion in the minds of taxonomists whether a primate is a man or a chimpanzee, or whether a rodent is a squirrel or a prairie dog (Marsh, 1947, p.101; first edition, 1944, pp.90–91; see also 1973, 1991).

Marsh said that taxonomists were able to erect their phylums, classes, etc. with ease because of discontinuity. In his last creationist book (1976), he said discontinuity “dooms the evolutionist’s tree of life” (p.115) and discontinuity “in living and fossil nature constitutes the greatest

single roadblock on the highway to organic evolution” (p.121).

Discontinuities separated the kinds (basic types), and fixity existed at the level of the kind (1960, 1964, 1968). Microevolution could occur “within any basic type,” but megaevolution (also called macroevolution)—change from one kind to another—was not supported by the Bible or by scientific data. Marsh said, “The production of like by like is a natural law of biology” (1969, p.21). Also he believed in creation with the appearance of age (1978).

The means of determining what organisms belonged to a kind involved simple fertility between two organisms. In the case of the mule which is a horse-ass hybrid and sometimes sterile, Marsh was not sure in 1941 whether the horse and ass belonged to one or two kinds (1941, p.56). However, by 1944 Marsh believed that the mule was evidence that the horse and ass were members of one kind—the horsekind (*ECS*, 1944, p.149; 1947, p.185). Other similar evidence was the tiglon (tiger-lion hybrid) and the cattalo (cow-bison hybrid), each of these representing a single kind (*ECS*, 1944, p.150; 1947, p.186).

For Marsh two forms could hybridize because of their physiological (chemical) likenesses. Even if forms are morphologically distinct, they could be members of the same kind if their basic chemical similarities permitted union of their germ cells (*ECS*, 1947, p.175). In 1957 Marsh sharpened this general idea by suggesting that this union of germ cells had to be true fertilization in which “both reduced parental sets of chromosomes join and participate in the first division of the fertilized egg” (Marsh, 1964, p.36). This would result in the formation of the first two blastomeres of the embryo (see Marsh, 1967, p.139). Marsh even recommended “artificial pollination and artificial insemination...as the best tools for the discovery of the limits of the baramins” (Marsh, 1960, p.8; 1964, p.37). Fertilization could occur in nature or in a laboratory test tube.

If true fertilization fails, then morphology may be used to determine membership in a kind because the form of the organism is based upon its chemical makeup (DNA). For example, complete sterility exists between two forms of *Drosophila* fruit flies which have identical external characters. So the two may be considered members of one baramin. When “individuals are produced by such asexual processes as simple fission, budding, formation of spores, and even by the sexual process of hermaphroditism” they still could be reproducing consistent with the law of reproducing “after their kinds” (Marsh, 1960, p.11; 1964, p.37).

Marsh continually referred to his recommendations for use of the word baramin for the types in nature. For example see 1944, 1947, 1950, 1960, 1964, 1967, 1976, 1979, 1991. In addition to being in the publications of Marsh, the name “baramin” has been used intermittently by oth-



Figure 5. Marsh collecting fossil fish and insects in the Green-River-Shale formation 13 miles west of Kemmerer, Wyoming, 1959.

ers since 1941. Popularity of the expression has increased since Kurt Wise’s 1990 paper in which he introduced a taxonomic procedure called “baraminology.” Wise’s presentation occurred at the same meeting in which Walter ReMine formally presented “discontinuity systematics” (ReMine, 1990). For a survey of literature in this field see Frair, 2000.

Until near the end of his life of almost 93 years Marsh continued to write and publish. His works included 16 different books, well over 100 articles for denominational periodicals, over three dozen in non-SDA organs, and many dozens of unpublished works most of which are to be found in the Adventist Heritage Center at Andrews University in Michigan. Interestingly Frank’s publishers of English editions of his books (excluding foreign translations) between 1941 and 1980 totaled 264,416 copies for a total of 29,942,929 pages of creationist literature. The foreign publications totaled over three million pages.

Other Activities and Personal Contacts

In 1950 Frank returned to his alma mater EMC in Berrien Springs, Michigan. He accepted an appointment as Professor of Biology and department chair. Frank and his wife Alice worked on plans for a new life sciences building which later was named Marsh Hall. In 1960 EMC became Andrews University. While at EMC and Andrews Frank gave lectures in the US and many foreign countries.

In 1958 Frank helped launch the “Geoscience Research Institute” on the Andrews University campus. For the research activities of this Institute, Frank expanded his own understanding and abilities in geology by auditing 18 earth science courses at Michigan State University (Figure 5). In 1964 Frank left the Institute which later was moved to Loma Linda in California. Frank continued teaching at



Figure 6. George McCready Price on left and Marsh on right in 1960. Price is 90 years old and Marsh 61.

Andrews including the seminary, officially retiring in 1971 after teaching a total of 43 years.

During 1928–1929 at EMC Marsh had been a student of an SDA scientific leader and flood geologist named George McCready Price, with whom Marsh stayed in contact until Price's death (at almost 93 years of age) in January 1963. Friendship between these two men had deepened over the years (Figure 6). Price came to appreciate the writing of Marsh, and told him, "When I retire from the battle my mantle shall fall upon you." (Numbers, 1995, p.xvi). It is clear that Price had a major influence upon the religious and scientific views of Marsh.

Frank Marsh was a member of the 1963 organizing group of the Creation Research Society (CRS) (see Armstrong, 1976; Williams, 1992) and remained on the Board from 1963–1969, holding the position of vice-president in 1966. He published 16 items in the *Quarterly* which was the greatest number he had printed anywhere outside his primarily denominational literature. He was elevated to the status of fellow of the CRS in 1976, and the

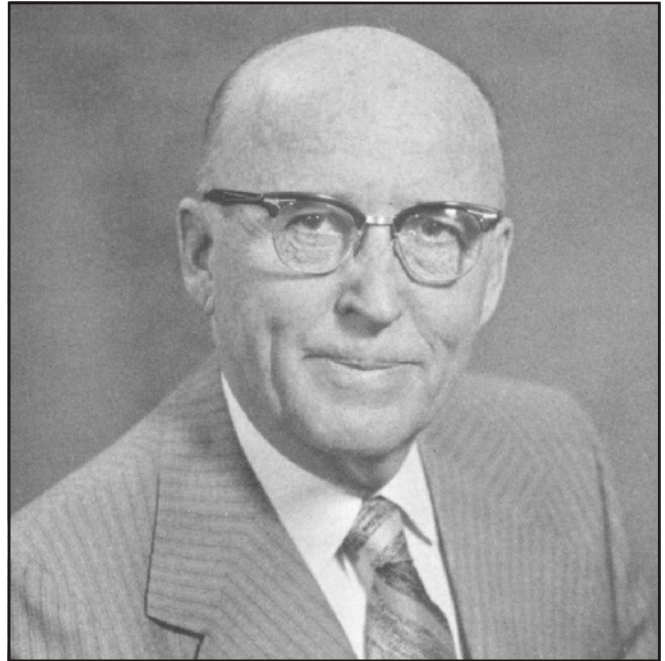


Figure 7. Marsh in 1976 when he became a fellow of the CRS, and the Annual Issue of *CRSQ* was dedicated to him in June of that year.

Quarterly for that year was dedicated to him (Armstrong, 1976). See Figure 7.

Henry M. Morris was another scientist who was working on the early CRS Board with Frank Marsh. I asked Henry about the impact of Frank Marsh's life and writings, and Morris replied that he believed he had read all of Marsh's books, appreciated him and had profited very much from the books. Morris characterized Marsh as "certainly a real pioneer in the modern creation cause" (Morris, 2001).

Frank Marsh's Influence on My Life

My undergraduate college years in the late 1940's and into the 1950's was a crucial period when I was struggling to solidify my views regarding origins issues. During the 1951–1952 year I read Frank's *ECS* book which had a major influence on my thinking. I was impressed by the mass of scientific data and profound scholarship of the author. Never since I studied that publication in the 1950's have I doubted a discontinuity model.

My recognition of discontinuity was reinforced during the early-mid 1950's when I discovered that the advisor for my master's degree in embryology had made a 180 degree turn from being a vigorous promoter of embryological recapitulation. He became an even more ardent anti-evolutionist with regard to embryology (Frair, 1999).

After I had chosen a discontinuity model, I had an opportunity to deliver my first formal presentation before a

learned audience which was a joint meeting of the American Scientific Affiliation (ASA) and the Evangelical Theological Society (see Frair, 1958). The impetus for this paper and its publication came mainly from Frank Marsh's *ECS* book.

In 1958 I was Program Chairman for the Thirteenth Annual ASA Convention at the University of Iowa in Ames, and I invited Frank to be on the program. His presentation was well-received by the attendees. Later the ASA published his document (Marsh, 1960). The work was modified and expanded for the first issue of the *Creation Research Society Quarterly* (Marsh, 1964).

Frank and I carried on correspondence over the years. I was there at the 1963 ASA Convention at Asbury College (Kentucky) where Frank read a paper written by Henry Morris who was not able to attend because of a schedule conflict. Privately a group of us met to discuss the possibility of a new creationist alliance which later was organized as the Creation Research Society.

Not long after Marsh had his booklet *Evolution or Special Creation?* published in 1963, he and I were discussing the pressures of an academic life, and I empathized as he was telling me how he had to sandwich his writing in between a host of other commitments.

In 1967 the book on the case for creation authored by myself and Percival William Davis was published, and it has had two subsequent revisions (see Frair & Davis, 1983). The book was inspired by writings of Frank Marsh.

Conclusion

It is interesting that in the saga of modern origins studies God has used an array of actors including scientists in a multitude of fields and of philosophical persuasion including atheists and theologians. From humble beginnings a farm boy named Frank Lewis Marsh was virtually a loner back in early decades of the twentieth century. He studied well the works of leading evolutionists and showed how their data fit better into a discontinuity context. By so doing he laid a foundation upon which an increasing number of scientists have been constructing their taxonomies (see Frair, 2000). He died 14 July 1992, three months short of his ninety-third birthday.

Another scientist, Ariel Roth (referred to previously), who like myself experienced a reorganization of his thinking after the reading of Marsh's *Evolution, Creation, and Science*, recently commented on the Scripture verse in Ecclesiastes 11:1 in reference to Marsh's life and work. The verse says—"Cast your bread upon the waters"—in other words, "give generously",—"for after many days you will find it again"—in other words, "your gifts will return".

Roth, in tribute to Marsh's comprehensive contribution to the subject of origins, said, "Frank Marsh did not live

long enough to realize how much bread he had cast" (Roth, 2001).

The legacy of Frank Lewis Marsh is being realized to an increasing degree even now as we consider the challenges and opportunities of 21st century science.

Acknowledgments

Considerable aid in locating information along with encouragement was given by Warren L. Johns. Frank Marsh's daughter, Sylvia Marsh Fagal, provided a bibliography of her father's writings along with photographs and personal information about her father and his wife, Alice. Ariel Roth volunteered pertinent personal information about Frank Marsh. Linda Skinner was especially helpful in sending material from Union College in Nebraska. Jim Ford and Wolfgang P. Kunze at Andrews University in Michigan cooperated in my locating resources from their library. Much information in this manuscript was obtained from unpublished material obtained from the above. Other aid and encouragement were given by Donald W. Munro, Robert Brown, Andrew Hui and my wife, Betty Frair. A personal invitation from Todd Wood initiated this project for the year 2001 which stands as the 60th anniversary of Frank Marsh's first book and introduction of the word "baramin" for the discontinuous forms of life.

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Book Review

Christian Men of Science by George Mulfinger and Julia Orozco
Ambassador Emerald International, Greenville, SC. 2001, 321 pages, \$15

This book is a compilation of notes from the late George Mulfinger (1932–1987). George was a musician, physicist, chemist and writer. He served on the CRS board during 1975–1987 and his memory was honored with Fellow status in 1988. His legacy includes eleven children who are musicians, missionaries and professionals. Daughter Julia completed this book from dad's files; son Mark did the artwork. The book is dedicated to their mom.

The book offers detailed biographies of eleven creationists, both historical and contemporary. They include Johann Kepler, Robert Boyle, David Brewster, Michael Faraday, Samuel Morse, Matthew Maury, William Thompson, James Clerk Maxwell, Howard Kelly, Henry Morris, and Walt Brown. Each man gets 20–30 pages of discussion. Special attention is given to the spiritual journeys of these scientists. There are many good quotes and anecdotes that are documented in older, less-familiar references. George obviously did in-depth research on the personalities.

The three modern names bring balance to the book. Howard Kelly (1858–1943) was a physician who pio-

neered lifesaving techniques in gynecology. He taught generations of medical students at Johns Hopkins Medical School. Background information is given on Henry Morris, *father* of the modern creation movement. His career includes engineering, university administration, Gideon ministry and writing. In fact Henry Morris has averaged a new, successful book each year over a 50-year span. He served on the CRS board during 1963–1982, was president for six years, and became a Fellow in 1983.

Walt Brown has a distinguished military and engineering career. He attended West Point, served in Viet Nam as a Colonel, then taught at the Air Force Academy. Surprisingly, the book also discusses quarrels that Brown has with other creationists concerning the priority of published ideas. The book sides with Brown. In fact his picture is placed on the cover alongside Kepler, Faraday and Morse. The book has a helpful bibliography but no index.

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Natural Bridge, Virginia: Origin Speculations

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Abstract

Natural Bridge, Virginia is a striking geologic structure, and this paper presents a model for its development within a young earth framework. A brief review of uniformitarian conjectures for the origin

of the bridge is given. The latter employ erosion by fluvial processes over long periods whereas the creationist model requires erosion by a large volume of water in a short time span.

Introduction

The Natural Bridge of Virginia is an impressive arch (Figure 1) located in Rockbridge County, Virginia (Figure 2). It is easily accessible being two miles from Interstate 81 or 14 miles southwest of Lexington, Virginia along U. S. Highway 11, which crosses the top of the natural structure. The arch has a thickness of 37 ft. on one side and 45 ft. on the other with a length of around 90 ft. The top of the arch is about 200 ft. above Cedar Creek which flows underneath the bridge (Spencer, 1964, p. 3; 1968, p. 3; 1985, p. 4; Thornburg, 1965, p. 123). Visitors can attend an awe-inspiring evening program viewing the bridge illuminated by various lighting effects with a background of music while the Genesis Creation account is recited.

History

The initials G. W. have been carved on the wall of the bridge at about 23 ft. above water level. These initials are believed to have been placed there by George Washington in 1750 when he was a surveyor. Two stone markers engraved with Washington's initials and the surveyor's cross have been found nearby. On July 5, 1774, 157 acres of land on which the bridge is located was



Figure 1. Natural Bridge, Virginia. People walking under the arch can be used as a scale to judge the immensity of the arch. Note that the strata are horizontal.

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transferred by King George III of England to Thomas Jefferson for 20 shillings. Jefferson referred to the feature as “the most sublime of Nature’s work” (Wright, 1936, p. 54). The bridge is still privately owned with a hotel, dining room, visitor center, gift shop, and wax museum and factory on site with Natural Bridge Caverns close-by.

Geologic Setting of the Natural Bridge Region

Natural Bridge is located in the central part of the Great Valley of Virginia which is floored by sedimentary rocks predominately limestones, dolomites and shales (Spencer, 1985, p. 37). This region includes sections of the Blue Ridge and Valley and Ridge physiographic provinces (Spencer, 1964, p. 1). The bridge consists of dolomites and limestones of the Ordovician Beekmantown and Chepultepec Formations (Spencer, 1968, p. 3). See Table I for a brief description of the lithology of these formations.

The Great Valley of Virginia is considered “...one of the major karst regions of the United States” (Thornburg, 1965, p. 120). Several caverns are found in the Shenandoah Valley of Virginia and Natural Bridge Caverns are adjacent to Natural Bridge. Other karst features found in the region are sinkholes, natural tunnels, and sinking creeks (underground streams).

Also as noted by Erikson (2001, p. 199):

In limestone terrain natural bridges are created in tunnels excavated by groundwater solutions, resulting in a collapse of the tunnel roof. Natural Bridge in Virginia... is the most famous example of this type of bridge in the United States.

Speculations on How Natural Bridge Formed

Thomas Jefferson wrote on the development of the bridge in 1785 stating that “It is on the ascent of a hill which seems to have been cloven through its length by some great convulsion” (as quoted in Wright, 1936, p. 54). Later Frances W. Gilmer accompanied by Jefferson viewed the arch and suggested that since the structure consisted of calcium-containing rocks which readily dissolve in water that the bridge is all that remains of the roof of a former cave (Gilmer, 1818). He conjectured that the waters of Cedar Creek were diverted through fractures and joints in the limestone and dolomites eventually forming an underground passageway which was gradually enlarged until the roof of the natural tunnel collapsed leaving the present Natural Bridge. As expressed by Cleland (1910, p. 327) when discussing the Natural Bridge of Virginia:

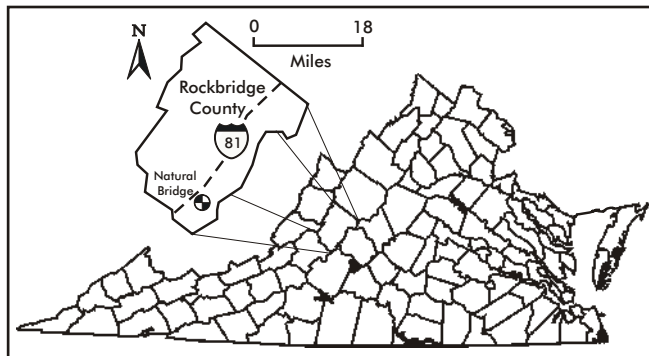


Figure 2. The location of Natural Bridge in Rockbridge County, Virginia.

In bridges of this character the cavity which later produced the bridge was formed by water percolating through a joint or fissure athwart [across] the stream [brackets added].

All subsequent uniformitarian discussions of the origin of the structure are variations of the Gilmer hypothesis and these ideas will be presented briefly in chronological order.

First, however it is not difficult to convince yourself that the Gilmer theory is reasonable. As you proceed up Cedar Creek from Natural Bridge, you walk along the bottom of a gorge which can be imagined as once having been a tunnel formed by rushing subterranean water, the roof of which collapsed and was carried away or dissolved by the flowing water. Later the walls of the gorge were modified by weathering (Figure 3). As you stroll beside Cedar Creek you hear rushing water in one of the ledges. This sound caused workmen to blast a hole in the ledge around 1812 (Spencer, 1985, p. 4) revealing a stream, called Lost River (Figure 4), flowing through fissures inside the rock. Observing a narrow gorge and an underground stream above the bridge makes it easy to believe the Gilmer concept!

The strata at the bridge are almost horizontal (Figure 1) whereas the layers of limestone in and along Cedar Creek are inclined toward the bridge both upstream and downstream (Figure 5). Thus the bridge is situated at the trough of a downward fold in the strata (i.e., a syncline). Ashburner (1885) suggested that the bridge is a remnant of

Table I. Geologic Formations that Comprise Natural Bridge (after Spencer, 1968, pp. 8, 22, 25)

Formation	Lithology
Beekmantown	Light to medium gray dolomite containing floating sand grains, interbedded with gray to dark blue limestones with chert beds
Chapultepec	Thin bedded to massive gray limestone containing layers of magnesian limestone and massive light gray dolomite containing floating sand grains

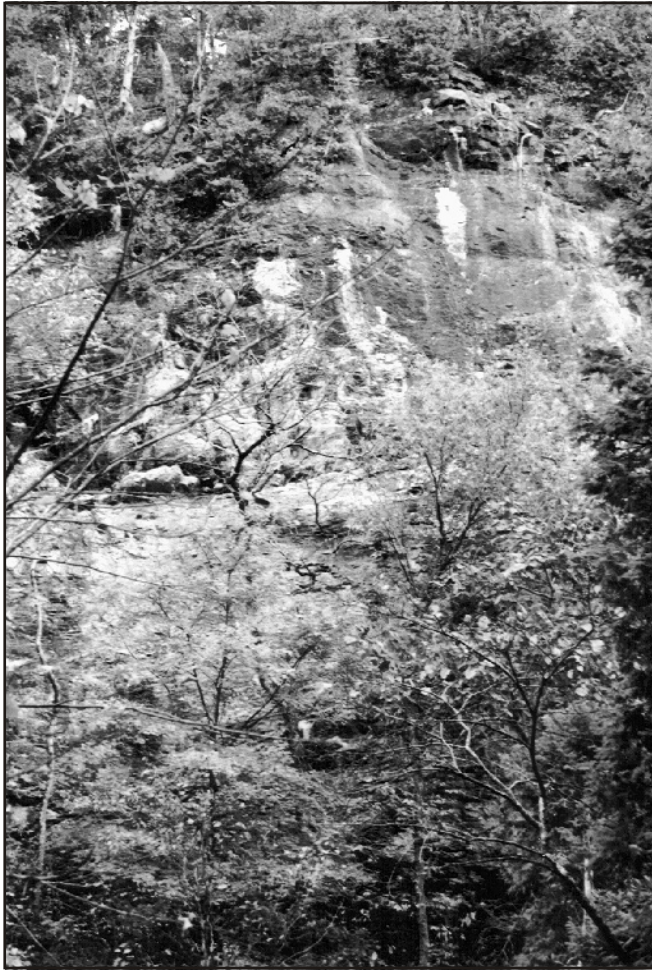


Figure 3. Steep-sided wall of gorge upstream of Natural Bridge, Virginia.

the top of a cave because of its location near the center of a gently dipping syncline, water would not penetrate and dissolve this portion of the strata as rapidly as it would the concave layers above and below the bridge.

Walcott (1893) offered a revised model that was more detailed and somewhat different from the Gilmer concept. Walcott proposed that Cedar Creek deepened the gorge (rejuvenation) from the the James River (Figure 6) to a point below the present level of the top of the bridge where a waterfall existed. Around the same time Cedar Creek developed a subterranean passage in the limestone strata upstream. This tunnel gradually enlarged until all of the water of the creek flowed through it leaving the bridge.

Malott and Shrock (1930) proposed another approach to bridge development. The water in Cedar Creek once flowed into Cascade Creek (Figure 6). Cedar Creek took a sharp turn about 0.25 mile above the present bridge along a meander spur to connect with Cascade Creek. At this sharp bend the water of Cedar Creek began to cut an underground passage into the spur. Cedar Creek formed the subterranean passage while a gorge was developing

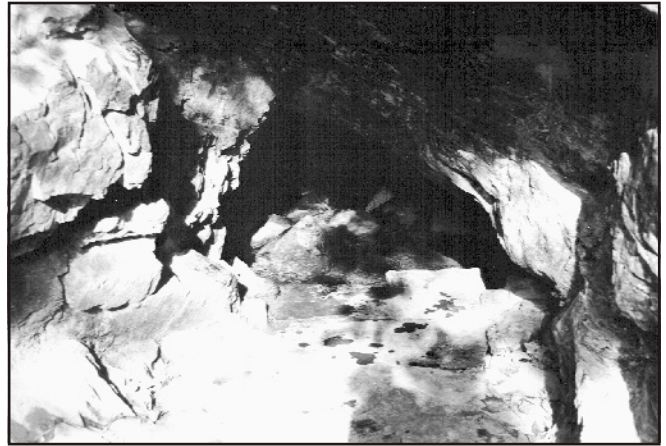


Figure 4. Lost River was revealed when a section of rock ledge was blasted away so that the stream could be observed. Lost River eventually empties into Cedar Creek. It is not known where the source of the stream originates.

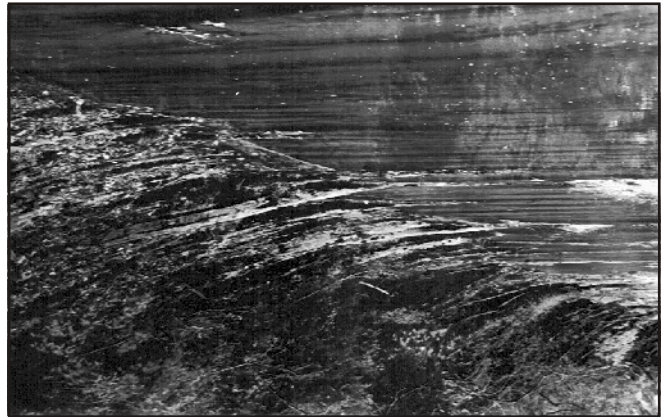


Figure 5. Gently dipping limestone layers in Cedar Creek upstream from Natural Bridge, Virginia.

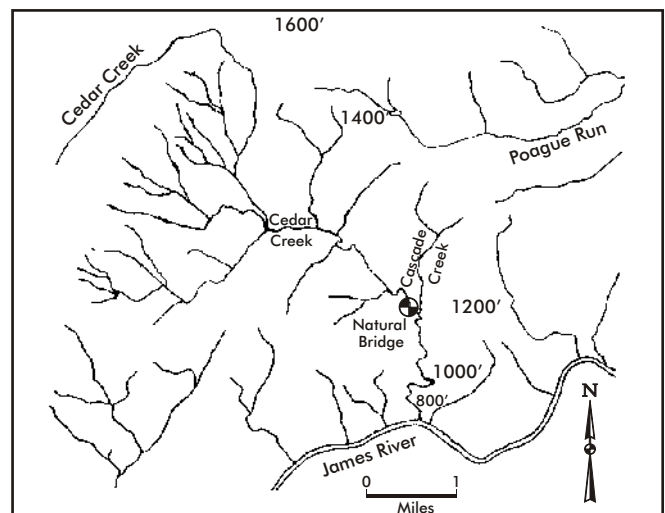


Figure 6. Regional drainage pattern around Natural Bridge, Virginia (after Spencer, 1968, p. 5). The various elevations are noted in feet at certain locations. Natural Bridge is at 1046 feet.

on the lower side of the spur by similar processes. The tunnel roof collapsed along the underground route except where the roof contained massive limestone and dolomite leaving the bridge. This “cutting off” of stream meanders forming natural bridges had been discussed earlier by Cleland (1910, pp. 314–321) by a process he called perforation of the neck of an incised meander. The Malott-Shrock model however involves the development of a longer passageway than would be required to cut off a meander neck. Also there is a height difference between the upper and lower portions of the meander that Cedar Creek breached.

Woodward (1936) and Wright (1936) presented separate, but similar stream piracy models leading to eventual bridge formation. Wright’s ideas have been called the sink-piracy model, whereas the Woodward concept involves the “ancestral” waters of Cedar Creek, Cascade Creek and Poague Run (Figure 6). This stream diversion scheme increases the volume of water available to form an underground tunnel.

Most of the previous uniformitarian proposals employ the massively bedded strata at the bridge to explain why the roof of a subterranean passage remains at that point. Monymaker (1948) observed from his studies in the Tennessee Valley that extensively jointed limestones were more cavernous than less jointed limestones a few miles away. Likewise all of the uniformitarian proposals for the development of Natural Bridge, Virginia feature erosion and dissolution of dolomites and limestones by fluvial processes acting over long periods of time.

Introductory Flood-Young Earth Model for Bridge Development

It is assumed that the deposition of the regional limestones and dolomites occurred during the Flood. It is assumed also that these calcium-containing sedimentary deposits would have set initially similar to the setting of portland cement (Williams and Herdtklotz, 1977, pp. 197–198). Since the newly deposited strata were underwater, the sediments would be water-laden and would need time under sub-aerial conditions to dewater which would cause them to further harden.

As the Flood began to retreat from the region, solution and erosion of the recently deposited limestones and dolomites could have formed a phreatic tube (underwater solution cavity) [Williams and Herdtklotz, 1977, pp. 193, 197–198; 1978, p. 88] along the synclinal fold as water easily penetrated the sloping layers of limestone. Eventually the decreasing Flood water level would be close to the top of the ridge. The phreatic tube would become a preferential flow path for the retreating water with the upper opening

of the tube acting like a sink hole. If this circumstance developed, the exiting water would cease to erode or dissolve the upper ridge surface leaving an arch intact. The gorge would form rapidly “upstream” and “downstream” as the water flow through it would cause the roof to collapse with the debris being swept away by the rapid water flow. Water would funnel through and under the arch of the bridge where the massive limestone at that location would resist extensive widening.

The major erosional process at this phase would be downcutting as gorge development would follow the ever decreasing water level toward the “ancestral” James River, likely a major Flood retreat channel (See Froede, 1994, p. 192 [Figure 7] for a miniature natural bridge formed in Georgia by similar processes as I have described.) The exposed sediments would begin to dewater and likely cliff sapping (Austin, 1994; Froede, 1996) would occur along the gorge widening it in places with the debris being washed away or dissolved in the rapidly-flowing water. The regional drainage pattern observed at the present time eventually would be established with the underfit Cedar Creek flowing beneath the bridge. This view of the development of Natural Bridge, Virginia depends upon considerable available water (Flood conditions) allowing the structure to be formed in a short period of time. The entire erosional process could have begun in the late phases of the Flood and continued possibly into the post Flood period.

Appendix: Geomorphic Models

My suggested model for bridge and canyon (gorge) development is one of many possibilities that could be suggested. The model appeals to the karst features in the region. The possibility of canyon formation in limestones in Trans-Pecos, Texas has been discussed previously (the lower portion of Santa Elena Canyon, Big Bend National Park [Williams and Howe, 1996]) and Contrabando Canyon (Williams, 1997) by processes of cave development and roof collapse. All models such as these are subject to revision or entirely different conjectures could be offered for canyon and bridge formation.

Recently Michael Oard (2001a; b) proposed an all-encompassing geomorphic model for the formation of canyons, water gaps, pediments, etc. in relation to the Flood. He did not include natural bridges or karst features in his model. General models often ignore local geomorphic features in various regions. Hopefully Oard will integrate other geomorphic structures into his model in the future. It would be worth the effort and I would enjoy reading the extension of his postulations into other regions.

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By Lane P. Lester, Dennis L. Englin, and George F. Howe

This is a 223-page biology textbook, which assumes the truth of creation, in contrast to most biology books which assume the truth of evolution. It is being used by Christian colleges and a correspondence course by Moody Bible Institute. It is written at the introductory level and is suitable for high school use as well. To reduce costs, it has line drawings in black ink and is plastic-comb bound.

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The Feasible Same-Site Reappearance of the Tigris-Euphrates River System after the Global Flood

John Woodmorappe*

Abstract

Those who recognize the reality of the global Flood have always appreciated its destructive and erosive power, and have accordingly concluded that the antediluvian Tigris and Euphrates Rivers were obliterated. So long as river courses had been understood as forming as the result of shallow-crustal processes, such deductions are entirely consonant with available evidence. New geologic evidence, however, indicates that the courses of major rivers are governed

by deep-crustal features. This opens up the serious possibility that the postdiluvian Tigris-Euphrates River system has reappeared at or close to the location and trend of its antediluvian counterpart—all despite the deposition of thousands of meters of Flood sediment. New geologic evidence undercuts the claim of compromising evangelicals that the retention of antediluvian place-names necessarily implies a local flood instead of a global one.

Introduction

The Tigris and Euphrates Rivers play a major role in Biblical history. These bodies of water, for example, are associated with the Garden of Eden (Genesis 2:10–14) as well as events surrounding end times (Revelation 9:14 and 16:12).

The question has been raised as to the identity of the two rivers before and after the Flood. The compromising-evangelical proponents of the local flood have insisted that the continued existence of these rivers proves that the Genesis Flood was local (e.g., Munday, 1996; Ross, 1998). Their supposition hinges on these two premises: 1) The river systems are identical before and after the Flood; and 2) The antediluvian topography had not been removed by erosion. Those who recognize the global extent of the Flood (Whitcomb and Morris, 1961, p. 83), on the other hand, point out that the antediluvian Tigris and Euphrates River systems likely had been completely obliterated. Only the names themselves of major antediluvian rivers had probably been re-used for the most familiar rivers of the post-Flood world. After all, the re-use of names was a frequent practice in Biblical times no less so than in modern times. Other commentators (for instance, the 19th-century Diluvialist Granville Penn; Mortenson, 1997, p. 371) believed that the ascription of the Tigris-Euphrates system to the pre-Flood world had been the result of a copyist's error. However, this opinion has apparently never found substantiation in fact.

I fully support the reality of the global Flood. In this work I present geologic evidence that, counterintuitively, the Tigris-Euphrates River system very probably redeveloped in very much the same geographic area that it had occupied before the Universal Deluge. If this is correct, it not only means that the same *names* had been re-used after the Flood, but also that the pre-Flood and post-Flood Tigris-Euphrates river systems are essentially the same *in spite of* the obliteration of the pre-Flood topography and the deposition of thousands of meters of Flood strata. Obviously, this could only have happened if the courses of major rivers was governed by something more than superficially-placed earth-surface processes. Recent geologic evidence indicates that such is indeed the case. It is also a striking fact that the regional sequences of sedimentary rock trend, in terms of thickness and depositional axes, are parallel to the present-day Tigris-Euphrates system (Ronov et al., 1984; 1989). If we further grant the premise that Noah's Ark landed, perhaps providentially, within a few thousand miles of its launching point, the two large rivers would have been the first ones encountered by the crew. It would have been natural for the Ark inhabitants to name the post-diluvian Tigris and Euphrates rivers after their antediluvian Flood counterparts, although in this case the rivers would have been essentially the same, and not merely the same names used for different rivers.

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Antediluvian Earth-Surface Features: Implications of Deep-Seated Faults

Whenever attempting to decipher the exact origins of topographic features such as rivers, we must determine the nature of the factors which govern the locations and directions of existing river valleys. Do rivers make their appearance at essentially random geographic locations as water flows from higher to lower elevation, or are there other factors involved which predetermine the courses of at least some of the earth's rivers? Let us briefly examine both alternatives in light of the Flood.

According to the first idea, rivers are, geologically speaking, strictly surficial features, and the result of incidental earth-surface processes. Following this line of reasoning, the antediluvian topography became obliterated during the worldwide Flood, and the locations and courses of the antediluvian rivers were erased forever. The post-Flood river systems originated as water flowed from higher to lower elevations. However, the locations of these new rivers otherwise had nothing in common with the numbers and courses of the antediluvian rivers that had preceded them.

Indeed, to the extent that they are entirely surficial systems, rivers could be likened to scratches on a wall of plaster. Whenever sufficient paint, wallpaper, or plaster is scratched off, the scratch is completely obliterated. This corresponds to the erasure of the pre-Flood topography (Whitcomb and Morris, 1961). As a new layer of plaster, wallpaper, paint, etc., is applied to the wall, it eventually may be subject to new scratches. However, the new collection of scratches will have nothing in common (in terms of numbers, locations, and directions) with the older set of scratches, except perhaps by coincidence. In my analogy the new scratches, of course, represent the post-Flood rivers.

Now let us consider what happens if, to the contrary, river systems (their locations, courses, etc.) are actually governed by deep-seated faults. Commensurate with the earlier analogy of the scratched wall, this situation may be likened to a deep-seated crack in the masonry of a building. This crack manifests itself also in the plaster of the adjoining wall, as it cuts through wallpaper and paint. Now suppose that the owner simply fills in the crack and adds a thick layer of plaster. He then covers up the cracked area with fresh wallpaper or paint. Since the underlying problem (the crack in the masonry) has not been repaired, the problem will re-emerge as soon as the building shifts slightly. The crack will propagate anew through the new layer of plaster, etc., and will re-appear at exactly or almost exactly the same position it did before.

In the above analogy, the crack in the masonry represents a fault in the Precambrian basement rocks underneath the Tigris-Euphrates Valley. The old crack in the

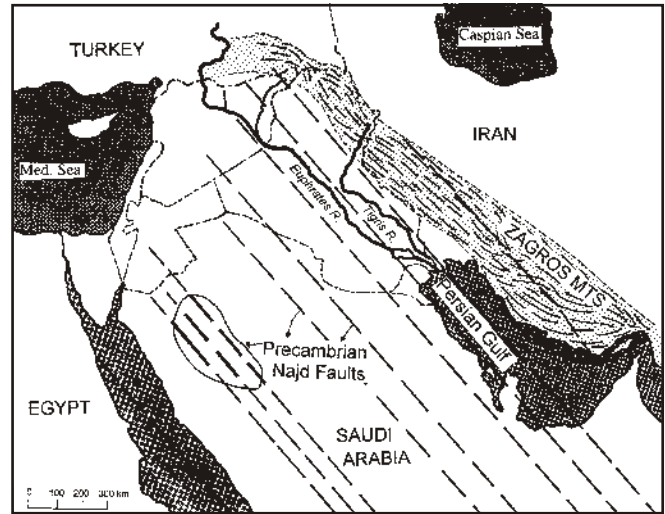


Figure 1. The entire region from the Red Sea to the Zagros Mountains appears to be dissected by largely-concealed northwest to west-northwest trending Precambrian faults. The present-day Tigris-Euphrates system also parallels these structures, suggesting an origin in terms of the latter. Because these faults appear to pre-date the Flood, the course of the antediluvian Tigris and Euphrates rivers was probably also governed by these faults.

wall represents the antediluvian Tigris-Euphrates system. The thick new layer of plaster represents the thousands of meters of Flood-deposited sediment. The new fault represents the post-Flood (and present-day) Tigris-Euphrates Valley.

Geologists now realize that faults are in fact a characteristic feature of the deep-seated geology of this part of the world:

Northwest-trending structures are apparent all over the northern Arabian plate, from the Red Sea to the Zagros Mountains... The Najd deformation may have imparted a deep-seated regional fabric that controlled the locus of later episodes of deformation... The fault trends mapped in this study generally are consistent with the exposed Najd faults, lending credence to those interpretations... (Litak et al., 1998, p. 1185).

All of this is illustrated in Figure 1. Landsat photos have been used to study these features, and studies on directional frequency demonstrate the fact that the rifts or faults tend to trend northwestward (Al Khatieb and Norman, 1982). It is believed that the Najd belt shows evidences of strike-slip action, reflecting the importance of shearing action (Moore, 1979). Further evidence that the Najd system continues eastward is provided by the geometry of the sedimentary beds of Oman and adjacent regions (Mattes and Morris, 1990).

The striking fact is that the Tigris-Euphrates River system *also* follows this NW-SE trending system of partly-ex-

posed, but largely-buried deep-seated faults. Because these pre-existing structures are Precambrian, they most likely have existed prior to the Flood¹. And, since the course of the present Tigris-Euphrates system is governed by these faults, it seems quite probable that any antediluvian river system in this general location *also* exhibited a course parallel to that of the present Tigris-Euphrates system. Of course, it cannot be ruled out that the antediluvian Tigris-Euphrates system existed at an entirely different location on earth from its present counterpart. However, we should be open-minded to the possibility that the antediluvian and postdiluvian versions of these rivers are essentially one and the same, especially in the light of the geologic evidence discussed in this paper.

Some Failures of Uniformitarian Geology in the Middle East

Consider index fossils. The use of fossils to date rocks often results in unpredictable revisions of expected age, and illustrates once again the circular reasoning of using index fossils. It also underscores yet again the neo-Cuvierist fallacy of assuming that sedimentary beds can be dated according to appearance and/or lithostratigraphic position. For example, a sedimentary formation near Tehran suddenly changed from Devonian to Early Cambrian for the following reason:

...the discovery of *Redlichia* trilobites of Early to Middle Cambrian age in the area northwest of Tehran. The mainly continental beds of the Lalun Formation, *formerly assigned to the Old Red Sandstone [Devonian] before their age was established*, give way to a Middle Cambrian to Ordovician succession of carbonates... (Alsharhan and Nairn, 1997, p. 137) (emphasis added).

In other words, the trilobite *Redlichia* establishes a sedimentary rock as Cambrian in age, and then the circle of reasoning closes whenever we are informed that *Redlichia* is found only in Cambrian rocks.

There are various ways that strata are massaged in order to force them to conform to the dictates of the evolutionary-uniformitarian geologic column. For example, irrespective of the final resolution of the following age-dating conflict in Iraq, it is clear that time-transgressive formations are always standing by to help the uniformitarian explain away any conflicts between lithology and age:

The relatively abundant fauna in the Sargelu beds indicates an age ranging from the latest Liassic [Early Jurassic] to Bathonian [Middle Jurassic].

¹I assign most of the Phanerozoic sediments to the Flood as well as the fossiliferous parts of the Precambrian. However, I reject the view which would have the entire Precambrian forming during the Flood.

However, as a possible Middle Jurassic age has been assigned to *Posidonia* faunas found in the underlying Sekhanian Formation, there must either be an error in the age assignment, or the boundaries between the two formations may be diachronous or simply facies-controlled (Alsharhan and Nairn, 1997, p. 285).

That the standard uniformitarian geologic column could be false is, of course, not a possibility entertained by Alsharhan and Nairn! Moreover, a number of paleontologic puzzles have emerged as the sedimentary rocks of the Middle East have been explored for fossils. For instance, a series of beds on Socotra Island (in the Gulf of Aden) contain fossils suggestive of an age near the Permo-Triassic (PT) boundary, except for the following uncomfortable find:

The similarity of the crinoid columnals to Devonian forms is marked; however, similar columnals are associated with what must be an Anisian [Triassic] ammonite (Bott et al., 1995, p. 227).

Many of the biostratigraphic considerations which I had discussed in my work on cephalopods (reprinted in Woodmorappe 1999) have recently been found to be very relevant to the ammonoids recovered on Socotra Island:

The macrofossil samples include a number of ammonites that are endemic to the limestone platforms of the paleo-tropical belt. A factor that makes age determinations even more difficult is that there are convergent homeomorphs of just these forms occurring in the Middle to Upper Triassic, the Albian-Cenomanian [Middle Cretaceous] and the Campanian-Maestrichtian [Upper Cretaceous]. Therefore, an accurate age based upon these homeomorphs is particularly difficult (Bott et al., 1995, p. 227).

Of course, the foregoing citations are hardly exhaustive. To the contrary: They are only examples that have come to my attention while researching the main topic of this study.

The Inapplicability of Plate Tectonics

Had continents drifted before or during the Flood, it would have been very difficult for the Tigris-Euphrates river system to reappear at its nearly-identical pre-Flood location, for reasons discussed below. Some creationist researchers (e.g., Watson 1997) have discussed the geologic activity surrounding the Dead Sea Rift and its actual or possible implications in Biblical history. However, one does not need drifting continents in order for faults such as the Dead Sea Rift to have been operative. Moreover, at least in a young-earth context, the slippage of earth's crust along the Dead Sea Rift need not have any direct relation to the geologic events surrounding the geographic region of the Tigris-Euphrates River System.

According to the ruling plate-tectonics paradigm, the Zagros Mountains formed when the Arabian plate collided with the Asian plate. Before that, an ocean separated what is now the Arabian Peninsula from what is now the remainder of Asia. It is believed by uniformitarians that, in much earlier geologic history, the Arabian Shield itself had been produced from the collision and suturing together of microcontinents. Such views are, of course, incompatible with the idea, discussed below, that the antediluvian Tigris-Euphrates system was located at the site of the Zagros geosyncline. It is therefore necessary to take a critical look at plate tectonics as it relates to the area of the present-day Zagros Mountains. It should thus be noted, at the outset, that continental-drift theories are not particularly convincing. To the contrary:

Numerous, often contradictory, plate tectonic models have been proposed to explain the evolution of the Arabian-Nubian Shield (Jackson and Ramsay 1980, p. 624).

Disagreements on the plate tectonics of the Middle East region are many... Nearly all of these hypotheses are mutually exclusive. Most would cease to exist if the field data were honored (Kashfi, 1992, p. 119).

Even the creation of ophiolite, believed to be the outcome of orogenesis resulting from motions of the Arabian plate, is the subject of at least three mutually-exclusive plate-tectonics hypotheses (Alsdorf et al., 1995).

In like manner, contradictory models have been proposed to clarify the nature of the alleged suture zone comprised by the Zagrosides (see Alavi, 1980). Moreover, not everyone with firsthand familiarity with the geology of the region believes that it is compatible with a plate-tectonics origin at all. In fact, some evidence at least suggests that what is now the Arabian Peninsula has *always* been a part of Asia:

The Zagros geosyncline is interpreted by many workers in terms of plate tectonics; they disregard many years of thorough geologic investigations in order to explain the geology of this part of the world... These data demonstrate that the concept of plate tectonics is completely in error in the Tethys region... some stratigraphic units of Early Cambrian to Middle Triassic age in Arabia and northeastern Africa can be traced through Iraq, Iran, and into Soviet Central Asia... structural continuity between Arabia, Pakistan, and western India since late Paleozoic time (Kashfi, 1976, p. 1488–1489).

One should seriously question the *necessity* of plate tectonics in the Creationist-Diluvialist paradigm (Reed, 2001). Proponents of Catastrophic Plate Tectonics (CPT) have argued that continental motion is necessary in order to maintain convection cells in the mantle that will allow rapid orogeny on a young earth. Only further research will

determine whether or not this is the case. However, when it comes to the local geology, the answer is in the negative:

The simple subsidence of the crust and accumulation of sediments in the subsiding trough, coupled with simple isostatic balance and compressive movements, were sufficient to produce the Zagros geosyncline. *There is no need to call for collision of Africa with Asia to produce it* (Kashfi, 1976, p. 1489) (emphasis added).

These data show that there is nothing in the geologic record to support a past separation of Arabia-Africa from the remainder of the Middle East (Kashfi, 1992, p. 119).

It would appear that vertical crustal tectonics are sufficient to explain the geology of at least the Middle East. Therefore, I have therefore adopted the position that, whatever structural changes took place in the geology of the whole region, it was entirely in the context of static and permanent continental masses.

The History of the Tigris-Euphrates River System During and After the Flood

In this section, I consider some probable locations of the antediluvian rivers in question. The deductions are based on the deep-seated geology of the region. Since the sedimentary rocks were deposited during the Flood, trends in their thickness can be used to discern the locations of deep-crustal features, and thus also to narrow down the prospective locations of the antediluvian Tigris-Euphrates River system.

The Zagros Geosyncline and Fold-belt.

The Zagros geosyncline and later fold-belt are believed by some geologists to have originated from a reactivated Precambrian lineament (Mattes and Morris, 1990, and citations), possibly related to the previously-discussed NW-SE trending Najd fault system (Figure 1). I thus consider the Zagros geosyncline as a possible site of the antediluvian Tigris-Euphrates system. To begin with, if correct, it means that the present Tigris-Euphrates system is almost exactly parallel to the antediluvian one, but located 200–300 km west (Figure 2). It is also worth noting that the sedimentary pile in the geosyncline became subject to compressive tectonic forces only towards the final phases of its filling:

In the Zagros folded belt, quiet and conformable sedimentation continued from Cambrian to Pliocene times. Only gentle epeirogenic movements and salt diapirism affected this belt before the Late Tertiary Zagros orogeny when the sediments became folded into a series of parallel anticlines and synclines (Takin, 1972, p. 148).

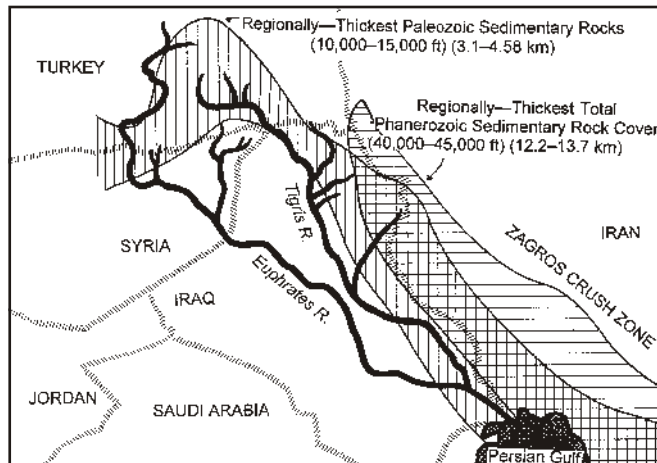


Figure 2. Greatest regional thickness of the oldest Flood-deposited rocks, and the greatest regional thickness of all Flood-deposited sedimentary lithologies. Data condensed from Beydoun (1991). In this and succeeding maps, the modern Tigris-Euphrates system and major political boundaries are included for clarity.

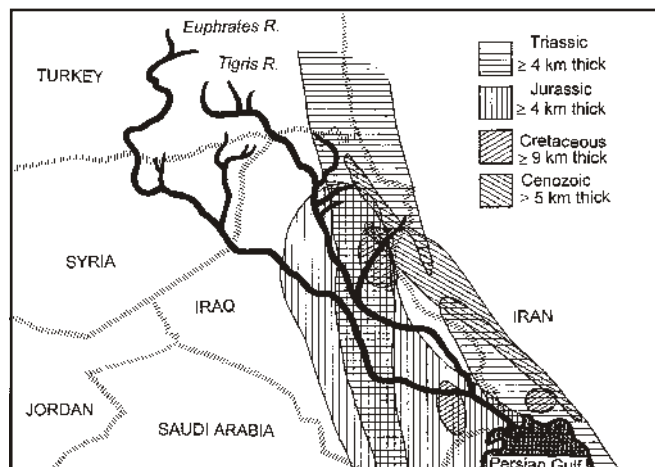


Figure 4. Greatest relative thickness of sedimentary rocks deposited primarily during the middle through latest stages of the Flood (Mesozoic and Cenozoic). Data combined from Alsharhan and Nairn (1997), Goff et al. (1995), and Setudehnia (1978).

We can understand this process in the light of the following sequence of events: The deep-seated rift system, which had governed the course of the antediluvian Tigris-Euphrates rivers, became reactivated during the Flood. The entire trough became filled with sediment. It then subsided, and accumulated a great thickness of sediment throughout much of the Flood. The trend of this thick accumulation of sediments is reflected by the thickest belt of Paleozoic and/or Phanerozoic sedimentary rocks in the region (see Figure 2). Not until late in the Flood, or in the post-Flood, did the sediment become folded. And even then, only the eastern part became folded (the limits of Zagros folding are shown in Figure 5). The remaining unfolded sedimentary column

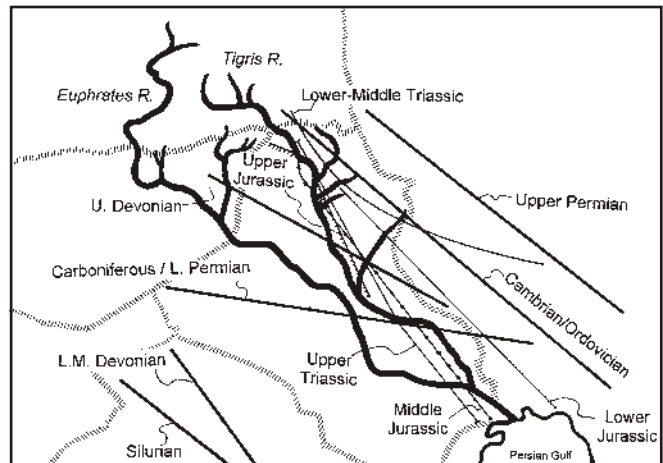


Figure 3. Major depositional axes of Flood-deposited rocks (Paleozoic—heavy lines, and Lower through Middle Mesozoic—thin lines). Data summarized from Ibrahim (1979).

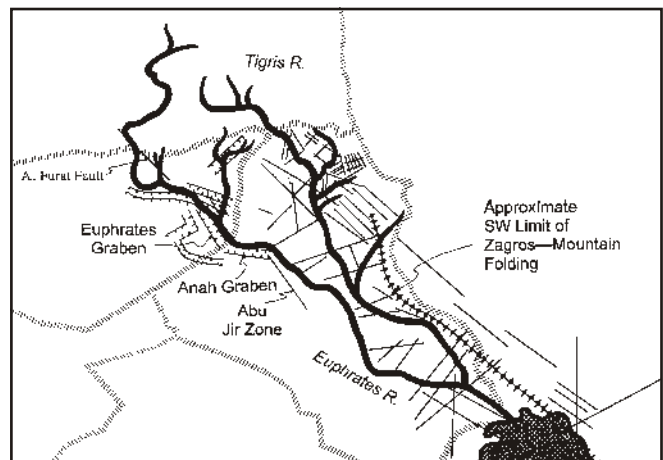


Figure 5. Schematic portrayal of major regional deep-crustal tectonic elements. Width of grabens is exaggerated for clarity. Data synthesized from Ameen (1992), Lovelock (1984), de Ruiter et al. (1995), Sawaf et al. (1993), Searle (1994), and Wells (1969).

gradually thins westward, underneath the present-day Tigris-Euphrates system, from 12 km to 7 km of total thickness (Alsinawi and Al-Banna, 1992).

Phanerozoic Depocenters as Alternate Locations of the Antediluvian Tigris-Euphrates

If the Zagros geosyncline is not the actual site of the antediluvian rivers in question, alternative locations can be considered based on isopach and depositional-axes data for specific systems. The data shown in Figures 3 and 4, although necessarily incomplete, is relevant to these concerns. Unlike the thicknesses of Mesozoic and Cenozoic sediments (Figure 4), those of Paleozoic sediments are generally not sufficiently demarcated, in all locations of

the region of interest to this study, to provide the basis for reliable isopach maps (Best et al., 1990; Sawaf et al., 1993). However, the available data indicates that trends in thickness of many Paleozoic systems show NW-SE trends comparable to that of younger rocks. For example, the belt of thickest Middle Cambrian to Lower Ordovician rocks (Husseini, 1989; 1990) covers very much the same area as the belt of thickest Paleozoic rocks as a whole (Figure 2). On the other hand, the thickest accumulations of Permian-Carboniferous sediments occur in relatively small areas within the Zagros Mountains and in east-central Syria (Al Jallal, 1995; Al-Laboun, 1988).

Let us examine the relevance of Phanerozoic depocenters to the question raised by this investigation. For example, suppose that the basement lineation which governed the course of the antediluvian Tigris-Euphrates did not become activated until the deposition of Triassic sedimentary rocks. The valley of these antediluvian rivers would then have become completely eradicated and subsequently buried by a thick carpet of early-Flood sediments. However, as the fault-system became active, the downfaulted area would subside, and Triassic sediments would then have been forced to accumulate to regionally-unusual thickness along the axis of this area. The thick belt of Triassic sediments (Figure 4) would thus end up marking the site of the antediluvian Tigris-Euphrates River System.

Of course, had the rift or fault which determined the course and location of the antediluvian river system become activated while rocks assigned to another geologic period had been deposited, the trend of deposition of these rocks would then mark the site of the antediluvian Tigris-Euphrates system. Any of the depositional axes (Figure 3) or major isopachs (Figure 4) would then indicate the site of the antediluvian river system. Note from Figures 3 and 4 that *all* of these trends are subparallel to each other and to the extant Tigris-Euphrates River system. This is clearly suggestive of a causal relationship between the manner of deposition of the Phanerozoic sediments, and the later appearance of the Tigris-Euphrates river system.

Let us now contrast the foregoing discussion in light of the two paradigms of origins. In conventional uniformitarian thinking, it is believed that Proterozoic structures were repeatedly reactivated during the Phanerozoic, giving rise to geologic features in different times in accordance with the standard geologic time scale (Best et al., 1993). For instance, it has been even suggested that the Precambrian Najd faults of the Arabian Peninsula had been reactivated in the Neogene-Quaternary to produce enigmatic volcanics having northwesterly-striking vents (Litak et al., 1997, p. 664; see Metwalli et al., 1974, p. 1782). To the Diluvialist, the time element is both artificial and erroneous. Proterozoic, Cenozoic, Quaternary, and everything in between are virtually contemporaneous

in the Creationist-Diluvialism paradigm, and there is no need to believe in the cumbersome process of repeated *ad hoc* episodes of activation and dormancy of Precambrian faults and rifts over hundreds of millions of years. Instead, if we are to accept the reality of renewed activity along basement faults and rifts between the time of Creation Week and some stage of the Flood, we are talking about a passage of time of only 1600 years or so.

The depocenters of the Phanerozoic systems appear to migrate with time on the Arabian Peninsula (Figures 3–4). The fact that both the depositional axes of Phanerozoic systems (Figure 3), as well as isopach extremes of the same (Figure 4) tend to occur in different geographic locations, has implications for the overall stratigraphic separation of fossils during deposition by the Flood. Thus, these observations are very consonant with the TAB model, which predicts an association between tectonic activity and age of the sediment (For further discussion of the TAB model, see the Diluviological Treatise, reprinted in Woodmorappe, 1999). As different areas of crust underwent downwarp, they simultaneously generated a stratigraphic differentiation of fossils as well as a geographic differentiation of especially thick accumulations of rocks assigned to successive geologic periods.

Reappearance of the Tigris-Euphrates at Its Exact Former Location?

I now consider the most extreme possibility: That at least part of the extant Tigris-Euphrates is located at the identical site of its antediluvian counterpart. To do this, we need to pursue the same reasoning behind that of the crack in the wall discussed at the beginning of this work. Is the crack merely an incidental earth-surface phenomenon, or is it governed by some process deep in the wall or even the building? To begin with, the pattern of sediment transport by the Tigris-Euphrates river system can hardly be characterized as recent or surficial. To the contrary: It is deeply rooted within the lithologies of (the presumed) geologic periods. The only question is this: *Just how early* in the Phanerozoic column do the effects of the present-day river system first appear? At a minimum, studies of paleocurrent directions in the Mesopotamian geosyncline indicate the following:

The persistence of the current pattern through all the geological ages from Triassic up to Pliocene speaks also for the persistence of the same trends of tectonic movements (Kukal and Saadallah, 1970, p. 684).

As for vertical movements of earth's crust, it is obvious that the faults which comprise the Euphrates graben are hardly surficial in nature:

Deeply penetrating faults have been identified in the Euphrates graben system, demonstrating the

thick-skinned tectonic style of this region (Brew et al., 1997, p. 628).

The Euphrates graben, and its satellite grabens (Figure 5) serve as depocenters for sediments that are Cretaceous and younger (deRuiter et al., 1995, p. 361). At least 3 km of Mesozoic and Cenozoic sediments have accumulated there (Sawaf et al., 1993).

Of course, these observations do not mean that the deep-seated features were necessarily absent at the time of the deposition of presumably older rocks. In fact, there is evidence that at least part of this feature which controls the course of the present-day Euphrates was in existence at least since the deposition of Early Paleozoic rocks:

The corresponding, albeit lesser, increase in thickness between the interpreted base Cretaceous (near the base Shiranish) and the top Silurian horizons *seems to indicate the presence of an earlier period of extension* (Litak et al., 1997, p. 657) (emphasis added).

A limited amount of borehole data suggests that the Paleozoic is somewhat thicker in the Euphrates depression than in surrounding areas, and the variation in isopach thickness is interpreted to be Paleozoic in origin (Best et al., 1993, p. 182). The Palmyride Mountains apparently developed over a pre-existing rift environment, with the northwest-trending Euphrates Graben forming contemporaneously with, and orthogonal to, the Palmyrides (Alsdorf et al., 1995). Moreover, at least part of the fault system may have antedated the Flood itself:

Although largely unexpressed by surface features, the Euphrates fault system represents an aborted rift system, striking roughly NW-SE and extending completely across Syria (Brew et al., 1997, p. 619).

The postulated Proterozoic Euphrates Suture may have extended through this area, making the present-day Palmyride/Euphrates intersection a Proterozoic triple-junction (Litak et al., 1997, p. 665).

This deep-seated feature is illustrated in Figure 6. More on this shortly. To further appreciate the possibility that the antediluvian river systems and their present-day counterparts and present-day occur at essentially the same location, we must examine the tectonic features which control the course of the present-day Tigris-Euphrates River system. These are illustrated in Figure 5. As discussed earlier, these feature parallel the well-known Najd fault system (Figure 1), and, in all probability, are essentially a continuation of the Najd system under the sedimentary cover (Litak et al., 1998). Let us follow the course of the Euphrates River as it is governed by these mostly-buried faults:

Recent geophysical work in Syria has resulted in identification of another important transcurrent fault zone, here called the *Al Furat fault zone*, which extends from the Turkish border in the northwest to the Syria-Iraq border in the southeast. This fault controls

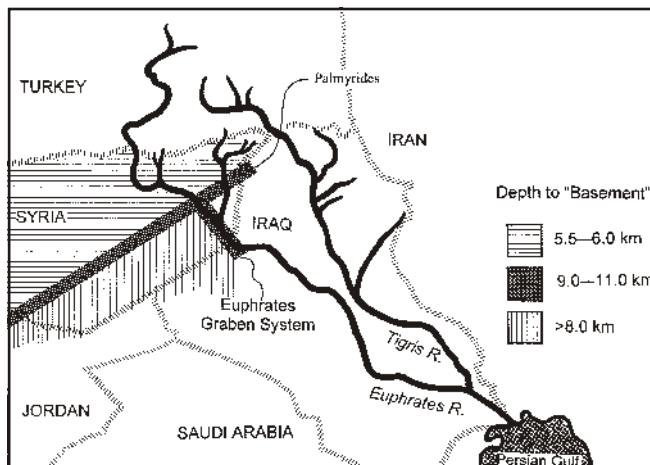


Figure 6. Overall sedimentary thickness in the western part of the Tigris-Euphrates system within and adjacent to the Euphrates graben system and Palmyride Mountain chain. Note the dramatic difference in sedimentary thickness north and south of this deep-seated system. Modified after Seber (1993) and Brew et al. (1997).

the course of the Euphrates River not only in Syria but also for a considerable distance downstream in Iraq...Further southeast, the Al Furat Zone passes into a rather narrow graben...This element, here called the *Euphrates Graben*...controls the course of the Euphrates... The Euphrates Graben is offset eastwards at an angle of 60 [degrees] at the Syria-Iraq border, where it forms the *Anah Graben*... Downstream of Anah, the Euphrates turns abruptly back again to a southeasterly course and runs in this direction for a further 100 km, as far as Hit and Aqabah. The section of the valley is controlled by the *Abu Jir fault zone*... (Lovelock, 1984, p. 581) (emphasis in original).

More recent research (Litak et al., 1997, p. 655) suggests that, instead of a single fault (El Furat), there exists a swarm of mostly-collinear NW-SE trending faults. In either case, the trend of this long system invites speculation that it (and, by implication, the course of much of the extant Tigris-Euphrates River system) owes its origin to basement faults which pre-date the Flood:

The Al Furat-Anah-Abu Jir Zone is a major cratonic lineament that crosses the north Arabian plate NW-SE for a total distance of about 600 km. It is *strikingly parallel* to the fold trends in the foreland and, as mentioned already, this raises the possibility that these trends are in some way controlled by old lineaments within the Arabian craton (Lovelock, 1984, p. 581) (emphasis added).

Also, recent research (Brew et al., 1997) has shed additional light on the dynamics of the Euphrates graben system at depth. We now have an idea of the depth of the sediments in it, and in areas surrounding this lineament. This information is summarized in Figure 6. Even more

striking is the discovery of the fact that the Euphrates graben system may be likened to a crustal glue which holds two essentially different crustal systems together:

The obvious difference in basement depth on either side of the Euphrates graben system could be evidence of a terrane boundary along the Euphrates trend... The stark difference in basement depth across the Euphrates could be an indication of two different crustal blocks accreting somewhat to the southwest of what is now the Euphrates graben system... The possible accretion event in Syria would have to be Proterozoic, or very early Phanerozoic, in age since seismic reflections from the Mid-Cambrian Burj limestone...are continuous across most of Syria... (Brew et al., 1997, pp. 627–628).

Of course, the sharp difference in crustal dynamics on either side of the Euphrates graben need not be understood as two microcontinents having been sutured together. Instead, it may simply indicate that the Euphrates graben is so deep-seated and of such ancient vintage that regions of Earth's crust are free to operate somewhat independently of each other on either side of this lineament. Furthermore, this evidence, along with the Precambrian stratigraphic placement of it, is very consistent with the proposition that the Euphrates graben system existed before the Flood, and governed major tectono-sedimentary processes in the region during the Universal Deluge. If indeed at least part of the antediluvian Tigris-Euphrates River system once existed there, it is easy to see how the Euphrates graben system must have served as the bridge between the antediluvian and post-Flood worlds. It would have governed the course of the antediluvian Tigris and Euphrates Rivers, and then caused the reappearance of these two rivers at essentially the same location after the Flood. This would complete the analogy of a crack in a wall reappearing in the same location despite the addition of a thick new layer of plaster—all because the crack is of deep-seated (not surficial) origin.

Implications Regarding Other Antediluvian Rift Systems

Attention is now focused on some broad applications of the fact that Precambrian rifts have exerted control over various Flood-related depositional events all over the Earth. For example, there is evidence that a variety of other sedimentary basins, are genetically connected by a system of zones of crustal weaknesses (Thomas, 1974). These give rise to lineaments. As areas of crust are stretched or compressed, movement along these deep-seated lineaments causes successive downwarp and uplift of basins:

Depositional sub-basins appear to be controlled in extent and configuration by the many blocks de-

fined in the framework... Thus, the block system of Precambrian age could to some degree control depositional conditions *throughout the stratigraphic section* (Thomas, 1974, p. 1309) (emphasis added).

One might, at first glance, suppose that large modern rivers are relatively recent features that have little or nothing in common with the underlying geologic structures. Such is far from the case, and it is hardly limited to the Tigris-Euphrates system. According to modern plate tectonic theory, the Amazon, Congo, Niger, and Mississippi Rivers are believed to have formed in failed rift valleys (aulacogens) that had developed orthogonally to the main rift valley which eventually became the Atlantic Ocean. Yet even if one does not believe in continental drift, one can still appreciate the fact that many large rivers of the world are in fact intimately associated with aulacogens that have a long history relative to the fossiliferous strata which covers most of the continents.

Take, for instance, the Mississippi River. Parts of its present course follow aulacogenic structures which are imprinted in Precambrian rock (Ervin and McGinnis, 1975; Dart and Swolfs, 1998). Because, according to mainstream Diluviological thinking, Precambrian rock is largely pre-Flood in origin, and dates back to Creation Week, it follows that at least part of the rift valley which later became the modern Mississippi River was in existence since this planet had been created. It is therefore likely that some form of waterway existed, in at least part of the course of the present-day Mississippi River, before the Flood.

During the Flood, the entire antediluvian topography had most likely been obliterated, and thousands of meters of sedimentary rock had been deposited all over the region. The fault thus became temporarily obscured by the thick carpet of sediments. During and/or after the Flood, however, the aulacogen had at least episodically been tectonically active. In between such episodes of tectonic activity, sediment would fill the rift after each episode of its opening. Eventually, however, there was not enough sediment being deposited to continue plugging up the rift. A linear rift thus eventually opened up permanently, and a valley was thus created for the present-day Mississippi River. This general sequence of events, albeit of course in a uniformitarian context, is shown in Figure 5 of Ervin and McGinnis (1975, p. 1293) as well as Figure 1 and Figure 8 of Dart and Swolfs (1998), to which I refer the interested reader.

Theological Implications

Would it not have been infinitely improbable for the Ark to have landed in the same general region, after the Flood, from which it had originated before the Flood? Only if it had been free to drift anywhere over the Earth with equal probability. The Bible is silent on the question of how far

the Ark eventually landed from the spot from which it had been launched. We must remember that the Flood currents most probably were far from unidirectional, and hence most likely tended to push the Ark in all directions. This would have been inconsistent with the movement of the floating Ark all over the Earth, for which a strong unidirectional current would have been necessary. More likely, the net distance of Ark travel had been no more than a few thousand kilometers from its original launch site. We must also consider any providential purposes of having the Ark land near this theologically-special region of Earth. In any case, the putative survival of the Tigris-Euphrates system through the Flood requires us to rethink our tacit assumptions about the Ark being moved all over the globe during the Flood. Of course, it is not here suggested that the postdiluvian Tigris-Euphrates river system had been *identical* to its antediluvian counterpart. This follows from the fact that, not only had the topography around the rivers been completely changed as a result of the Flood, but even the Persian Gulf had been smaller in the immediate post-Flood period than it is today (Lambeck, 1996).

The discovery of the fact that the courses of major rivers are governed by deep-seated crustal fault systems completely changes the landscape (pardon the pun) of the argument between compromising evangelicals and those who recognize the clear Biblical teachings on the global extent of the Noachian Deluge. Until now, acceptance of the temporal continuity of antediluvian place-names with their present usage has been taken as *ipso facto* rejection of the global Flood in favor of the local-flood compromise. This is no longer the case. It is astonishing to realize that the antediluvian Tigris-Euphrates system could have survived the deposition of thousands of meters of sedimentary rock on a planet-covering Flood, and then re-emerged in the post-Flood world. We can thus go as far as granting the compromising evangelical his argument about antediluvian place names, as he has now lost his remaining quasi-Biblical argument for a local flood.

Followup Research

If subsequent research verifies the premise that the northwest-trending Najd fault system is unique, in scale and direction, on earth, it would greatly strengthen the conclusion that the present-day northwest-trending Tigris-Euphrates system reflects the reappearance of a very similar northwest-trending antediluvian river system in the same general location and very likely bearing the same name. Further investigation of the Paleozoic rocks located beneath the present-day Tigris-Euphrates River system, extending the research conducted by Brew et al. (1997), is necessary to help clarify how the Euphrates graben, which governs part of the course of the present river system, was

active at the start of the Flood. If new evidence corroborates the activity of this structure during deposition of the earliest Phanerozoic sediments of the region, it would strengthen the possibility that the present Tigris-Euphrates system is actually located at the same site as its antediluvian counterpart.

The fact that the courses of the Tigris-Euphrates, and Mississippi, Rivers are controlled by deep-seated rifts can only inspire curiosity about the origins of the world's other major rivers. Once the entire Earth has been tectonically mapped in great detail, it will be possible to determine if most of the world's large rivers are indeed governed by such faults in the Precambrian basement. If such turns out to be the case, we could then conclude that the main antediluvian river systems had re-appeared at nearly the same locations on the post-Flood Earth.

Acknowledgments.

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- GB: Geological Society of America Bulletin
- GE: Geology
- GJ: Geophysical Journal International
- GL: Journal of the Geological Society of London
- GM: Geological Magazine
- PE: Journal of Petroleum Geology
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Note from the Panorama of Science

Time Warp I: The Permian-Triassic Boundary in the Texas Panhandle

John K. Reed*

Time: Whose Problem?

Lyell preceded Darwin: even before organic evolution, uniformitarian deep time was attacking Christian natural history (Reed, 2000), and it has proven an even more intractable problem than evolution for a host of Christians ever since. Many opposed to evolution cannot bring themselves to challenge the bastion of uniformitarian natural history. In fact, old-earth/young earth seems to have formed a major divide between those opposed to organic evolution. Many apparently cannot conceive how a “swimming pool” of uniformitarian earth history can fit into the “tea cup” of biblical history, and they explicitly reject a young earth while knowingly or unknowingly rejecting the Genesis Flood in the process. After all, the biblical presentation of a year-long Flood and its inferred effects can find no place in the geologic column.

But whose problem is time? What if the “swimming pool” is filled with strongly-shaken, warm, carbonated soda? In that case, the pool is full of air trapped in bubbles with only a veneer of “history”, and the real substance of uniformitarian natural history is actually insignificant. I believe that this analogy is valid and that most of uniformitarian earth history is hot air, waiting to be revealed as such when the “bubbles” are burst. As creationists are able to do so they accomplish two tasks: (1) resolving their time “dilemma”, and (2) presenting uniformitarians with one of their own. For if the physical evidence does not support all those millions of years, then their case is supported only by an argument from a lack of evidence. This problem becomes all the more acute when we realize that as Naturalists, their only possible evidence is empirical (Reed, 2001).

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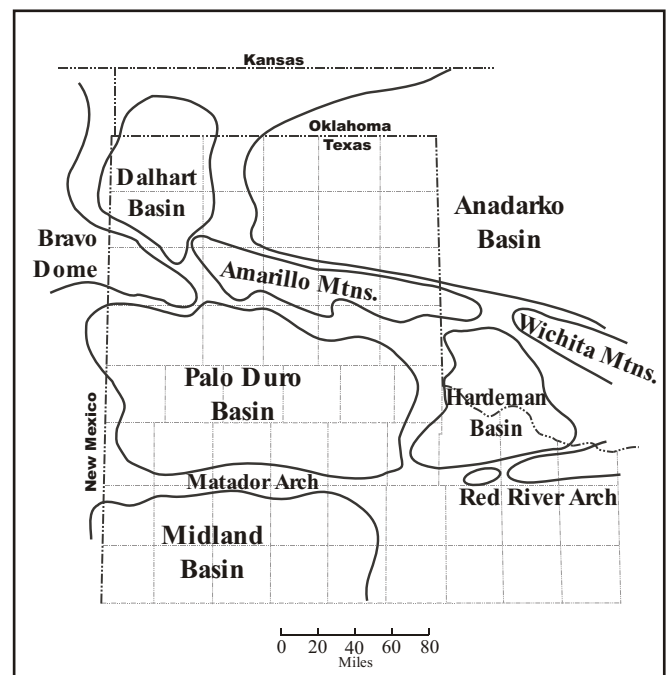


Figure 1. Tectonic sketch of the Texas Panhandle showing basins and arches.

I propose to begin bursting the bubbles of uniformitarian history by documenting “time warps”; places where conflicts arise between the physical evidence of the rock record and the framework of the uniformitarian geologic column. As the bubbles burst, the time problem for uniformitarian natural history will become more and more evident; hopefully encouraging all opposed to Naturalism in its biological manifestations to similarly oppose it in its geological expression. I encourage other creationists to look for similar “warps” and document them in this series.

The Permian-Triassic Boundary in Texas

This time warp documents 20,000,000 missing years in the Texas Panhandle. Upper Triassic red beds of the Dockum Formation appear to conformably overlie Permian sediments in the Palo Duro Basin (Figure 1), yet according to the uniformitarian geologic timescale, there should be 20,000,000 years between the two units.

Upper Permian sediments (Figure 2) include a thick suite of mixed carbonate, evaporite, and clastic sedimentary rocks that marks the pulsating retreat of marine waters from the Palo Duro Basin (Reed, 2002). These sediments mark a time of subsidence and deposition across a wide area of Texas known as the West Texas Basin (Ewing, 1990). The Palo Duro Basin is merely the northern extension of that much larger depocenter which has a maximum of more than 8,000 ft. of preserved post-Wolfcamp (lower Permian) sediments. Typical cycles in the upper Permian strata consist of dolomite-anhydrite-halite-red beds (Gustavson et al., 1980). Combinations of these units are also present, i.e., mixed dolomite and anhydrite or mixed salt and mudstone.

The progression from carbonate to anhydrite to halite to red beds is thought to represent cyclic marine retreat, with shallow water carbonates being succeeded by sulfate and halite flats before being covered by clastic sediments from emergent source areas. This cycle is repeated throughout the upper Permian section. The final marine incursion is represented by the Alibates dolomite overlain by red beds of the Dewey Lake or equivalent Quartermaster Formation.

According to the uniformitarian geologic column, 20,000,000 years passed before sediments of the upper Triassic Dockum Formation were deposited after the final retreat of marine waters. Dockum sedimentation occurred in a closed basin located roughly coincident with the present day Palo Duro and Midland Basins. It received sediments from surrounding highlands (Johns, 1989), and conglomerates, sands, silts, and mudstones were deposited by rivers and deltas into a large lake in the Dockum Basin.

The dilemma for uniformitarians arises from three lines of evidence that conflict with the hiatus required by the geologic column. These include: (1) the lithologic similarity between sediments of the Permian and Triassic red beds; (2) the nature of the physical contacts observed in outcrop and in logs and cores; and (3) the seemingly seamless progression of environments from the Permian to the Dockum Formation strata.

Lithologic Similarity

The Dockum Formation sediments are virtually indistinguishable from those of the Permian section. Even in outcrop, it is difficult to observe the boundary.

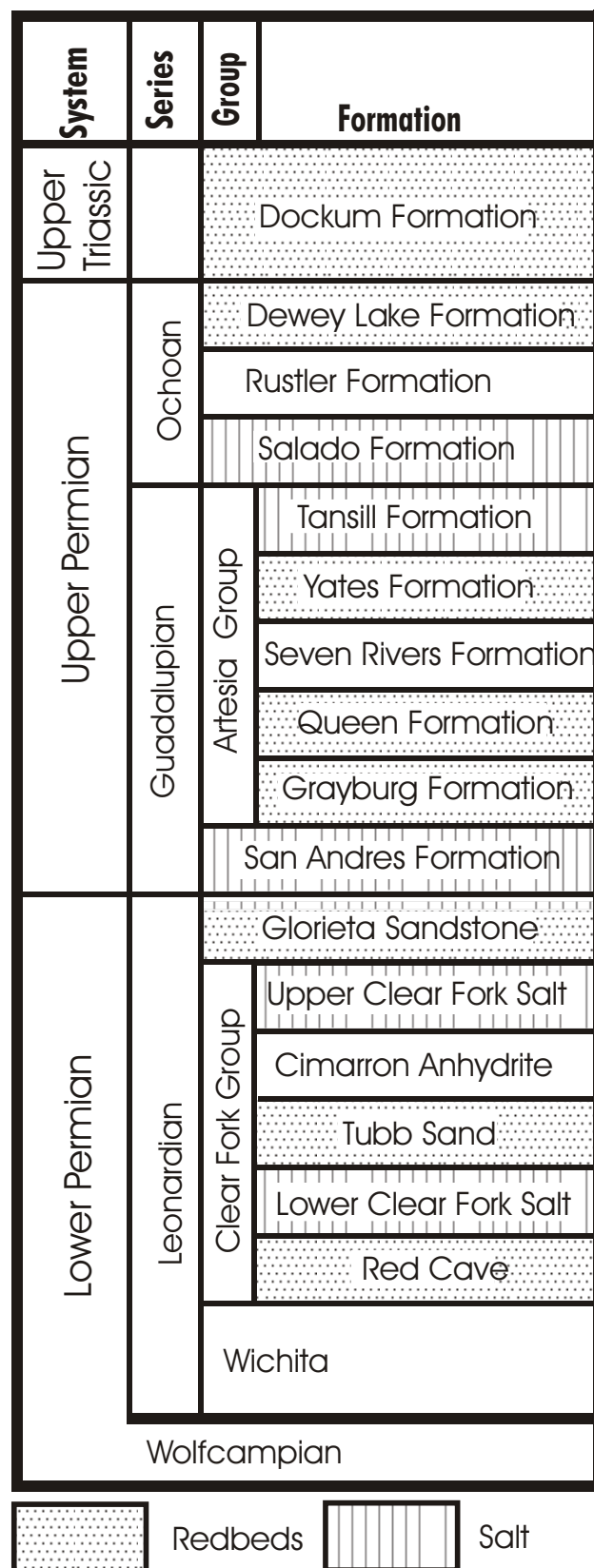


Figure 2. Stratigraphic chart of the Permian and Triassic in the Texas Panhandle. Gray horizons indicate prominent salt-bearing strata, and dotted horizons indicate red beds.

The confusing nature of the basal contact, both locally and regionally, is further obscured by the similarity of lithologies and depositional systems of the Dewey Lake and basal Dockum Formations. [Johns, 1989, p. 5].

Sandstone and siltstone deposited by Gilbert deltas [reference cited] and fluvial channels, which crop out in the upper Permian Quartermaster Formation (equivalent to the Dewey Lake in the subsurface) in Caprock Canyon State Park in Briscoe County, resemble the sediments of the basal Dockum Formation [references cited]. [Johns, 1989, p. 42].

Nature of the Bounding Surface

In addition to the lithologic similarity between the sediments alleged to be separated by 20,000,000 years, there is no clearcut regional unconformity separating the two units.

McGowen and others (1979, 1983) and Granata (1981) thought that in the subsurface both conformable and unconformable contacts existed between the Dockum and Dewey Lake... [Johns, 1989, p. 4-5].

In Tule Canyon, Boone (1979) reported a gradational contact between the Permian Quartermaster Formation, which includes the outcrop equivalent of the Dewey Lake, and the Dockum Formation. [Johns, 1989, p. 5].

In order to place the physical evidence of both conformable and unconformable contacts into perspective, I propose two principles; Reed's two principals of unconformities, if you will. Principal 1 states that there is no diagnostic measure of time in any unconformity *per se*, only what can be inferred from the nature of the strata below and above the unconformity. In other words, even the physical evidence of an unconformity does not automatically imply a long period of missing time. Principal 2 states that if the boundary between two units is both locally conformable and locally unconformable that it is less likely for the boundary to represent a large period of missing time. The slowest possible rate of the section of continuous sedimentation defines the maximum amount of time missing across the unconformable sections.

At the Permian-Triassic boundary, there exist both conformable and unconformable contacts. Thus, any amount of missing time depends upon the physical nature of the two bounded stratal units, which as noted above appear very similar. Since there is evidence of continuous sedimentation at locales, then the likelihood of large amounts of missing time being represented by those locales that show an unconformable contact is decreased.

But what is the presumed strong evidence for the missing time? It is the biostratigraphic classification of the Dockum beds as Upper Triassic and the biostratigraphic and radiometric classification of the underlying Permian section. If evolution has not occurred, then conventional biostratigraphy is wrong. Woodmorappe (1999), among others, has provided many reasons to doubt radiometric methods. Thus, the conceptual evidence that supports the missing time is weak while the empirical evidence that militates against it is strong.

This difficulty carries over to the subsurface interpretation of well logs and cores. Until recently, the subsurface pick of the Permian-Triassic boundary was done based on an increase in gamma activity at the boundary. However, Johns (1989) documents this method as erroneous because core data reveal that the cause of the gamma increase was the termination of anhydrite fracture fill in Permian sediments, not a clear lithologic boundary.

The lower contact of the Triassic System is not easily identified in the subsurface using cores or well logs. [Johns, 1989, p. 5].

Given the lithologic similarities and the problems with no clearcut physical boundary between the two units, Johns (1989) concluded:

The base of the Dockum is considered to be the first major sandstone bed above the Permian Alibates Formation, unless core data suggest otherwise. [p. 6].

Of course, the sedimentary environments described in careful detail by Johns (1989) elsewhere in his report, suggest a heterogeneous distribution of sediment types, and it appears unreasonable to expect a blanket sandstone as a time marker for the base of the Dockum Formation.

Progression of Environments

The third line of evidence is found in the progression of depositional environments from the Permian section into the Triassic. There is a consistent trend in depositional environments seen in the upward progression of facies—a trend that does not demonstrate a significant break between the Dewey Lake and Dockum Formations. The transition from marine to nonmarine conditions is not, in and of itself, an indicator of a particular length of time. It merely represents a change in environment—one that could occur rapidly given certain environmental conditions. Johns (1989) cites this difference as evidence for the break between the Permian and Triassic.

The lacustrine environmental setting of the Dockum Formation contrasts with that of underlying Permian strata in the Palo Duro Basin... [Johns, 1989, p. 42].

However, a change in environment does not require long periods of time. If this change was as diagnostic as

System	Series	Group	Formation	
Triassic	U		Dockum Formation	208 Ma
	M		Biostratigraphy says 20,000,000 quiescent years or all evidence of interval erased by “subtle unconformities”.	225 Ma
	L			
Upper Permian	Ochoan		Dewey Lake Formation	245 Ma
			Rustler Formation	
			Salado Formation	

Rock record demonstrates
 1. Lithologic similarity
 2. Conformable contact
 3. Depositional continuity

Figure 3. The uniformitarian geologic column demands 20,000,000 years of time for the lower and middle Triassic. It is missing in the Palo Duro Basin, and a choice is demanded between field evidence and the column.

supposed, then within the uniformitarian model why do not the many similar progressions in the upper Permian section demonstrate a hiatus of 20,000,000 years? For example, the Tubbs, Glorieta, and Queen/Grayburg formations all include red beds that mark the retreat of marine deposition to the south, yet there is no doubt that they are a part of continuous cycles of sedimentation in the Permian. I have seen no article on the subject that calls for 20,000,000-year gaps within the red beds of the Upper Permian section.

Conclusion

The uniformitarian geologic column cannot explain physical evidence from the rock record in the Texas Panhandle that indicates continuous sedimentation across a supposed gap of 20,000,000 years between the Permian and Triassic sections (Figure 3). Johns (1989) tacitly admits this and attempts an explanation.

Postulation of a locally conformable basal contact suggests that Dockum deposition was at least locally transitional with that of the Permian Dewey Lake. About 20 m.y. passed between deposition of the late Permian Dewey Lake and the deposition of the Late Triassic Dockum, and numerous depositional and erosional events could have occurred in the relatively quiescent basin, resulting in subtle unconformities. [p. 43].

This explanation has two major problems. (1) It postulates a quiescent basin during the hiatus without explaining why it is less quiescent above and below that boundary. (2) It speaks to geologic activity for which there is not a shred of physical evidence. When the physical evidence is not present in the rock record, uniformitarians must resort to arguments from a lack of evidence to fill in the missing pieces. Thus the Permian-Triassic boundary in the Palo Duro Basin bursts a bubble in the uniformitarian “cola” pool, demonstrating that the rock record and its uniformitarian interpretation are at odds. This is only one bubble – one small brick in the uniformitarian edifice; but I am convinced that as creationists continue to document similar time warps, that the essential hollowness of uniformitarianism will be revealed as creationist models are developed to replace it.

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An Evaluation of the Human Skeletal Remains and Artifacts Found in the Tomb of the Eagles on the Orkney Islands

Lawson L. Schroeder, J.C. Campbell, and George H. Latta*

Abstract

The Tomb of the Eagles is formally known as the Isbister Chambered Tomb. It is located north of Scotland on the remote southeast coast of South Ronaldsay Island, one of the Orkney Islands. The tomb was minimally excavated in 1958. When tho-

roughly excavated in 1975, a significant collection of human remains, artifacts and animal bones was discovered. This study of the Isbister remains summarizes the state of health enjoyed by the people who lived on this island more than 4000 years ago.

Introduction

The Neolithic period Tomb of the Eagles is officially identified as the Isbister Chambered Tomb. It is located almost due north of John O'Groats and Duncansby Head in Scotland on the southeast coast of South Ronaldsay Island, the southernmost major island in the Orkney archipelago (Henshall, 1963). In 1958, a minimal excavation of the tomb by Ronald Simison, owner of the farmland, revealed many interesting objects. His curiosity and diligence provided the impetus for a thorough excavation of this well-preserved burial place in 1976, and later restoration of the tomb in the following years (Hedges, 2000). A significant amount of information concerning the life and death of the Orkney people has been obtained from the contents and construction of the tomb that archaeologists believe was constructed over 4000 years ago. The Isbister tomb is one of seventy-six known chambered tombs in the Orkney Islands (Fraser, 1983) that, together with stone houses, standing stone circles and monuments, were built in the same period (Ritchie, 1978).

Description of the Isbister Chambered Tomb

The early people of the Orkneys built numerous structures that demonstrate an advanced understanding of engineering, astronomy and mathematics (Thom, 1971). The spectacular setting of the Isbister tomb is about 220 feet from the precipitous cliffs by the sea. Its entrance overlooks the Pentland Firth that separates the northern coast of Scotland from the Orkney Islands (Noonan, 2000). Archaeologists consider this chambered tomb to be one of the most splendid found in the region and believe it gives evidence that they had great respect for the value of life. The rock structure has a sophisticated architectural

design that required a great deal of skill and an intimate appreciation of building materials. The design and placement of stones for the doors, walls and roof required workers with exceptional talent, especially since it is assumed that only primitive tools were available to move dirt and rock for site preparation and construction of the tomb and retaining walls (Figure 1).

A great flagstone forecourt surrounded the Isbister Tomb. The exterior was oval-shaped with more or less vertical walls that were 3.5 meters tall and a single entrance on the long wall closest to the sea. The floor area of the interior, including two small end chambers, was in the shape of a long rectangle about 8.33 X 1.45 meters; the height was around 3.5 meters (Figure 2). The roof was a sloping dome with the highest point in the center of the chamber. Three small chambers were built off the long sides of the chamber, two on the side opposite the entrance and one on the long wall to the right of the entrance. Two small chambers, each with a built-in stone shelf, were located at either end of the long section of the chamber (Hedges, 2000).

According to calibrated radiocarbon dates, construction of the Isbister Chambered Tomb began in 3150 B.C. (80

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Figure 1. The Isbister Chambered Tomb

years) and may have taken as much as two hundred years to complete. This date precedes construction of the pyramids of Egypt and is shortly after the recorded dispersion of people groups from the City of Babel (The Bible, Genesis 11). Archaeologists believe the tomb was used regularly for 800 years, with the last burial around 1600 B.C. (Hedges, 2000).

Contents of the Isbister Chambered Tomb

A limited excavation of the northern interior of the Isbister Chambered Tomb took place in 1958. A number of human skulls and bones were removed from the tomb for safekeeping. A photograph of this collection shows sixteen human skulls, six boxes that presumably contained bones, a portion of a pelvis and four or five femurs. Four small fragments of pottery were also removed before the excavated area was filled with dirt (Hedges, 2000).

In 1976, Ronald Simison initiated and completed an extensive excavation of the entire tomb. An enormous amount of material was removed, including human bones, animal bones, shells, fragments of pottery suitable for cooking, tools, seeds, necklace beads and a V-bored very highly polished jet button (Figure 3) (Henshall, 1963). Many talons and bones from white-tailed sea eagles were found mixed with the human bones and so, the Isbister Chambered Tomb is also called the Tomb of the Eagles.

A remarkable finding concerning the bones in the tomb was the absence of intact skeletons. Rather, piles of bones

associated with a skull were arranged along the sides of the stalls (Figure 4). In the side chambers, the floor was filled with skulls lying at all angles and mixed with bones from other parts of the body. In addition, the bones were bleached and weathered. This arrangement and condition of bones made it obvious that the soft tissue of the deceased was missing when the bones were brought into the tomb (Hedges, 1998). This mortuary practice is called *excarnation*, a custom that people groups around the world have practiced in various forms for thousands of years (Renfrew, 1979).

The human bones removed from the tomb were sent to Edinburgh for analysis by Judson T. Chesterman, a retired surgeon working for the Department of Prehistory and Archaeology at the University of Sheffield. Including

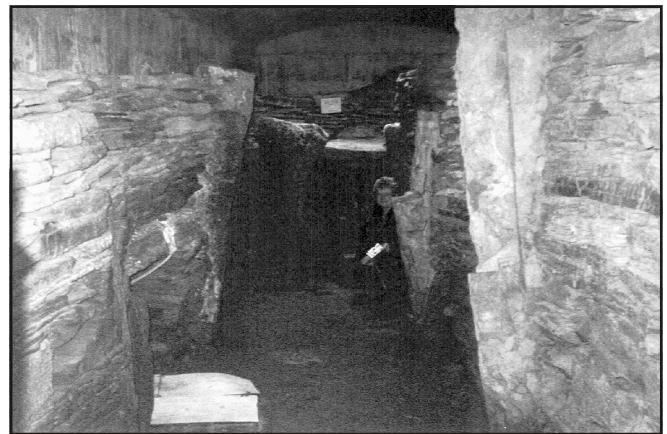


Figure 2. Interior of the Isbister Chambered Tomb.



Figure 3. Highly polished button from the Isbister Chambered Tomb.

¹This term and other anatomical terms are defined in a glossary located at the end of this paper.



Figure 4. Human skull from the Isbister Chambered Tomb.

the remains obtained in 1958, there were 16,000 human bones and fragments that required evaluation. In 1981, Chesterman reported that bones of at least 342 individuals were recovered from the Isbister Chambered Tomb (Hedges, 2000). This investigator has also evaluated the human remains removed from other ancient burial sites in the United Kingdom (Renfrew, 1979).

Even though the builders of the tombs, houses, villages and standing stones possessed advanced engineering skills and an understanding of astronomy and mathematics, there is no evidence that they had yet developed a written language.

Evaluation of the Human Skeletal Remains

The condition of the skulls and other bones removed from the Isbister Tomb were in a range from intact and perfect, to incomplete fragments. Presumably, this was the result of post-mortem manipulation by the people who originally placed them in the tomb and the crushing weight of earth and rocks intentionally placed over them at burial. Additional damage to the remains may have occurred during the removal process, in storage, or in transit to the examiner, Judson Chesterman. As a result, the accuracy of

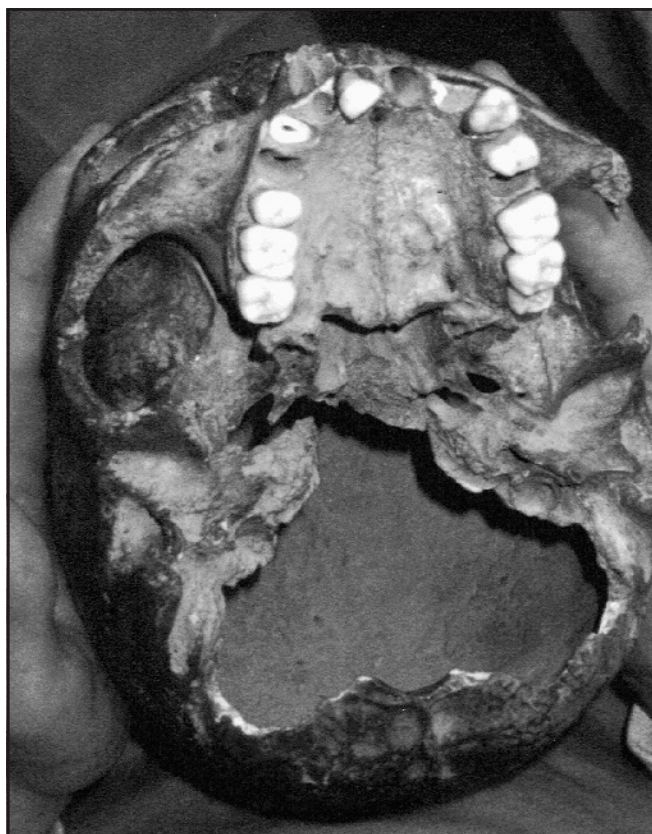


Figure 5. Remarkably healthy teeth showing wear but little caries.

the evaluation may have been compromised to some degree by the incomplete condition and damaged condition of the skulls and bones.

The examination revealed that some skulls, mostly female, exhibited a markedly increased attachment of the neck muscles to the back of the skull. In these same instances, a visible depression running laterally across the top of the cranium was noted. These findings were interpreted to mean that both anomalies resulted from individuals carrying loads on their back supported by a band over the head (Hedges, 2000).

Elizabeth J. Glenn from Ball State University in Indiana independently studied the Isbister skulls. In comparing these specimens to others from both the British Neolithic and Bronze Age, she reported that the females had noticeably smaller heads than males, but that the males tended to have longer heads anteroposteriorly than females. She also concluded that these people would have been visually distinguishable from those living further south in the British Isles, probably the result of a slightly different genetic make-up in their ancestry (Hedges, 2000).

Chesterman discovered a possibly inherited peculiarity on the articulating surfaces of the occipital *condyles* (this and other anatomical terms are defined in a glossary

located at the end of this paper) with the atlas in the Isbister skulls. Each occipital condyle normally has only one facet and the occurrence of two facets on one or either side is highly unusual; evidence of the normal distribution lies in a study of 585 skulls from different countries and periods that describes only five instances of this unusual trait in 1,144 articulations. In contrast, thirty of the occipital condyles showed two facets in the Isbister skulls, and one skull even exhibited a triple facet. Thus, more than a third of the Isbister skulls demonstrated this rare anatomic configuration. (Hedges, 2000)

Another unusual occurrence in the Isbister remains was the precocious closure of the sutures of the skull. The normal distribution of this anatomic anomaly is about five in 10,000 births, whereas there were six examples of this phenomenon in the meager number of Isbister skulls. In a related matter, degenerative spinal disease was diagnosed in at least 47% of the individuals and, in one male believed to be 45–50 years of age, a 14-mm. thick skull exhibited asymmetry of the foramen magnum. (Hedges, 2000)

For the most part, the dentition of the remains seemed remarkably healthy. Although the occlusal surfaces of some teeth demonstrated extraordinary wear, dental caries was not a common finding (Figure 5). Out of 1537 teeth examined, only nine had deep carious lesions and merely five posterior teeth exhibited periapical abscesses. On the other hand, many mature individuals showed minor to moderate generalized resorption of the alveolar bone, a finding commonly associated with periodontal disease. Even though the examination revealed impaction of six third molars and three canine teeth, a greater than average absence of third molars was noted in the specimens. The skull of a thirty-five year old female exhibited a palatal lesion associated with a canine measuring 28 X 18 X 18-mm; it appeared to be benign, most probably a cyst. The shovel-shaped maxillary central incisor is a rare occurrence, but this anomaly was identified in one out of seventy-seven skulls. Malpositioned or misaligned teeth were found in some skulls and temporomandibular joint disorder was exhibited in three males and two females (Hedges, 2000).

The large number of human bones in the tomb allows for a meaningful description of the size, gender and age of these ancient people. The average male was 5 feet 7 inches tall (range: 63 to 70 inches) whereas the average female was 5 feet 3 inches tall (range: 58 to 64 inches). Both genders appeared to have been muscular and an alteration in the bones of the ankle may have been the result of scaling the surrounding cliffs from an early age. Two percent of the individuals suffered a broken bone at some stage in their life, but accidents appeared to be a relatively minor cause of death since most of the broken bones were healed. Out of the 179 teenagers and adults, 80 were male and 39 were female, while the gender of the 60 others could not

be determined. Even though calculation of the age of human remains by examination of bones and teeth is imprecise (biological rather than chronological), estimates of the 342 individuals buried in the tomb were as follows: 24 died before the age of two, 70 died between two and twelve, 63 died as teenagers, 185 died as adults. And so, it is believed that few people in the Isbister community lived to the age of fifty, that large numbers died at an early age, and that the average life expectancy was around twenty years (Hedges, 2000).

This review is based solely on the bones of 342 individuals who were buried in the Isbister Chambered Tomb. However, it is not believed to be the only burial place for people who lived on this island during this time period. The physical characteristics of these other individuals and how the bodies were treated are not known (Hedges, 2000).

Conclusion

The remains buried in the Isbister Chambered Tomb provide physical evidence of the people who populated this area 4000 years ago. Their bones and teeth demonstrate the presence of health, injury and disease. Estimates of age indicate that their life span was much shorter than modern day man.

The quality of life experienced by these people is partially revealed by their ability to construct substantial structures with primitive materials. The extraordinary effort displayed in construction of this tomb, and at least 75 other tombs in the Orkneys, gives ample proof that they had an advanced understanding of engineering, astronomy and mathematics, and a great respect for the value of life. Their artifacts also demonstrate a high level of expertise in the use of a drill to perforate and polish hard rock into jet buttons, and the ability to make pottery in a manner that allowed it to be used for cooking.

Despite these advancements, there is no evidence that they possessed a written language. This should not be unexpected since most peoples of the same era (the dispersed people of Babel) also had no recorded language skills. In fact, the Isbister people could possibly be a part of this dispersion.

The human bones discovered in the Isbister Chambered Tomb reveal that these people experienced energetic lives of health, but also encountered many of the injuries and diseases that afflict contemporary society.

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Glossary

alveolar bone: the portion of the maxilla or mandible that forms the dental arch and serves as a bony support for the teeth.

articulations: the place of union or junction between two or more bones of the skeleton.

atlas: the name of the first cervical vertebrae supporting the skull or head.

carious lesion: an area of tooth decay resulting in an alteration in the continuity of tooth structure.

facet: a small smooth flat surface on a bone or tooth.

foramen magnum: a large, oval opening in the inferior and anterior part of the occipital bone. It serves as a communication between the cranial cavity and the vertebral canal.

impaction: the condition in which the eruption of a tooth is prevented because it is blocked by a physical barrier or another tooth.

occipital condyle: one of the two oval bony processes adjacent to the foramen magnum in the occipital bone that articulate with the atlas.

occlusal surfaces: the main chewing surfaces of the posterior teeth.

palatal lesion: a pathologic disturbance of the hard or soft tissues that separate the oral cavity from the nasal cavity.

periapical abscess: an inflammation of the tissues surrounding the root tip of a tooth and characterized by a local accumulation of pus. It is generally a sequela of tooth pulp death.

periodontal disease: disease of the supporting tissues of the teeth which may lead to gum recession or shrinkage and loss of alveolar bone.

shovel-shaped maxillary central incisor: an unusual condition of the inside of an upper front tooth where the marginal ridges and cingulum are larger than normal.

suture: an articulation in which two contiguous bones of the skull are united by intervening periosteum.

temporomandibular joint: one of the two joints between the temporal bone of the cranium and a condyle of the mandible. The joint is enclosed in an articular capsule and its surface is lined with fibrocartilage.

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Book Review

Genesis of the Big Bang by Ralph A. Alpher and Robert Herman
Oxford University Press, New York, NY. 2001. 214 pages, \$21.95.

This book is written by two of the originators of the Big Bang model for the origin of the universe. The authors together with George Gamow took some of Gamow's early (pre 1946) ideas on the origins of the universe, especially cosmic nucleosynthesis of light elements, and developed a general relativistic model for the expanding universe.

These three first published results of their nucleosynthesis calculations and this model in the April 1, 1948 issue of *Physical Review*. In that article they predicted a cosmic background radiation at a temperature less than 10 Kelvins. Refinements on the model since that time have brought it into remarkable agreement with the measured

relative ratios of the abundance of light elements and the background radiation temperature of 2.725K. This book is written to give the personal account of the authors in developing this model and showing that it is still the best naturalistic theory that man has devised. Alpher is the main author since Herman, his collaborator for over 50 years, died soon after the outline of the book had been worked out and a couple of chapters summarized in 1997. Alpher is definitely an evolutionist but he addresses competing cosmologies that require what he calls an “extramundane entity” (i.e. p. 39), his euphemism for any religious god. In addressing these creation cosmologies he makes it plain that these are religion-based and he does not consider them scientific in nature. In his opinion creationists attempt to answer the question why we exist and not how we came into existence.

In the first chapter the authors give a brief overview of their Big Bang model. It is based on the assumption that at some time in the past the universe was much denser and hotter so that the light elements could be formed from elementary particles. Their model does not go back to the actual beginning. They calculate with their model the time when all the elementary particles (protons, electrons, antiprotons, positrons, neutrons, neutrinos and antineutrinos) have emerged from the radiation at approximately 1 second after the big event. They calculate it took one minute for all the protons and neutrons to combine into hydrogen atom nuclei that start the nucleosynthesis (fusion) process. This process took the next four minutes to make helium, deuterium and the other light element nuclei. Between the end of this nucleosynthesis process and when radiation decouples from matter is calculated to have taken 300 thousand years, during which this opaque plasma expands and cools. This is called the recombination period and is the time the newly formed nuclei are capturing free electrons (forming atoms) and losing them again because of the density of the radiation trapped in the plasma. Once the plasma cooled to a level where enough of the atoms retain their electrons it turns into a neutrally charged or transparent gas and the remaining radiation is released. This release of the trapped radiation is called the decoupling event. The authors believe we can see only a portion of the universe that has expanded and evolved in the 14 billion years since that event. What they claim is observed on a very large scale is a universe that is homogeneous and continually evolving. The experimental evidence the authors cite to back their model includes: (1) the red shift of light observed from far away stars implying the universe is continuously expanding, (2) the cosmic background radiation temperature is what would be expected from such a hot dense start billions of years ago and (3) the ratio of light elements measured in the observable part of the universe is what would be expected from the early nucleosynthesis process and

the ratio of heavy elements is what would be expected from continual supernovae since then.

In the next two chapters they backtrack to give first a brief history of cosmology before the Big Bang model and then describe how the Big Bang model was developed during the period from 1942 to 1965. The authors start in 400 BC with the Greeks who calculated the length of the solar year and proposed that the planets visible to the naked eye were located on concentric spheres around the earth. Slowly the concept of a solar system was developed by the 15th century and then the galaxy was recognized as a collection of stars in the 18th century. Finally in the early 20th century the universe was recognized as a collection of millions of galaxies out to great distances and modern cosmology began. With the recognition of large scale structure in the universe theoreticians such as Einstein began developing models to explain these observations. Up to this time the universe had been assumed to be static and Einstein even added the cosmological constant into his famous equations of general relativity to make his model fit a static universe. Dynamic modern cosmology begins with Hubble's discovery of the relationship of the redshift (Doppler shift of wavelength) of stars and their distance from earth published in 1930. The authors mention Halton Arp's discordant view that redshift is an intrinsic phenomena to stellar objects but dismiss it as a statistical artifact (p. 60). In the late 1930s and early 1940s Gamow began to propose that the light element nuclei were formed in successive neutron-capture reactions (nucleosynthesis) under non-thermal equilibrium conditions (i.e. a hotter and denser medium). This led the authors to propose the conditions under which such reactions could occur in the early universe and make the calculations that form the basis of the Big Bang model we read about today. Early problems faced by their model included (1) how to explain the initial singularity from which the universe formed, (2) how to explain the ratio of nucleons to antinucleons observed, (3) where and how were the heavier isotopes of light elements formed in the abundances measured, (4) how did neutrinos factor into the total density of matter in the early universe and (5) when did the structure observed in the universe form. The authors believe that they have satisfied all these early criticisms of their model. In my opinion their answers to (1) and (5) only say we see this result and therefore something must have happened to cause it but we do not know exactly what.

Chapter 4 and 7 address some of the alternative theories against which the Big Bang model was or still is in competition. The major alternative is the Steady State model based on theories championed by people such as Fred Hoyle, Geoffrey Burbidge and Jayant Narliker. The authors discuss three problems with this theory: (1) the non uniform distribution of radio sources in the universe, (2) the inability of a cool and dilute universe to produce suffi-

cient amounts of helium and (3) the inability to explain the source of cosmic background radiation. As a creationist I would say these problems are based on the naturalistic assumptions used as the foundation for the Big Bang model and therefore would undermine any other naturalistic model. Therefore these problems are substantial enough in the eyes of an evolutionist that the Steady State model will not regain its prominence unless better explanations are found for these aspects of the theory then presently proposed by their proponents. Other models they discuss more briefly are the continuous creation model of Halton Arp, the matter-antimatter model of Hannes Alfvén, the time varying gravitation models derived from theory proposed by P.A.M. Dirac, the equilibrium models of S. Chandrasekhar and L.R. Henrich, the plasma models and the anthropic principle based model of Barrow and Tipler. The anthropic principle model is close to what we now would call Intelligent Design and the authors dismiss it with the argument “life has evolved to fit the constraints, rather than the other way around” (p.104). According to the authors all of these alternative models have some critical characteristic that does not match observations. The authors also discuss in more detail the intrinsic redshift theory of Halton Arp but not the quantized redshift of Tifft. In a short section they discuss the cosmological entropy associated with the production of light elements. They do not know where the entropy came from (the initial singularity problem again) because their initial conditions require a state of equilibrium for radiation and matter prior to decoupling that masks anything happening before that time. So they leave it as a problem for the inflation theorists to resolve with future research.

Chapter 5 is an in-depth discussion of the cosmic microwave background radiation and how the authors believe it verifies the Big Bang model. The authors take pride in the fact they were the first to predict this in 1948 and that their model was first widely accepted when it was discovered in 1965. They discuss the more recent measurement programs (i.e. Cosmic Microwave Background Explorer or COBE satellite) that have made discoveries of a preferred direction (velocity vector toward the Virgo cluster) and small but statistically significant temperature fluctuations (30 micro Kelvin rms) over spatial angles of 1 degree for this background radiation. They describe how in their model the preferred direction is due to the detector motion with respect to the origin of the radiation at decoupling. The small fluctuations in temperature they explain as caused by development of the structure in the universe since the decoupling.

Chapter 6 is a discussion of the theories of inflation that supposedly happened before the universe was 1 second old. The authors claim, “this epoch in the Big Bang does not require new physics” (p. 132) because lab experiments and theory have duplicated results on a small scale. They

discuss theories by others that try to explain how this could take place on a massive scale (from 10^{-33} to 10^{+17} centimeters) in such a short period of time (from 10^{-43} to 10^{-30} seconds) but have not chosen a winner yet. One main concern for the short time is dismissed with the statement: “The speed with which the inflation occurred would not violate the relativistic speed limit on the velocity of light, because there would have been no information transfer, as required for this limit to be meaningful.” (p. 133). They do not like the idea of an inflation period but without it their theory does not explain the initial conditions (large-scale uniformity of temperature and density on a spatial scale of 300,000 light years or more) for nucleosynthesis that it depends on.

Chapter 8 is a look at what the Big Bang theory implies for the future of the universe. Based on three possible solutions for Einstein’s equation of gravity depending on the density of matter in the universe it will expand forever, remain the same or collapse on itself. Presently the density that can be determined is 6% of the value for expansion to stop. However, they have hope that the “dark matter and energy” in the universe will fill that gap. The only prediction the authors are sure of is that the universe will continue to evolve and any consequences to people on earth are billions of years in the future.

The final chapter is devoted to a more detailed discussion of the anthropic principle and the difficulties it presents for the Big Bang model. They dismiss these problems as philosophical issues and therefore not related directly with the “science” of the Big Bang. Rather the principle is based on “far-fetched explanations for those features of the universe physicists cannot yet explain” (p. 170).

The appendix is made up of the equations and calculations the authors have published to back up the Big Bang model. Most revealing are the assumptions they make for initial conditions for their model. Assumptions such as a homogeneous, isotropic expanding universe (p. 175), a perfect fluid density free of shear (p. 176), constant entropy during expansion (p. 178), and adiabatic expansion of radiation all seem to neglect the non-linear effects present when matter and radiation are at extreme temperatures and densities necessary for their model. Their basic result using the Big Bang model is to calculate the age of the universe of approximately 15 billion years. This figure is derived from the present value of the cosmic background radiation extrapolated back in time to the temperature required to form the ratios of the light elements measured in the universe today. These calculations are only true if you make the assumptions of the authors for the initial conditions in the universe and how it has evolved since then.

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Author and Title Index for Volume 38 2001–2002

Lazella M. Lawson*

This title/author index covers articles, panorama notes and other features. For items with two or more pages, the reference is to the first page only. After the page number, a letter indicates which type of entry is involved: article (A), panorama note

(P), letter to the editor (L), book or video review (R), cover photo (CP), or other departments (such as laboratory director's comments, president's remarks, photo essays, etc.) (D).

A

- A Fish Caught in Time*, Don DeYoung, 113 (R)
 Aerodynamics of Wind Pollination in Living and Fossil Plants, Colin Brown, 212 (P)
Age of the Universe/The, Richard Overman, 17 (R)
Age of the Universe: What are the Biblical Limits?/The, Carol Armstrong, 49, 78 (R)
 Akridge, A. Jerry
 The Slumgullion Earthflow, 101 (P)
 Anderson, C. Lane
 Telomeres and Cloning, 110 (L)
 Arguments for Design/On Conclusive and Illustrative Significance of, Yuri N. Ivanov, 222 (L)
 Armitage, Mark
 Scanning Electron Microscope Study of Mummified Collagen Fibers in Fossil *Tyrannosaurus rex* Bone, 61 (A)
 Armstrong, Carol
 The Age of the Universe: What are the Biblical Limits?, 49 (R)
 Origins: Linking Science and Scripture, 138 (R)
Astronomy on Trial, Danny Faulkner, 1 (R)
 Aufdemberge, Ted
 CCC Model-An Opinion, 110 (L)
 Author and Title Index for Volume 37, Lazella Lawson, 199 (D)

B

- Beowulf*, Clifford L. Lillo, 198 (R)
 Bergman, Jerry
 Climbing Mount Improbable, 50 (R)
 Creation Science Made Easy, 51 (R)
 The Dangers of Cloning Humans, 220 (L)
 Homosexuality, Disease, and Creationism, 68 (A)
 Impeaching Mere Creationism, 66 (R)

- Influential Darwinists Supported the Nazi Holocaust, 31 (A)
 The Molecular Biology of Genetic Transposition, 139 (A)
The Wedge of Truth: Splitting the Foundations of Naturalism, 59 (R)
 Why Mutations are Lethal to Darwinism, 181 (A)
Big God vs. Big Science, Don B. DeYoung, 158 (R)
 Blievernicht, Eric
 Hasty Conclusions, 227 (L)
 Board of Directors Meeting Minutes, David A. Kaufmann, 205 (D)
 Book Reviews: *The Age of the Universe (What are the Biblical Limits?)*, George Drake, 224 (L)
 Bowden, Malcolm
 Origin of Clays- HTW (Hydrothermal Water) Still the Most Viable, 111 (L)
 Brown, Colin
 Aerodynamics of Wind Pollination in Living and Fossil Plants, 212 (P)
 Much Ado About Nothing, 227 (L)
 Symmetric Variation, Mendel, and Garther, 100 (P)
 The Production of Form, Hox Genes, and Symmetric Variation, 48 (P)

C

- CCC Model-An Opinion, Ted Aufdemberge, 110 (L)
 Chaffin, Eugene F.
 A Model for the Variation of the Fermi Constant with Time, 127 (A)
 Chui, Christopher
 Erosion Rates of Hawaiian Rock Samples Are Consistent With Young Earth Postulates, 105 (P)
 Clays- HTW (Hydrothermal Water) Still the Most Viable/Origin of, Malcolm Bowden, 111 (L)
Climbing Mount Improbable, Jerry Bergman, 50 (R)
 Cockerham, Janice
 Lights Out: Sleep, Sugar, and Survival, 229 (R)

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Creation Rediscovered, Don B. DeYoung, 39 (R)
Creation Science Made Easy, Jerry Bergman, 51 (R)

D

Dangers of Cloning Humans/The, Jerry Bergman, 220 (L)
Darwin's God, Don B. DeYoung, 125 (R)
Day Behemoth & Leviathan Died/The, Donald Ensign, 39 (R)
 Defense of CCC Model, E.C. Lain, 165 (L)
 DeYoung, Don B.
 Big God vs. Big Science, 158 (R)
 Creation Rediscovered, 39 (R)
 Darwin's God, 125 (R)
 $E = mc^2$, 117 (R)
 A Fish Caught in Time, 113 (R)
 Hallmarks of Design, 52 (R)
 Humanist Manifesto 2000, 51 (R)
 Stellar Evolution Challenged-A Reply to Henry, 220 (L)
 Vision, 190 (A)
 The World of Chemistry, 216 (R)
 Dobberpuhl, Del
 God's Equation, 44 (R)
 Seeing Red: Redshifts, Cosmology and Academic Science, 206 (R)
 Drake, George
 Book Reviews: The Age of the Universe (What are the Biblical Limits?), 224 (L)

E

$E = mc^2$, Don B. DeYoung, 117 (R)
 Earth History/Evidence for, Conflict over, and Confidence in Creationist Models of, John K. Reed, 213 (P)
 Editor's Comments, Emmett L. Williams, 1, 59, 117, 173 (D)
 Ensign, Donald D.
 The Day Behemoth & Leviathan Died, 39 (R)
 The Horned Dinosaurs: A Natural History, 112 (R)
 Epistemology and Correctly Defining Science.../The Crucial Importance of, Robert E. Kofahl, 193 (A)
 Erkel, Michael
 Cover Designs by Michael Erkel and Associates, (CP)
 Erosion Rates of Hawaiian Rock Samples Are Consistent With Young Earth Postulates, Christopher Chui, 105 (P)
 Evolution is Lethal Antiscience, Joseph Mastropaolo, 151 (A)
 Extraterrestrial Bombardment of the Inner Solar System: A Review..., Carl R. Froede Jr., 209 (P)

F

Faulkner, Danny
 Astronomy on Trial, 1 (R)
 Does the Collapse of a Gas Cloud to Form a Star Violate the Second Law of Thermodynamics?, 40 (A)
 Fermi Constant with Time/A Model for the Variation of the, Eugene F. Chaffin, 127 (A)
First Fossil Hunters: Paleontology in Greek and Roman Times/The, John Goertzen, 74 (R)
 Flood Geology of the Crimean Peninsula Part I: Tavrick Formation, Alexander V. Lalomov, 118 (A)
 Flood Geology versus the CCC Model, John K. Reed, 227 (L)
 Frair, Wayne
 Icons of Evolution: Science or Myth, 29 (R)
 Froede, Carl R. Jr.
 Extraterrestrial Bombardment of the Inner Solar System: A Review..., 209 (P)
 Hotspots and Hotspot Tracks: New Issues for Plate Tectonics and Catastrophic Plate Tectonics, 96 (P)

G

Gas Cloud to Form a Star Violate the Second Law of Thermodynamics?/Does the Collapse of a, Danny Faulkner, 40 (A)
Genesis, Creation, and Creationism, John Goertzen, 215 (R)
God: The Evidence, Ross S. Olson, 124 (R)
God's Equation, Del Dobberpuhl, 44 (R)
 Goertzen, John
 The First Fossil Hunters: Paleontology in Greek and Roman Times, 74 (R)
 Genesis, Creation, and Creationism, 215 (R)
 The Great New England Sea Serpent: An Account of Unknown Creatures Sighted by Many Respectable Persons Between 1638 and the Present Day, 52 (R)
 New Zuiyo Maru Cryptid Observations: Strong Indications It Was a Marine Tetrapod, 19 (A)
Great New England Sea Serpent: An Account of Unknown Creatures Sighted by Many Respectable Persons Between 1638 and the Present Day/The, John Goertzen, 52 (R)

H

Hallmarks of Design, Don B. DeYoung, 52 (R)
 Hasty Conclusions, Eric Blievernicht, 227 (L)
 Henry, Jonathan
 Star Formation: Natural or Supernatural?, 217 (L)

- Homosexuality, Disease, and Creationism, Jerry Bergman, 68 (A)
- Horned Dinosaurs: A Natural History/The*, Donald D. Ensign, 112 (R)
- Hotspots and Hotspot Tracks: New Issues for Plate Tectonics and Catastrophic Plate Tectonics, Carl R. Froede Jr., 96 (P)
- How to Define the Expanse in Genesis 1, Paul Seely, 164 (L)
- Howe, George F.
The Growth Rate of *Muhlenbergia torreyi* (Ring Muhly Grass) Colonies in Central Arizona, 159 (P)
- Quarterly Dedication to Dr. John R. Meyer, 57 (D)
- Humanist Manifesto 2000*, Don B. DeYoung, 51 (R)

I

- Icons of Evolution: Science or Myth*, Wayne Frair, 29 (R)
- Impeaching Mere Creationism*, Jerry Bergman, 66 (R)
- In Memoriam: Carol B. Armstrong 1916-2001, Emmett L. Williams, 58 (D)
- In Memoriam: Thomas G. Barnes, Emmett L. Williams, 173 (D)
- Influential Darwinists Supported the Nazi Holocaust, Jerry Bergman, 31 (A)
- Ivanov, Yuri N.
On Conclusive and Illustrative Significance of Arguments for Design, 222 (L)

J

- Joseph B. Prestwich: Uniformitarianism and Catastrophism, William Weston, 162 (P)

K

- Kaufmann, David A.
Board of Directors Meeting Minutes, 205 (D)
- Keyword Index for Volume 37, Emmett L. Williams, 106 (D)
- Kofahl, Robert E.
The Crucial Importance of Epistemology and Correctly Defining Science..., 193 (A)
- Kulikovsky, Andrew S.
Literary Framework Critique – A Response to Paul Seely, 164 (L)

L

- La Brea Tar Pits: An Introductory History (1769-1969), William Weston, 174 (A)
- Lain, E.C.
Defense of CCC Model, 165 (L)
- Lalomov, Alexander V.
Flood Geology of the Crimean Peninsula Part I: Tavrck Formation, 118 (A)
- Lattimer, Robert
Quest for Truth: Scientific Progress and Religious Beliefs, 203 (R)
- Lawson, Lazella
Author and Title Index for Volume 37, 199 (D)
- Lights Out: Sleep, Sugar, and Survival*, Janice Cockerham, 229 (R)
- Lillo, Christopher
Beowulf, 198 (R)
- Literary Framework Critique – A Response to Paul Seely, Andrew S. Kulikovsky, 164 (L)

M

- Mastropaolo, Joseph
Evolution is Lethal Antiscience, 151 (A)
- Meyer, John R.
The Growth Rate of *Muhlenbergia torreyi* (Ring Muhly Grass) Colonies in Central Arizona, 159 (P)
- Molecular Biology of Genetic Transposition/The, Jerry Bergman, 139 (A)
- Much Ado About Nothing, Colin Brown, 227 (L)
- Muhlenbergia torreyi* (Ring Muhly Grass) Colonies in Central Arizona/The Growth Rate of, George F. Howe and John R. Meyer, 159 (P)
- Mutations are Lethal to Darwinism/Why, Jerry Bergman, 181 (A)

O

- Oard, Michael J.
Signs of Intelligence – Understanding Intelligent Design, 126 (R)
- Vertical Tectonics and the Drainage of Floodwater: A Model for the Middle and Late Diluvian Period – Part I, 3 (A)
- Vertical Tectonics and the Drainage of Floodwater: A Model for the Middle and Late Diluvian Period – Part II, 79 (A)
- Olson, Ross S.
God: The Evidence, 124 (R)
- Origins: Linking Science and Scripture*, Carol Armstrong, 138 (R)

Overman, Richard
The Age of the Universe, 17 (R)

P

Production of Form, Hox Genes, and Symmetric Variation/The, Colin Brown, 48 (P)

Q

Quarterly Dedication to Dr. John R. Meyer, George F. Howe, 57 (D)
Quest for Truth: Scientific Progress and Religious Beliefs, Robert Lattimer, 203 (R)

R

Reed, John K.
 Evidence for, Conflict over, and Confidence in Creationist Models of Earth History, 213 (P)
 Flood Geology versus the CCC Model, 227 (L)

S

Signs of Intelligence – Understanding Intelligent Design, Michael J. Oard, 126 (R)
Seeing Red: Redshifts, Cosmology and Academic Science, Del Dobberpuhl, 206 (R)
 Seely, Paul
 How to Define the Expanse in Genesis 1, 164 (L)
 Simple Logical Fallacies in Evolution, Walter I. Sivertsen, 225 (L)
 Sivertsen, Walter I.
 Simple Logical Fallacies in Evolution, 225 (L)
 Slumgullion Earthflow/The, A. Jerry Akridge and Emmett L. Williams, 101 (P)
 Spontaneous Generation Hypothesis/The, David P. Woetzel, 75 (A)
 Star Formation: Faulkner and Mulfinger – II, Emmett L. Williams, 45 (P)
 Star Formation: Natural or Supernatural?, Jonathan Henry, 217 (L)
 Stellar Evolution Challenged-A Reply to Henry, Don B. DeYoung, 220 (L)

Symmetric Variation, Mendel, and Garther, Colin Brown, 100 (P)

T

Telomeres and Cloning, C. Lane Anderson, 110 (L)
Tyrannosaurus rex Bone/ Scanning Electron Microscope Study of Mummified Collagen Fibers in Fossil, Mark Armitage, 61 (A)

V

Vertical Tectonics and the Drainage of Floodwater: A Model for the Middle and Late Diluvian Period – Part I, Michael J. Oard, 3 (A)
 Vertical Tectonics and the Drainage of Floodwater: A Model for the Middle and Late Diluvian Period – Part II, Michael J. Oard, 79 (A)
 Vision, Don B. DeYoung, 190 (A)

W

Wedge of Truth: Splitting the Foundations of Naturalism/The, Jerry Bergman, 59 (R)
 Weston, William
 Joseph B. Prestwich: Uniformitarianism and Catastrophism, 162 (P)
 La Brea Tar Pits: An Introductory History (1769-1969), 174 (A)
 Williams, Emmett L.
 In Memoriam: Carol B. Armstrong 1916-2001, 58 (D)
 In Memoriam: Thomas G. Barnes, 173 (D)
 Keyword Index for Volume 37, 106 (D)
 The Slumgullion Earthflow, 101 (P)
 Star Formation: Faulkner and Mulfinger – II, 45 (P)
 Woetzel, David P.
 The Spontaneous Generation Hypothesis, 75 (A)
World of Chemistry/The, Don DeYoung, 216 (R)

Z

Zuiyo Maru Cryptid Observations: Strong Indications It Was a Marine Tetrapod/New, John Goertzen, 19 (A)

Keyword Index for Volume 38:2001–2002

Emmett L. Williams

AD: Addendum
AR: Article
DE: Dedication
EC: Editor's Comments
LE: Letter to the Editor

ME: In Memoriam
NO: Notice
PN: Panorama Note
QU: Quote
RV: Review

A

abiogenesis, 151AR
aerodynamics, wind pollination, 212LE
antiscience, evolution as, 151AR
Archaeopteryx, 29RV
ark, 3AR
Armstrong, Carol B., 58ME
astronomy, 1RV, 39RV
astrophysical revolutionary school of thermodynamics,
45PN

B

back mutations, 181AR
Barnes, Thomas G., 173ME
basking shark, 19AR
behemoth, 39RV
Beowulf, 198RV
beta decay, 127AR
Biblical worldview, 213PN
Big Bang, 1RV, 44RV, 158RV
biogenesis, 59EC
biology, molecular, 139AR
blue gramma grass, 159PN
bone, 61AR
Bouteloua gracilis, 159PN
breached dam hypothesis, 79AR

C

cacti, 159PN
cancer therapy, 139AR
canyons, submarine, 3AR, 79AR
Carcharodontosaur, 190AR
catastrophic plate tectonics, 79AR, 96PN, 213PN
catastrophism, 162PN, 174AR, 227LE
CCC model, 110LE, 165LE, 227LE
coelacanth, 113LE
Cetorhinus maximus, 19AR
Chamberlain, Houston, 31AR
chemical evolution, 59EC

chemistry, 216RV
clay, 111LE
cloning, 110LE, 220LE
cosmology, 26RV
coupling constant, 127AR
creation, 39RV, 51RV, 66RV, 68AR, 193AR, 215RV,
222LE, 224LE
creation week, 209PN
Crimean Peninsula, 118AR
cryptochromes, 229RV

D

Darwinism, 31AR, 59RV, 125RV, 181AR
Darwin's finches, 29RV
dating, radiometric, 127AR
deduction, 193AR
design, 52RV, 222LE
devolution, 181AR
dinosaurs, 61AR, 112RV, 165LE, 198RV
dinosaur vision, 190AR
disease and homosexuality, 68AR
DNA, 100PN, 139AR, 220LE

E

earth history models, 213PN
earth, orbit of, 39RV
earthquakes, 3AR
Eksirdian Formation, 118AR
embryology, 29RV
energy, 117RV
entropy, 40AR, 45PN
epistemology, 193AR
erosion, 3AR, 79AR, 105PN
erosional remnants, 3AR
erosional surfaces, 3AR
eugenics, 31AR
evolution, 29RV, 50RV, 125RV, 138RV, 151RV, 193AR,
215PN, 225LE, 230QU
extraterrestrial bombardment, 209PN

F

feathers, origin of, 163QU
 Fermi constant, 127AR
 Flood, 3AR, 39RV, 79AR, 110LE, 118AR, 162PN, 209PN, 227LE
 Flood, channelized phase, 79AR
 Flood geology, 118AR
 Flood/post-Flood boundary, 3AR, 79AR
 Flood/pre-Flood boundary, 3AR
 Flood, recessional stage, 3AR, 79AR
 Floodwater, drainage, 3AR, 79AR
 flysch, 118AR
 fossil record, 74RV, 110LE, 112RV, 113LE
 fountains of the great deep, 3AR
 Froede, Carl, 3AR

G

gap theory, 203RV
 Garden of Eden, 30QU
 gas cloud, 40AR, 45PN
 genes, hox, 48PN
 Genesis, 164LE, 215RV, 224LE
 genetics, 100PN, 139AR
 geomorphology, 3AR
 geophysics, 3AR
 God, evidence of, 124RV
 God's equation, 44RV
 Grand Canyon, 79AR
 grasses, 159PN
 gravel, course, 3AR
 gravitation, 40AR, 45PN

H

Haeckel, Ernst, 31AR
Halobia fossils, 118AR
 Haversian canals, 61AR
 Hawaiian rocks, erosion, 105PN
 heat capacities, 40AR, 45PN
 heat flow, 40AR
 helpful mutations, 181AR
 hepatitis, 68AR
 holocaust, 31AR, 114AD
 homosexuality
 hotspots, 96PN
 hox genes, 48PN, 227LE
 humanism, 51RV
 Humanist Manifesto, 51RV
 human vision, 190AR
 hydroplate model, 3AR
 hydrothermal water, 111LE
 Hypothesis, multiple working, 3AR

I

ice age, post-Flood, 3AR
 impact craters, 209PN
 induction, 193AR
 information, 59RV
 insects, origin of, 189QU
 intelligent design, 66RV, 75AR, 126RV, 193AR, 203RV
 International Conference on Creationism, 54NO
 intragenomic parasites, 139AR

K

Kaluza-Klein excitations, 127AR

L

LaBrea Tar Pits, 174AR
 lacunae, 61AR
 Lake City, Colorado, 101PN
 landslides, 101PN
 Late Diluvian Period, 3AR
 leviathan, 39RV
 life, origin of, 58EC, 75AR, 151AR
 lipin, 229RV
 literary framework hypothesis, 164LE
 Luther, Martin, 30QU

M

macroevolution, 158RV
Mammillaria cacti, 159PN
 marine tetrapod, 19AR, 52RV
 Mengele, Joseph, 31AR
 mere creationism, 66RV
 Meyer, John R., 57DE
 microevolution, 158RV
 Miller-Urey experiment, 29RV, 151AR
 Moab man, 61AR
 monogenesis, 151AR
 monotremes, 227LE
 moon, 209PN
Muhlenbergia torreyi, 159PN
 mutation rate, 181AR
 mutations, 139AR, 181AR

N

natural history, 213PN
 naturalism, 59RV
 natural selection, 151AR
 Nazi race policies, 31AR
 New Age, 51RV

O

origins controversy, 138RV

P

paleontology, 74RV, 174AR
pediments, 3AR, 79AR
planetary accretion, 217LE
plants, pollination of, 212LE
plesiosaur, 19AR
Prestwich, Joseph B., 162PN
progressive creation, 158RV

R

race polices, Nazi, 31AR
radiation, 40AR, 45PN, 49RV
red shifts, 206RV
relativity, 44RV
religion, 203RV
reptile, marine, 19AR
ring muhly grass, 159PN
RNA, 58QU, 100PN, 139AR

S

San Juan Mountains, 101PN
scanning electron microscopy, 61AR
science and faith, 193AR, 203RV
science, definition of, 193AR
Scripture, 138RV
sea serpent, 52RV
second law of thermodynamics, 40AR, 45PN, 217LE
sedimentology, 118AR
sediments, 79AR, 118AR
senses, 227LE
shark, basking 19AR
sheet erosion, 3AR
sleep, 229RV
Slumgullion earthflow, 101PN
solar system, 39RV
spontaneous generation, life, 59EC, 75AR, 151AR
star formation, 40AR, 45PN, 217LE, 220LE
stellar element production, 127AR
stellar evolution, 217LE, 220LE
string theory, 127AR
submarine canyons, 3AR, 79AR
subsidence, 3AR
sugar, 229RV
supernaturalism, 51RV
survival, 229RV
symmetric variation, 48PN, 100PN

T

tar pits, 174AR
tar springs, 174AR
Tavrick Formation, 118AR
tectonically-associated biological provinces, 3AR
tectonics, vertical, 3AR, 79AR
telomers, 110LE
tetrapod, marine, 19AR, 52RV
The Genesis Flood, 3AR, 227LE
theistic evolution, 39RV
thermodynamics, 40AR, 45PN, 217LE
topology, 127AR
transposition, 139AR
transposons, 139AR
trilobite vision, 190AR
turbidites, 118AR
Tyler, David, 3AR
Tyrannosaurus rex, 61AR

U

uniformitarianism, 162PN
universe, 40AR, 45PN
universe, age of, 17RV, 49RV, 78RV, 224LE
universe, expanding, 44RV
uplift, 3AR
uranium isotopes, 127AR

V

valley, formation of, 79AR
Van Andel Creation Research Center, 57DE, 159PN
Vardiman, Larry, 3AR
vertical tectonics, 3AR, 79AR
virus, 50RV
vision, 190AR
volcanic upheavals, 3AR
volcanism, 101PN

W

Walker, Tas, 3AR
water gaps, 3AR, 79AR
wedge movement, 59RV
Whitcomb-Morris model, 3AR, 227LE
Woodmorappe, John, 3AR

X-Z

Xenos peckii vision, 190AR
young earth model, 105PN, 209PN
Zuiyo Maru cryptid, 19AR

Minutes of the 2002 Creation Research Society Board of Directors Meeting

On Thursday, 30 May 2002 a meeting of the Board of Directors (BOD) was held at Bob Jones University, Greenville, South Carolina, from 1900 hours to 2100 hours to plan for the committee meetings on Friday. On Friday, 31 May 2002 between the hours of 0830 and 1700 the Finance, Membership, Research, VACRC, Internet, Constitution/Bylaws/Advanced Planning, RATE, Quarterly, and Publications Committees each met separately for approximately two hours to plan for the Saturday business meeting.

On Saturday, 1 June 2002 the closed business meeting of the BOD was called to order at 0830 hours. Present: T. Aufdemberge, E. Chaffin, D. DeYoung, W. Frair, R. Gentet, D. Gish, G. Howe, R. Humphreys, D. Kaufmann, L. Lester, G. Locklair, J. Meyer, M. Oard, J. Reed, E. Williams, G. Wolfrom. Absent: R. Samec.

A devotion was lead by Frair.

The minutes of the 2001 BOD meeting were accepted as distributed prior to the meeting.

Recording Secretary Kaufmann reported that the following were elected to a three-year term to the BOD: Aufdemberge, Gentet, Howe and Oard.

The Treasurer's report by Gentet was presented and accepted. A budget of \$282,400 income and \$278,400 outgo was accepted.

The finance committee report by Aufdemberge resulted in the following actions: it was passed that the VACRC cash flow process be streamlined. In order to do this a number of new bank accounts have to be established at VACRC. The recommended flow chart was adopted, and it was passed that the VACRC Director shall be authorized to open up to three additional bank accounts. These may be located at Bank One, Stockman's Bank, the Evangelical Christian Credit Union and/or other financial institutions deemed appropriate by the Treasurer in consultation with the President of the CRS. Signers on the accounts shall include the VACRC Director and two other signers designated by the Treasurer in consultation with the CRS President. Checks drawn on these accounts need only one of the above signatures. It was passed to transfer \$35,000 from the CRS research spendable funds to the VACRC.

The membership report by Wolfrom was given as follows: total membership for 2001/02 was 1664 (641 voting, 648 sustaining, 364 subscriber and 11 students). This is a decrease of 53 from the 2000/01 membership year.

The membership committee report by Kaufmann resulted in the following actions: the membership committee plans to advertise the membership advantages of joining CRS, to utilize the "Friends of VACRC" list for

membership solicitation and to possibly hold a Debate Workshop with Gish in Orlando. It was passed that CRS pay for the cost of listing the *CRSQ* in the *Buyer's Guide to Scientific and Technical Journals*, which is published by Allen Press, Inc. It was passed to authorize Kaufmann to provide for a "CRS Hospitality Hour" at the 2003 ICC Conference in Pittsburgh. It was passed to authorize Oard to setup the CRS display at the 2003 Answers In Genesis conference in Indiana.

The lab committee report by Chaffin resulted in the following actions. It was passed to reappoint J. Meyer as Lab Director at VACRC for the coming year. The VACRC budget was approved with an income of \$135,700 and outgo of \$135,700.

The Internet committee report by Locklair resulted in passing a resolution to present our volunteer webmaster, Fred Williams, with a certificate commending him for his services to CRS.

The constitution committee report by Frair resulted in the following actions. It was finalized to change in the constitution the title of "Secretary" to "Recording Secretary." It was passed to add the Internet and Membership Committees to our organizational structure flow chart.

The RATE committee report by Humphreys stated that the RATE project will meet at ICR in San Diego in Mid-July, 2002. The CRS RATE fund will pay for DeYoung's and Chaffin's travel expenses; ICR will pay for Humphrey's expenses. The CRS-related RATE projects are: Chaffin—Theoretical Mechanisms for Accelerated Nuclear Decay; DeYoung—Radioisotopes in Meteorites; Humphreys—Experimental Helium Diffusion Evidence for Accelerated Nuclear Decay. Research papers will be presented on these projects at a special session on RATE at the 2003 ICC conference in Pittsburgh.

The *CRS Quarterly* committee report by Lester stated it was decided to enhance the posting of *CRSQ* articles and notes on the CRS website. Concerns were expressed about the need for an appeal process when an author and an editor reach an impasse on the rejection of an article. It was decided that a second editor can be consulted for a resolution of the matter. It was passed to send a certificate of appreciation to Michael Erkel for his cover designs of the *CRSQ*.

The *Creation Matters* report by Wolfrom stated that we need to acquire more manuscripts.

The publications committee report by Oard resulted in the following actions. It was passed to set the cost of *CRSQ* CD's to \$150 for members and \$175 for non-members and the three year upgrades to \$50 for members and \$60 for non-members. The Committee is considering advertising

in home school magazines and/or *World* magazine. The Committee is delaying streamlining publication procedures until an Associate Director of VACRC is officially employed.

It was passed to nominate the following for the BOD election in 2003: Chaffin, Lester, Reed, Wolfrom and new nominee, Kevin Anderson.

The following officers were elected for 2002/03: President, D. DeYoung; Vice President, E. Chaffin; Recording Secretary, D. Kaufmann; Treasurer, R. Gentet; Member-

ship Secretary, G. Wolfrom; and Financial Secretary, T. Aufdemberge.

It was passed to hold the 2003 BOD meeting at Milwaukee, Wisconsin, on Thursday, May 29 to Saturday, May 31.

The meeting was adjourned at 1500 hours.

Respectfully submitted,
David A. Kaufmann, Recording
Secretary

Note from the Panorama of Science

Floral Organs and Fossil Water Lilies

Many of us will have seen, at one time or another, the results of mutations in Hox genes. Some examples are legs being produced where antennae would be, and flies with two pairs of wings where they would normally only have one pair. Another example is the inactivation of two Hox genes in a beetle larva, which produces sixteen extra legs instead of the normal three pairs (Hecht, 2000, p. 20).

Such outcomes are said to take these life forms back to their ancestors, which seems a rather silly argument, because if you think about these results you get a range of ideas, some of which are peculiar. For instance, what ancestor of the fly had legs on top of its head, if we are to take every one of these changes seriously?

Another more recent example is that of floral organs. With the right changes, you can get carpels where sepals should be, stamens where petals should be, leaves in place of floral organs, and leaves which produce stamen-like organs (TheiBen and Saedler, 2001, pp. 469–471) and (Honma and Goto, 2001, pp. 525–528). This is supposed to take floral organs back to a time when they were all leaves. However, many of these characteristics can have their normal positions in the floral arrangement changed; this is more consistent with a manipulation of the Hox genes than anything else.

The discovery of fossil water lilies at about 125 million years before present (BP) puts these plants back to the early Cretaceous. They were likely to have been pollinated by beetles. But the plant's features are all to be found in modern plants, with about 99 per cent of them found in modern lilies (Friis, Pedersen, and Crane, 2001, p. 359).

The start of the Cretaceous varies from 140–144 million years BP, depending on which authority you consult.

These water lilies must have had a history going back millions of years beforehand, with the non-angiosperm plants having had their heyday in Jurassic times.

No evidence of that ancestry exists. The size, structure, reproduction, and life-cycle of non-angiosperm plants are so different from the water lily, that one cannot envision pines or cycads developing into such angiosperms.

The fossil position between angiosperm and non-angiosperm plants seen here is so geologically short that it must surely cast question upon any connection between the two groups of plants, and must add strength to the view that experimentally changing the floral position of any of the floral organs amounts to no more than “playing around” with the basic body plan, rather than producing anything remotely “ancestral”.

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Letters to the Editor

The Age of the Universe According to Gray

George Drake writes (in a review of my book, *The Age of the Universe: What Are the Biblical Limits?*) “We need Gray to answer some questions,” which I am pleased to do.

Question 1

“If the earth hung around in space for ‘multiple ages’ before Day One, and then God remade it completely so that one could not tell it had been around for billions of years, wouldn’t that be out of character for God to deceive us as to its antiquity?”

The biosphere, all living things including fossils and derivatives, is young, less than 8000 years old as defined from the Bible record. The geology of our earth, Cambrian and above is less than 6000 years old, the result of a recent global Flood where God “remade it completely.” But the planet Earth mineral base is undefined before Day One as to date of origin. It could be old or young, biblically, so we go to science and make our questionable guesses.

The six days of Genesis were literal, consecutive, solar days and also recent. But God speaks in Job 38 telling Job that the ocean-covered earth, *at its birth*, was enveloped in a “thick cloud of darkness” and no one is able to define how long the darkness continued before God commanded light to shine through that darkness, thus illuminating the ocean to establish Day One on earth. Biblically it could be two weeks or two billion years. I do not know how old the earth is. I know the duration of the oceanic darkness before Day One is not defined in the Bible nor is the age of the stars. Whether “no one could tell that the earth had been around for billions of years” is a subjective judgment, which even many creationists do not share. I agree it would be out of character for God to deceive us and He has not done so, not at all, and never will.

Question 2

“Whether or not the earth was ever extant, as Gray insists, or not, the creation of Day One is no less miraculous... What is the compelling logic demanding that an infinite God let it lay around for billions of years before doing anything with it?”

There is no compelling logic demanding that an infinite God must let it lay around for billions of years as far as the earth is concerned, but because we thoroughly agree God does not deceive us, there might be some logic for God to wait, after the creation of stars, to allow light from distant galaxies to arrive on earth before creating Adam and the biosphere. I suppose He wanted Adam and migrat-

ing geese to see star patterns and people today to see quasars. If He would create the light rays enroute with images of cosmic novelties encoded in the light beams, as Dr. Henry Morris used to suggest, He would really appear a deceiver letting us see supernovas, variable stars, etc. that do not exist in reality. That would, it seems to me, to be “out of character” for the God of truth.

The same applies to theories of Drs. Humphreys and Setterfield, neither of which has passed rigid scrutiny of peer review outside of the creationist community and neither of which could be conceived before the 20th century and *even if true* does not prove that the Bible demands a young universe nor that the universe is indeed young. Humphreys, in particular, whom I regard as a friend (we hiked the Grand Canyon together) promotes what appears to me a forced bible interpretation. I have devoted a chapter in my book to his cosmology.

I do not know from the Bible how old the universe is either, but I know it is not defined from Exodus 20:11 nor from the fourth day record. Whether it is actually old or not, it makes no difference to my central thesis, which is, “The age of the universe is not defined in the Bible.” Waiting time is a problem for us men but billions of years of “waiting” is no problem at all for a transcendent God—it is the same as yesterday for Him.

Question 3

Drake’s last question: “Why should anyone believe him (that is, me)?” Well, no one should necessarily believe assertions from anyone but we should believe the testimony of Scripture which most of CRSQ readers do. Science is second and can be supportive, but the plain language of Scripture in the original language is first. I suggest that critics thoroughly digest the book I have written including the author’s preface and provide some substantive negative arguments, if they can, to a fair exposition of Scripture.

If two reviewers come to opposite views of both “tone” and substance (as Mr. Drake concludes regarding previous reviews of my book) could it be that one of them is coming unfairly from a preferred, preconceived view? Good scientists as well as theologians will, without bias as far as possible, *thoroughly* examine all the data including mine. It is not easy to change for those who have promoted long-held positions and especially for those who have published them.

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Gray Clouds

"For in six days the Lord made the heavens and the earth" — Exodus 20:11

While I am glad that Gorman Gray counts me as a friend (I need all the friends I can get), I am not so glad that he has neglected my negative opinion of his modified "gap" theory. In 1995, he sent me an early manuscript of his book and asked for my comments. I replied:

On page 17 you try to show that the "heavens" of Exodus 20:11 does not include the stellar heavens. For that to be so, the phrase "the heavens and the earth" there would have to have a different meaning from its first occurrence in Genesis 1:1, where it clearly has the meaning of "the universe." According to Thayer's *Greek-English Lexicon* (1977, page 464), the phrase in both Hebrew and Greek means "the universe." Can you point to any use of the phrase in Scripture in which the heavens clearly do not include the stars?

He responded by adding comments about Exodus 20:11 throughout his book (Gray, 1997). However, as far as I can tell, he has failed to show us a verse in which the phrase "the heavens and the earth" definitely excludes the stellar part of the heavens. He merely asserts such an opinion several times—without proof. And though he exhorts us on page 18 to use lexicons to check meanings, he neglects to answer my lexicon citation above or to give any other. But the venerable Hebrew lexicon he recommends (Brown, Driver, and Briggs, 1979, p. 1030) tells us the meaning of "the heavens and the earth" is "universe."

Gray's Scripture index lists *eighteen* separate entries for this one verse. In all of them he is arguing against the "face-value" meaning, often adding his own rather peculiar spin to the words, such as using "worked on" instead of "made". Why all this fuss over one verse? Because taking it and its context straightforwardly says that God made the universe in six ordinary weekdays. That excludes Gray's gap.

Another thing to notice is that Gray fails to cite any verse that explicitly says the universe is old. That is because there is none. He tries to make a virtue out of this lack by contending that the age of the cosmos is "undefined". But compared to the verses that plainly declare the universe is young, his contention has a hollow ring.

There are many other areas in Gray's faulty hermeneutics I could point to, such as the way he deals with the Hebrew words for "make" and "create", *asah* and *bara*. But other authors have devoted whole books to critiquing that point and other points Gray's theory has in common with the old "gap" theory (Fields, 1976). Perhaps one of them will feel like similarly critiquing this new variant, which some have dubbed the "Neo-Gap" theory.

This new gap theory is somewhat better than the old version, which tried to stuff both the fossils and starlight travel time into the gap. While Gray, to his credit, leaves the fossils to be formed in the worldwide Flood of Noah, he does not seem to realize that doing so does away with a half billion years of that long-ages timescale he may deeply fear is correct. But if the fossil strata dating methods are so grossly wrong, why then should Gray worry about the rest of the timescale, which uses the same methods?

The Neo-Gap theory is just another member of the long series of often-clever compromises we have seen over the centuries. It wearies me, and I wonder if it grieves God. Why is it so hard for men to simply take Him at His word?

"O fools, and slow of heart to believe all that the prophets have spoken" — Luke 24:25

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Flood Geology Model versus the CCC Model: A Response to John K. Reed

Reed says that I cite "Josephus, the book of Jashar, and Eusebius as authorities supporting the CCC model" (Reed, 2002, p. 228). My original letter to the editor (Lain, 2001, p. 165) *first of all* pointed out that "Genesis tells us that God did place a curse on the land and on mankind in general as a result of Adam's sin." My references to the book of Jashar, Josephus and Eusebius were show-

ing how they parallel the Book of Genesis. Dr. Reed said he prefers Genesis and other pertinent passages of the Bible. Let us see if he really means it. He insinuates that I am in error by quoting sources outside the Bible in order to support my views, but I have biblical authority for doing so. Let the reader consider the following passages of Scripture:

Titus 1:12–13: “Even one of our own prophets has said. Cretans are always liars, evil brutes, lazy gluttons. This testimony is true” (NIV). The reader will note that St. Paul is quoting a source outside the Bible, the poet Epimenides from the sixth-century BC, and a pagan source at that! Jude 14–15: “Enoch, the seventh from Adam, prophesied about these men: See, the Lord is coming with thousands upon thousands of his holy ones to judge everyone, and to convict all the ungodly of all the ungodly acts they have done in the ungodly way, and of all the harsh words ungodly sinners have spoken against him” (NIV). Here Jude is quoting from the Apocryphal book of Enoch. II Samuel 1:17–18: “David took up this lament concerning Saul and his son Jonathan, and ordered that the men of Judah be taught this lament of the bow (it is written in the Book of Jashar)” (NIV). The rest of the chapter, verses 19–27 are from the book of Jashar. Joshua 10:12–13: “O sun, stand still over Gibeon, O moon, over the Valley of Aijalon. So the sun stood still, and the moon stopped, till the nation avenged itself on its enemies. As it is written in the Book of Jashar” (NIV). I have a question for Dr. Reed. What kind of weight did the authors of Joshua and II Samuel give to the Book of Jashar as a historical source?

Dr. Reed: “Biblical truth should take precedence with creationists” (2002, p. 228). Biblical truth should take precedence over what? Other truths? Truth is truth, is it not? It is true whether in Scripture or outside of the Bible. The Mississippi River is in the United States, not Asia. That is truth, but it is not found in Scripture.

In an attempt to explain the destruction of sea life throughout the geologic record by Noah’s Flood, Dr. Reed invokes such things as volcanism, tectonic upheavals, etc., and concludes by claiming the reason Moses did not mention the destruction of sea life in Genesis was due to the economy of his language (2002, p. 228). If you read Genesis 7, you will see that the emphasis is always on land creatures, including man. No mention is ever made of the destruction of sea life.

God commanded Noah to take land animals aboard the Ark in order to keep seed alive on the face of the earth (Verses 2–3). Verse 4 of Genesis 7 is speaking of land life, not marine life. Verse 8, once again, speaks of land animals and things that creep upon the earth, not things that creep upon the ocean floor. Verse 14 is clearly speaking of land animals, no mention is made of marine life. Note Genesis 7:21–22: “And all flesh died that moved upon the earth, both of fowl and of cattle and of beasts and of every creeping thing that creepeth upon the earth, [not on the ocean floor], and every man [men did not live in the ocean], all in whose nostrils was the breath of life of all that was in the dry land died” (NIV). How simple it would have been for Moses to have inserted the phrase in Verse 22: “...and many of the sea creatures died as well” but he did not say that. He emphasized all that on the dry land died.

Now I am going to deal with Dr. Reed’s accusation that I am invoking uniformitarianism to support my views. Uniformitarianism went out of vogue years ago. Let us take a look at what modern geology has to say about uniformitarianism.

In the 19th century Lord Kelvin challenged strict uniformitarianism and geologists realized that the intensity of geologic processes had varied greatly through time. Allow me to quote an anecdote from Dott and Batton (1981, pp. 39, 40) to illustrate how uniformitarianism has been discredited:

One is told that a certain boy grows one-tenth of an inch a year and that he is four feet high. The geologist then argues, “Ten years to grow one inch, four hundred-eighty years to grow four feet. Therefore, the boy is four hundred eighty years old.” A person who knows more about the boy in question comes forward to inform us that when he was younger, he grew much faster and that after all, his age is only ten years. The geologist replies, “It may be so. Let me see. One tenth of an inch in a year under the doctrine of uniformity, one inch in ten years. No, you are clearly mistaken. Ten years is far too short of time. The organic processes of growth could not possibly have occurred in this time. I grant you my own calculation is not rigorously exact. Let us say then, that our boy is but 400 years of age.”

Moreover, in support of Kelvin, it was clear that conditions on earth had changed irreversibly so that in certain respects, different epochs of geologic time were unique. History was not strictly uniform as Lyell had contended. Examples of major noncyclic events include...evidence of meteorite impact on all planetary bodies in the distant past, far more intense than today, and most familiar of all, the complete extinction of large groups of organisms such as the great dinosaurs...Because of all the controversy and many different shades of so-called uniformitarianism, we feel that this term should be relegated to be an historic artifact of Lyell’s extreme position...The only assumption geology makes is that physical and chemical laws are constant, which is properly called ‘actualism’, an older French term that uniformitarianism...by inductive reasoning and analogy, the study of geologic processes acting today, provides us with powerful clues to their past action, but we do not assume that these processes always acted with the same rates and intensities, contrary to what our critics say we believe...Geologists today routinely accept sudden, violent and even unique events as perfectly consistent with contemporary earth theory.

I am certain that Dr. Reed would not argue, as did Lyell, that processes have always remained uniform at the same rate throughout history. Otherwise, he could not believe in the Flood. Therefore, Dr. Reed is faced with mak-

ing a choice. Either he has to accept actualism or uniformitarianism because there is no middle ground.

Dr. Reed: "There is nothing in Genesis 1 that equates the days of Creation with specific ecosystems..." (2002, p. 228). Let us look at the fifth day: "And God said, 'Let the water teem with living creatures, and let birds fly above the earth across the expanse of the sky.' So God created the great creatures of the sea and every living and moving thing with which the water teems, according to their kinds and every winged bird according to its kind" (Genesis 1:21, NIV). The ocean is one gigantic ecosystem. Genesis 1:12 informs us that God created all of the various life forms that we find in the ocean. Genesis does not break down the various ecosystems of the sea creatures. Verse 21 simply uses all-inclusive language to cover everything in the ocean. God created a finite number of sea creatures and birds just as He did with human beings. He did not create the ocean immediately full of billions of sea creatures around the world. This is clear and significant in the language in Verse 22: "God blessed them and said, 'Be fruitful and increase in number and fill the water in the seas and let the birds increase on the earth'" (NIV). This would not have been said if originally God had created millions and millions of sea creatures and birds. This wording reminds us of the command He would shortly tell Adam and Eve: "Be fruitful and multiply and fill the earth." (Gen. 1:28).

It is clear that the fifth day began with a limited number of sea creatures and this allowed the natural process of reproduction and migration to take over as the food chain would allow as ecosystems expanded. God would not have told them to increase in number if their ecosystem were already filled, and this applies both to the creatures in the sea and the birds.

Dr. Reed: "If the uniformitarian geologic periods are paleoenvironments, then why is there a unidirectional order in the sequence? Why is there not a random distribution of say, Precambrian-Cenozoic-Paleozoic-Mesozoic at least in some locales?" (2002, p. 229). With this statement, Dr. Reed has just blown his flood geology model out of existence. He freely admits that the fossil record does have order in it and that it is not random. If the entire geologic record had been the result of Noah's flood, it is hard to see how there would be such precise fossil order, in fact, any fossil order. It would all be random. There would be no means to classify it as Paleozoic, Cenozoic or anything else. If the Flood were as violent as Dr. Reed tells us it was, then it would have never laid down a fossil record with such incredible order. The whole thing would be random and mixed up.

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Response to Mr. Donnelly's Letter Concerning Pre-Columbian Horses

Mr. Donnelly seems to think that the problematical reference to pre-Columbian horses in the Book of Mormon can be resolved through the La Brea Tar Pits. Horses are indeed fairly well represented in the tar pits, and the discovery of human bones in Pit 10 shows that man and horse had once co-existed together in prehistoric Southern California. According to the academic establishment, horses (and other kinds of animals) were victimized by entrapments that occurred over a period covering tens of thousands of years. However, this is not a true picture of the facts. In a second article (soon to be published) I will show how the traditional view of animal entrapments cannot explain the actual configurations of bone deposition that were uncovered during the course of scientific excava-

tions. In a third article I will present my thesis that the animals of Rancho La Brea were the victims of a global flood. Both human and animal populations were completely wiped out in the Western Hemisphere. Since the horses of the La Brea Tar Pits would therefore be considered antediluvian, we must turn to other sources to determine when and where these animals made their re-appearance into the New World. Considering the lack of archaeological evidence for the existence of horses among pre-Columbian civilizations and cultures, I would contend that they did not return until after Europeans began colonizing the Americas in the fifteenth and sixteenth centuries.

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Overstatement of Volcanic Activity during the Flood?

Donnelly's query about large amounts of carbon dioxide and sulfur dioxide being emitted during the Flood because of volcanic activity sounds strangely familiar. In 1996 one of the claims made by Yake concerning the quantity of heat supposedly released by volcanoes during the Flood was shown by Huff (CRSQ 32:199) to be too large by a factor of 1000. Possibly the same type of overstatement was made when claiming the amount of CO₂ and SO₂ released by volcanoes during the Flood?

Donnelly should furnish the exact figures of released CO₂ and SO₂ that was claimed as well as the number of volcanoes involved before any judgment can be made on the validity of such estimates.

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Naturalistic Science and Creationism

In answer to Ted Aufdemberge's letter, no particular note, article or letter to the editor in the *Quarterly* represents editorial policy. Such policy is determined by our Statement of Belief. (This statement can be found below the Order blank for Past Issues in all issues of the *Quarterly*.)

Allow me to paraphrase the Statement of Belief:

1. Our members are committed to full belief in the Biblical record of creation and early history and to the concept of dynamic special creation as opposed to evolution.
2. We recognize the Bible as the written word of God.
3. We recognize that the Noachian Deluge was a *historical* event.
4. We are an organization of Christians who accept Jesus Christ as our Lord and Savior.
5. We propose to re-evaluate science from the aforementioned viewpoint.

The following statement concerning the age of the earth is in Article IV, Section 2 of the Constitution of the Society:

While publications of the Society are not intended to support any particular chronology, such as Ussher's, they shall be in keeping with creation in a Creation Week as expressed in the Statement of Belief. Since by its Statement of Belief the Society is understood to be opposed to the concept of vast geological ages, its publications shall be consistent with the concept of the creation week in relatively recent time.

The editorial policy is as follows:

Section 1. Criteria Technical Articles in the *Quarterly*:

- a. Any article in which scientific macroevolution, theistic evolution, progressive creation, or the gap theory are espoused shall be rejected by the Editor.
- b. Any article in which there is an attack on the inerrancy of the Bible or in which questions are raised concerning the historical or scientific truth of the original autographs shall be rejected by the Editor.

c. Any article in which the account of origins in Genesis is challenged as factual presentation of simple historical truth shall be rejected by the Editor.

d. Any article in which there is a rejection of the view that all basic types of living things were made by direct creative acts of God during the Creation Week shall be rejected by the Editor.

e. An article in which any biological changes (other than changes within the original created kinds) are accepted as occurring since the Creation Week shall be rejected by the Editor.

f. Any article in which the Noachian flood (as a historical event worldwide in its extent and effect) is attacked shall be rejected by the Editor.

g. Any article in which there is a challenge against the need of an individual to accept the Lord Jesus Christ as one's personal Savior shall be rejected by the Editor.

h. Any article in which questions are raised concerning the fall of man into sin shall be rejected by the Editor.

Section 2. Criteria for Other Sections of the *Quarterly*:

a. The Panorama of Science section in the *Quarterly* shall contain technical notes. These notes are subject to the same editorial criteria as technical articles.

b. Book Reviews are subject to the same editorial criteria as technical articles.

c. Letters to the Editor may express any opinion and may be published at the Editor's discretion.

d. If an article, technical note, or book review contains significant scientific information that would be of value in the *Quarterly* and contains objectionable material not acceptable by the criteria for technical articles, and the author agrees to remove the objectionable material, the article can be considered for publication.

The "Creation Research Society Editorial Policy" was published in the December 1985 *Creation Research Society Quarterly* 22(3):139–140.

John Reed's note does not violate the Statement of Belief of the Society or our editorial policy. Whether one chooses to follow his hierarchical approach is a matter of personal taste of the individual creationist model builder. In comparison the Aufdenberge concept to evaluate a theoretical system does not espouse any of the beliefs of the Society.

We as a Society, are not attempting to appeal to naturalists, but to re-evaluate science from a Biblical perspective.

Naturalists and creationists are different in the sense that their fundamental presuppositions are different. Naturalists use philosophy when developing their models and often they are blind to their procedure or they believe that *only* their philosophy constitutes a proper framework for science.

Interested readers are welcome to comment on the issues raised during this exchange.

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Response to Ackridge's Reflections on the CCC Model

First, I'm pleased that my Creation/Curse/Catastrophe (CCC) geologic model (Gentet, 2000a) continues to provoke thought among CRSQ readers. Mr. Ackridge's latest letter (2002, pp. 65–68) shows the length to which the CCC model is gaining understanding, while still having some misconceptions among those who have read my earlier paper.

I would like to take this opportunity to "clear the air" sometimes, once again on a number of points Mr. Ackridge's letter raises. He concludes his letter by asking seven questions "for consideration by supporters of the CCC Model." Let us examine them one by one:

"How can thick deposits (even miles thick) of sedimentary material containing fossilized animals and plants and covering much of the present land surfaces be explained in a pre-Flood context?" (Ackridge, p. 68).

I realize that to the thinking of those who hold to the Flood Geology model, the Flood itself somehow provides all the power and energy needed to form the vast amount of practically all of the fossiliferous rocks. I say "somehow" because to this day the Flood Geology model does not have a clear-cut understanding of the "how" of it. Only various suggestions have been made over the course of the years.

It seems that God caused the ocean basins to adjust in such a way that, together with the enormous amounts of rainwater that fell over the 40 days and nights, the oceans were a vital part in drowning out the continental areas. Those who currently believe in Plate Tectonics have invoked the flooding of the continents due to the raising of the mid-ocean spreading centers, thereby causing ocean water to be displaced on the land surfaces.

Furthermore, any vertical movements (due to whatever reason) of any part of the ocean basins would accomplish the same feat. Conventional geologists also rely upon such displacements to account for partially flooding land areas during Times of epeiric sea invasions. The plain truth is that none of us knows for sure how God did it. My point is

that whatever God used during the Deluge He could also have used earlier *in a more limited way* to cause disruptions in the cursed, pre-Flood world.

"How can a 'Cretaceous' sedimentary stratum in Alabama be age-correlated with a 'Cretaceous' stratum in England without using the principles of evolution-based biostratigraphy?"

First, remember that the CCC model is not saying that the two are necessarily deposited at the same time. The "Cretaceous" areas, the one in Alabama and the one in England, need to be examined independently to see what they say in reference to Biblical chronology. Are they both pre-Flood? Could one be pre-Flood? Could one be pre-Flood and the other one the Genesis Flood Event (GFE) itself? Or, is it even possible that one (or both) are post-GFE? It seems that at least some of the dinosaurs survived the GFE.

The first order of business would be to establish where in each local geologic rock record the GFE is recorded. That would give a benchmark to solve many of the above questions. If, for example, both "Cretaceous" layers were found to be pre-GFE, then one could also ask how closely they are related during the long, pre-Flood times. How does one go about determining a time scale in the pre-Flood world, or for that matter, even for post-Flood times?

Here we find ourselves much like the geologists of former times! Now, of course, isotopic (radiometric) dating methods are used to attempt such correlation, when possible. And these are used with the mistaken assumption that each geologic Period is unique and not contemporaneous with any other geologic Period.

How much can isotopic-based methods be trusted even in a *relative* way? This is the question we all are wrestling with currently it is not unique with the CCC model! I personally feel that there is meaning in a relative sense to those dates which are "accurate" (that is, not derived from contaminated samples). Certainly, if, for example, the speed of light has declined in a regular fashion that we can

“clock” the effects on isotopic derived dates, such would prove to be of great help.

“Why do fossils of animals and plants from over the globe demonstrate their having lived in warm to moderate climatic conditions?”

Assuming that the paleoenvironments have been correctly assessed, it would clearly indicate that when the life forms were living in that area, the local climate was warm or moderate at the time that particular stratum was deposited. Why did the climate over North America and Europe drastically change *for a time* after the Flood? Why was it moderate or warm before that icy change? Again, we are guessing. Many factors can come into play to dramatically change a climate and the world’s scientists themselves continue to research possible causes.

The point is that the CCC geologic model at least *allows for the possibility* that in the long, pre-Flood times glaciers could have also existed and left their mark. The Flood Geology model does not allow such a possibility in flood deposits. Any *impartial* evaluation of alleged glacial remains is therefore impossible with the Flood Geology model. This is painting us in a theological/geological corner.

“How is the Flood boundary both locally and globally differentiated from strata deposited during the events of Creation week and the curse on mankind?”

I have previously given an answer to this identical question (Gentet, 2000b, p. 207). Until others worldwide are willing to take up the challenge and apply the principles of the CCC model to their areas, I cannot improve much upon what I have already stated. In the Western USA “...the GFE is noted by massive regional erosion.”

Furthermore, I said: “What additional criteria for identifying the GFE strata may be for other areas of the world remains to be seen. Right now the best I can say is: look for something that does not contain time indicators such as footprints, nests, and other *in situ* remains. To say that the GFE could preserve such time indicators makes the Flood into something Scripture seems to totally disallow....”

“Does the presence of fossils in rock strata deposited during Creation Week conflict with the Scriptural teaching of no death existing before the introduction of sin?”

I do not believe that I have ever said fossils were formed during Creation Week. I have said that at least parts of the pre-Paleozoic strata were formed during the Creation Week. If any fossils are found in such strata, then they

would not be of “advanced” air-breathing forms. It has been noted by such YEC writers as Morris (1994, p. 130) that plants “and perhaps also that of many of the ‘lesser’ forms of life technically classed as animals [do] not constitute the death of a Biblically living, breathing, blood-filled creature” and their fossils would not, therefore, constitute a contradiction to death existing before human sin.

“What was the mechanism for the origin of continental glaciation in the pre-Flood world?”

Again, if, and note that I do say “if” evidence of such glaciation is proved valid, then we are back to the answer of question three. What causes such periods of dramatic climatic changes? We simply do not know *for sure* at this time.

“Why are modern examples of widespread catastrophic activity not observed?”

I need to ask: “How widespread is ‘widespread?’” I’m assuming you mean over an area of perhaps hundreds of thousands of square miles. If so, I wonder the reason for such a question in connection with the CCC model! It stresses that the present is not like the pre-Flood world in terms of the intensity of the Cursed Earth! Great lengths were taken in the CCC model paper (Gentet, 2000a) to show the reasons for the *diminished* effects of the Curse on the Earth in post-Flood times. Also, when widespread catastrophic activity resumes in the future at the Lord’s Second Coming, it is once again a result of His *direct* Rule as in the pre-Flood and Flood times when civil governments were not yet authorized to carry out punishments on the wicked.

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Response to Carl Froede on Extraterrestrial Bombardment

I would like to respond to Carl Froede’s recent comments in Panorama of Science, in the March 2002 *CRSQ*. His comments were entitled, “Extraterrestrial Bombardment of the Inner Solar System: A Review with Questions and Comments Based On New Information.” Carl Froede is

an individual I respect very much. Our views differ on some points but are very similar on other points. Dialog on questions about impacts is a constructive activity for creationists. In my view, we are at an early stage of research on the solar system and impacts from space. Thus it is im-

portant to approach the subject with humility as we consider how to explain the solar system and Earth impacts from a young age perspective.

It has been suggested (Froede and DeYoung, 1996) that a planet created in the asteroid region was destroyed in the past shortly before Noah's Flood began and that this caused many impacts in the inner solar system. Froede's review above indicates the basis for there being a planet in the asteroid region is the Titius-Bode Rule (Froede and DeYoung, 1996). I do not believe the Titius-Bode Rule is an indication of intelligent design at all, as Froede states. First of all, it is not the only mathematical rule or algorithm for calculating the distances to the planets. There have been others from solar system researchers, so it is not unique. Secondly, it does not fit all the planets well at all (Baughner, 1988; Roy, 1988). The Titius-Bode Rule is within about 6% of the actual distances out to and including Uranus. But, it is more than 8 Astronomical Units too large for Neptune and it is off by more than 37 Astronomical Units for Pluto! This is not surprising considering that Neptune and Pluto had not been discovered at the time the rule was proposed. In my opinion, the Titius-Bode Rule is not evidence of anything but is merely a coincidence. It is not surprising there would be a rule like this by coincidence, considering there are only nine planets.

Froede argues that the asteroids are the source for impactors for the inner solar system. This may be the case, but I do not think this necessitates proposing a destroyed planet in the asteroid region. There are other possibilities that should be examined. Evidence that impacts on Earth came from source objects in the asteroid region includes the following. First, some Earth impact sites have large amounts of either impact melt sheets or ejecta or both that are high in metal content, such as nickel, iron, and other metals. High metal content in and around astroblesmes on Earth suggests impacting objects similar to known asteroids. The Sudbury impact would be a good example. Also, the composition classes of meteorites seem similar to the composition classes of asteroids. This suggests a possible relationship between meteorites and asteroids. On the other hand, from the form and geometric properties of craters there is no clear way of distinguishing between the impactor being an asteroid or a comet.

Danny Faulkner and I in a joint letter in *TJ* argued against a former planet in the asteroid region (Faulkner and Spencer, 2000). Froede comments that the only objection Faulkner and I have to an asteroidal planet is the time required for the fragments and material from it to clear, given the assumption of a young solar system. This is a potential problem, depending on the scenario, but I feel there are additional problems with the concept of an asteroidal planet from the properties of the asteroids. In my 1994 ICC paper I pointed out something significant regarding the rotation rates of asteroids (Spencer, 1994).

When you examine the relationship between rotation rates of asteroids and their size, there is a curious change at about the 150 km diameter size. From about 150 km to about 250 km diameter, the larger the asteroids are, the faster they rotate. If angular momentum were randomly distributed among fragments from a planet breakup or explosion event, the larger fragments would rotate slower since they have more inertia, proportionally. So the observed rotation pattern for the larger asteroids does not seem to fit collision fragments. The smaller asteroids, on the other hand, exhibit the opposite pattern. The smaller they are the faster they rotate, in general. (Note that in recent years many many more of the smaller asteroids have been discovered and their orbits determined.) This is evidence against a destroyed planet in my opinion. Another important fact about the asteroids is that the asteroids closer to the Sun are in general more dense and those farther from the Sun are less dense. The planets follow a similar pattern. I do not see any reason this pattern would be the result of a destroyed planet. It suggests to me that there are two populations of asteroids. I suspect that the larger ones were created essentially where they are and the smaller ones are collision fragments. There have clearly been many collisions between asteroids and new evidence shows asteroids themselves to be heavily cratered. I believe all this does suggest the asteroids were an important source of impacting objects for the inner solar system, but, I believe this argues against a destroyed planet in what is now the asteroid region.

Froede makes a comment regarding the Oort Cloud and Kuiper Belt as proposed sources for impacting bodies. Froede suggests both the Oort Cloud and the Kuiper Belt are imaginary. The Oort Cloud is certainly unobservable and I agree with Froede that it is probably imaginary. However, the Kuiper Belt should not be so easily dismissed. There are now a number of objects whose orbits have been determined that lie beyond the orbit of Neptune. The first of these was discovered in 1992 and was designated 1992QB1. Though there has been some controversy over methods used to detect some of them, today there may be 20-30 or more of these objects that have been observed. Whether this reflects the number of objects in the Kuiper Belt theory is another question. But there definitely are some known observed objects in the general region considered the Kuiper Belt. These objects may be sources of at least some of the comets. But there are still problems with evolutionary models that propose objects trajectories being modified from the Oort region to the Kuiper region and then to the inner solar system. These so-called Kuiper Belt Objects or KBO's could be essentially a second asteroid belt.

No young-age creationist has yet put forward a model of cratering that is detailed enough have definite predictions that could be tested by observations. I hope that these discussions and further collaborations between creationists

on these issues will help develop such models. Thus far, only general ideas have been put forward and there is a need to furnish details. I agree with Froede that the source or sources of the impacts should be clarified, but in my view there are other fundamental questions that must be addressed first. We must guard against jumping to conclusions too quickly before we have adequately looked at all the relevant data. What are some of the fundamental questions that need answering?

First, it is critical to clarify from observational evidence the number of impacts involved. How many impacts occurred on our Moon and on Earth? The scientific literature publishes widely disparate figures for the number of impacts that have occurred on the Moon. This is surprising considering how much the Moon has been studied. Creationists must reevaluate lunar crater statistics because long age assumptions possibly have led to inflated estimates of the number of impacts. This is an issue I continue to research. I would encourage great caution in accepting estimates of cratering rates and cumulative numbers of impacts for Earth or the Moon.

Other fundamental questions revolve around whether there was one bombardment event or more than one and how long the event or events lasted. I think Earth's cratering record can give us clues as to the duration of the event surrounding the Flood. The Earth impact record, considered in relation to the Flood, suggests an event or events of more than one year duration, at least. This is a valuable clue to what type of mechanisms could have been involved.

Creationists also need to address all of the crater data across the solar system and consider the various patterns of crater distributions on various objects. This has to be considered in relation to celestial mechanics to identify plausible scenarios that could explain cratering in the solar system. All of this needs to be addressed exhaustively before we can have definitive answers on the source of the objects that caused the impacts. Some very large impacts are close to the poles of objects, such as the Aitken impact on the Moon. These kind of impacts would seem unlikely in a destroyed planet scenario considering what we know about most asteroids and comets. On some objects in the outer solar system, craters are very nonuniformly distributed over surfaces. This may suggest catastrophic brief events. For some planetary moons we do not have complete data. Even for Mercury, though it is relatively close, we do not have photographs of the entire surface.

Thus, we have much work to do, but I am glad to see creationists discussing the issues because our goal should be to work together and learn from each other. I agree with Froede that there was a massive bombardment that affected the entire inner solar system. I also agree that if there were impacts during the creation week or prior to Noah's Flood, those craters would have been destroyed in

the violence of the Flood. Considering the number of impacts involved throughout the solar system, it may be valid to say we do not see anything in our solar system that could provide adequate sources of impacting objects. The asteroids are one source of impactors but current impact rates are very low. This is why I believe we should consider the possibility of objects coming from outside our solar system. A cloud or field of solid objects passing through our solar system in the past could cause collisions with asteroids and moons that would lead to impacts for a definite period of time. This is a promising possibility.

Danny Faulkner has suggested a comet bombardment event around the time of the Flood (Faulkner, 1999). One problem with this is that a comet impact, even if it breaks up into a number of fragments, only lasts days or perhaps a few weeks. But the evidence from Earth impacts suggests a longer event, though it could be that the largest impacts occurred in a short time span. Faulkner's approach would require a large number of comets, even considering comets breaking up into fragments as the Shoemaker-Levy comet did. We are left with a similar question again of "Where did the comets come from?" Froede suggests that if there were a comet or meteor swarm four to five thousand years ago at the Flood, that astronomers would be able to observe it today speeding away from Earth presumably. This depends on the scenario. The fact that such is not observed could simply mean that the objects were widely scattered into a variety of trajectories or that they are too small to observe. It is very doubtful that small objects that had traveled away from our Sun for four thousand years would be visible today.

Froede also raises a theological and philosophical issue regarding impacts occurring in the solar system at Creation or thereafter, as Faulkner has proposed. Is it "very good" to have impacts in the solar system around the time of Creation or the Fall? I tentatively agree that impacts at the time of Creation does not seem to naturally fit into a Biblical view of history. But this is an assumption and I would not be dogmatic on the point. God does not always do what seems logical from our perspective. Impacts seem to have been part of God's divine judgment on the Earth in the Flood. But this does not necessarily mean there is any judgment involved in impacts occurring at Creation, if it did not affect any created life forms. Impacts at Creation as Faulkner proposes implies Earth was miraculously protected from impacts at Creation. I do not believe that the Earth has been miraculously protected from impacts. It may also imply a miraculous acceleration of impacts at Creation in order to complete everything quickly, during the six days of Creation. Faulkner's approach implies there would be more impacts around the time of Creation than during the Flood. Distinguishing between two bombardment events (Creation and the Flood) and just one event (at the Flood) may be difficult.

Further research from creationists on radiometric dating techniques and new solar system research may give further clues. Froede comments that new radiometric dating studies of lunar samples and meteorites designates the time (in a relative sense) when the bombardment occurred. Froede suggests taking the uniformitarian scenario as a relative chronology or history of impacts and not an actual history. I am uncomfortable making this assumption, at least until creationists have addressed many aspects of radiometric dating further. I see no clear means of correlating the uniformitarian impact history with either Creation or the Flood, because it is laden with too many questionable assumptions. If it is a relative chronology of impacts, how do we know it does not indicate a bombardment at Creation? However I agree it suggests a bombardment from space in the past with an impact rate greater than the present.

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Book Review

How to Build a Time Machine by Paul Davies
 Penguin Press, London. 2001, 147 pages, \$20

H.G. Wells certainly started something back in 1895 with the publications of his book *The Time Machine*. I write this review during the remake of the film by this name. Over the years a growing number of scientists have come to take seriously the subject of time travel, and many of them are mentioned in this book.

The book is mainly divided into two areas, traveling into the future, and also into the past. At first we are shown on a small scale how strange the concept of time can be. I will give one of my own artificial examples here to illustrate Davies' point. If something of importance happens in New York at 10 p.m. on June 6, England will hear of it at about 4 a.m. on June 7. So, for us you could say it happened in our past. A trip into the future we are told can only happen if we travel close to the speed of light. So if we travel at 99.999 percent of the speed of light we might get to the year 3000 in under 6 months (p.16). The question we could ask, "Is this really time travel?" At the above speed we are safe from the aging process while those that we knew when we started off our journey would have long since gone and a new set of humans would now be living on earth.

The second part of the book involves more of what we would understand about the concept of time travel when we discuss the prospect of traveling into the past. Here we are told that we would need the use of a wormhole (p.105). Davies states that if the first wormhole were created in the year 3000 we could not use it to go back to the year 2000. One cannot go back beyond the time of the creation of the wormhole. To go back to see the Battle of Hastings in 1066 one would need to find a wormhole already in existence at that time. Stephen Hawking has put forward the idea of the *chronology protection conjecture*, which says that the universe has an inbuilt means which prevents us from traveling through time (p.124).

The book is well written and has a number of good illustrations. I am neither for nor against the idea of time travel; the universe already is a truly wonderful albeit strange place. Although the door is not at this stage completely closed to the idea of time travel, there are a number of serious doubts about it. Perhaps time travel is no more than an illusion. Either way, at least for now, the departure lounge for the Battle of Hastings and also viewing the birth of Einstein are not open for business.

Colin Brown

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An original plus two copies shall be submitted to the editor of the *Quarterly*. Manuscripts and illustrations will not be returned to authors, unless accompanied by a self-addressed, stamped envelope. Authors are requested to supply a list of key words for subjects covered in their articles.

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CRSQ: *Creation Research Society Quarterly*. [for multiple *Quarterly* references]

Cockman, Joneen. 1988. Collecting plants for the Creation Research Society Herbarium. CRSQ 24:187–193.

Margulis, Lynn. 1971a. The origin of plant and animal cells. *American Scientist* 59:230–235.

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Book review headings, like references, have a particular style which should be followed. This issue of the *Quarterly* will provide examples.

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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. As part of its vigorous research and field study programs, the Society operates The Van Andel Creation Research Center in Chino Valley, Arizona.

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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 Savior. The act 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.