Creation Research Society

# Q

QUARTERLY

Volume 53 Winter 2017 Number 3

- *Bighorn Basin: Monument to the Flood--Part I*
- *Cratering and the Earth*
- *Founder Events and Post-Flood Diversification*
- *Variable Neutrino Mass, Supernovae, and Accelerated Decay*

V53N3

Q

# Creation Research Society Quarterly

Volume 53
Number 3
Winter 2017

## Articles

Variable Neutrino Mass, Supernovae, and Accelerated Decay ........ 180
Eugene F. Chaffin

Cratering and the Earth: Clues in Lineaments ........ 191
W. R. Barnhart

The Bighorn Basin, Wyoming—Monument to the Flood Part I: The Flooding Stage ........ 206
Michael J. Oard

Founder Events: Foundational in Rapid Post-Flood Diversification ........ 217
Jean K. Lightner and Jon Ahlquist

Minutes of the 2016 Creation Research Society Board of Directors Meeting ........ 225

## Departments

Media Reviews ........ 229

Instructions to Authors ........ 235

Membership/Subscription Application and Renewal Form ........ 237

Order Blank for Past Issues ........ 238

**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*

# Creation Research Society Quarterly

**Volume 53**
**Number 3**
**Winter 2017**

Cover by Michael E. Erkel, Afton, Virginia

Cover image: Dominguez-Escalante National Conservation Area in Colorado's Uncompahre Plateau. Photo by Bob Wick, Bureau of Land Management. Public domain photo.

Design services by Cindy Blandon, cblandon@aol.com

The *Creation Research Society Quarterly* is published by the Creation Research Society, 6801 N. Highway 89, Chino Valley, AZ 86323, and it is indexed in the *Christian Periodical Index* and the *Zoological Record*.

Send papers on all subjects to the Editor: CRSQeditor@creationresearch.org or to Danny R. Faulkner, 1414 Bur Oak Ct, Hebron, KY 41048.

Send book reviews to the Book Review Editor: Don B. DeYoung, 200 Seminary Dr., Winona Lake, IN 46590, dbdeyoung@grace.edu.



ISSN 0092-9166

Printed in the United States of America

*Creation Research Society Quarterly* 2017. 53:180–190.

# Variable Neutrino Mass, Supernovae, and Accelerated Decay

**Eugene F. Chaffin***

## Abstract

The antineutrino flux from radioactive uranium, thorium, potassium-40, etc. on the earth's surface is of the order of $10^6$ antineutrinos per square centimeter per second. The flux of neutrinos from the sun is four orders of magnitude larger. Larger than that would be the cosmic background of neutrinos and the possibility of a nearby supernova. Recent physics literature contains theories in which the neutrino mass is coupled to the neutrino density via a so-called acceleron field. This acceleron field is hypothesized to resemble the Higgs field, and to change strength due to neutrino couplings and variation in neutrino density. The radiocarbon evidence for a nearby supernova is discussed and related to the possibility that such a supernova showered the earth at the time of Noah's Flood. This would contribute to accelerated decay and provide evidence that radioisotope data can be consistent with a biblical timescale.

## Introduction

The RATE project (Vardiman, Snelling, and Chaffin, 2005) identified accelerated decay as a likely contributor to reconciling radioisotope data with a biblical timescale. For some time, possibly at the onset of the Deluge, or Noah's Flood, decay rates were greater than those directly measured in laboratories today. A possible mechanism involves a change in the strong nuclear force, the weak force, or both. Recent physics literature includes studies of the possible variation of the neutrino mass over cosmological time (Fardon et al., 2004; Brookfield et al., 2006a). The variation of the neutrino mass will be related in this paper to the fraction of the decay energy carried away into space by the neutrinos and to possible changes in modes or types of radioisotope decay. Also, Fardon et al. (2004) related the neutrino mass to a hypothetical field called the acceleron field, and this to the neutrino density. If we explore this possibility, it leads us to consider a nearby supernova as a cause for a sizeable increase in neutrino density, and thus to a change in the neutrino mass and furthermore to a change in decay parameters. The neutrino burst from a nearby supernova may have reached Earth at the onset of accelerated decay episodes. In fact, we will see that the radiocarbon record provides evidence for these nearby supernovae (Firestone, 2014).

* Eugene F. Chaffin, Simpsonville, SC, ChaffinEF@aol.com
Accepted for publication May 23, 2017

## Mass of a Particle: Partial Origin from the Weak Force?

English physicist J. J. Thomson (1881) is often credited with the discovery of the electron because of his extensive experiments with beams in cathode ray tubes. Thomson hypothesized the existence of the so-called "electromagnetic mass." As the electron moves through space, it would experience a nondissipative resistance due to the electric and magnetic fields bound up with it. Thomson described this as a contribution to the mass similar to the resistance felt by a sphere moving through a frictionless fluid. Figure 1 shows a cannon being fired underwater. In pushing the water out of the way, the cannonball has inertia that would be experienced even if there were no fluid friction (viscosity). In modern times, we also associate the weak force, the force that causes beta decay, with the electron. Weinberg (1972, p. 388) discussed the electromagnetic mass, stating:

> The idea that electromagnetism is responsible for mass differences within isotopic multiplets, and possibly also for the whole mass of the electron, has historically proved very attractive but not very fruitful.

He went on to discuss the failure of this approach to explain any real data. He stressed that the lesson that emerges from this work is that it is pointless to try to evaluate electromagnetic mass differences without taking weak interactions into account.

Another Nobel Prize winner, Wilczek (2000, p. 13), noted that protons and neutrons are the major contributors to the mass of everyday objects (basketballs, apples, etc.) and that "most of the mass of ordinary matter arises from the energy associated with quark motion and color gluon fields." However, Wilczek agreed with Weinberg that the weak force is also a contributor:

> Most of the mass of ordinary matter, for sure, is the pure energy of moving quarks and gluons. The remainder, a quantitatively small but qualitatively crucial remainder—it includes the mass of electrons- is all ascribed to the confounding influence of a pervasive medium, the Higgs field condensate. (Wilczek, 2000, p. 14)

Wilczek (2006, p. 709) went on to discuss a simplified theory in which heavy quarks are ignored in deference to the lighter "up" and "down" quarks:

> QCD Lite is cooked up from massless gluons, massless u and d quarks, and nothing else. (Now you can fully appreciate the wit of the name.) If we use this idealization as the basis for our calculation, we get the proton mass low by about 10%.
>
> Full-Bodied QCD differs from QCD Lite in two ways. First, it contains four additional flavors of quarks. These do not appear directly in the proton, but they do have some effect as virtual particles. Second, it allows for non-zero masses of the u and d quarks. The realistic value of these masses, though, turns out to be small, just a few percent of the proton mass. Each of these corrections changes the predicted mass of the proton by about 5%, as we pass from QCD Lite to Full-Bodied QCD. So we find that 90% of the proton (and neutron) mass, and therefore 90% of the mass of ordinary matter, emerges from an idealized theory whose ingredients are entirely massless.

Here QCD stands for "Quantum Chromodynamics," the explanation of matter in terms of quarks and gluons, and including a property called "color" because of cogent analogy with the properties familiar to painters. After the discovery of the Higgs boson, credence was given to the idea of the Higgs field pervading all space and to an explanation of mass due to the necessity for particles to move through the Higgs field. However, Wilczek points out that the proton and neutron masses are more due to gluon/quark fields than to the Higgs (see Raya, 2009; Wilczek, 2008). Nevertheless, the weak force does contribute a small amount to the masses of quarks, electrons, and neutrinos. We shall discuss possible variation of the neutrino mass over cosmological time below and shall note that the associated changes in the weak force could also slightly affect the neutron and proton masses.

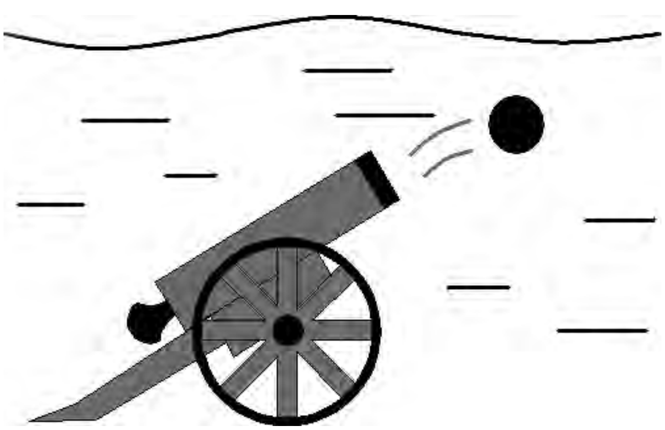


**Figure 1. Firing a cannon under water causes a cannon ball to appear to have a greater inertia than in air. Even if the water had zero viscosity, there would be greater "INERTIA." The Higgs field is postulated to have a non-zero value, even in the vacuum of space far out between the stars. This plays the role of a "perfect fluid." The Higgs particle is an excitation in the Higgs field. It gives mass to other particles.**

## What if the Nuclear Mass Changed?

These slight changes in particle masses could have very important consequences. What if, during accelerated decay, the U-238 beta-minus half-life were to become close to or greater than the alpha decay half-life? Figure 2 shows the nuclei near U-238, in a plot of proton number Z versus neutron number N, illustrating the possible changes. As the proton number Z

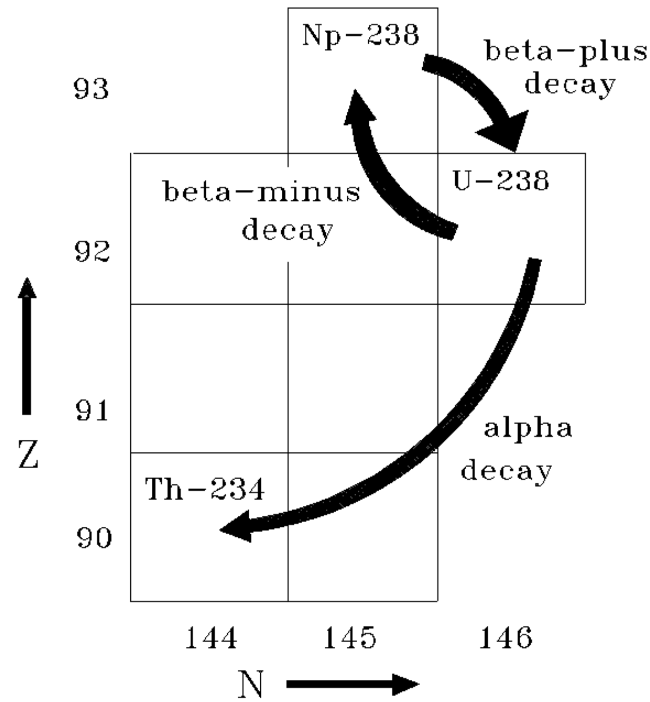



**Figure 2. A portion of the chart of the nuclides, showing the possible decays connecting to U-238. An alpha decay removes an alpha particle, made of two neutrons and two protons, producing Thorium-234. If the U-238 were to undergo beta-minus decay, it would produce Neptunium-238, which has one more proton than U-238 but one less neutron.**

is changed from 92 to 93 to 94, we transition from uranium to neptunium to plutonium. A neutron is changed into a proton, keeping the total particle number at 238. Then an alpha decay of plutonium-238 would change Pu-238 to U-234. Thus, if U-238 were to undergo beta-minus decay, the beta-decay branch would be:

U-238 → Np-238 → Pu-238 → U-234

At this point, the normal decay chain is joined, and the resulting isotopic abundances would be substantially as usual. Uranium-238 is under normal circumstances found to undergo alpha decay, leading to the sequence:

U-238 → Th-234 → Pa-234 → U-234

Thus we end up with U-234, joining the usual decay chain, the same as in the other scenario.

The mass of Np-238 can be deduced from that of Pu-238 given the Np-238 decay energy E = 1.292 MeV (Parrington, et al., 1996).

$$
\begin{aligned}
M_{\text{Np-238}} &= M_{\text{Pu-238}} + E/c^2 \\
&= 238.049553 + 1.292/(931.5) \\
&= 238.049553 + 0.00138701 \\
&= 238.05094 \text{ MeV} \qquad (1)
\end{aligned}
$$

This is slightly greater than the U-238 mass of 238.050785, making beta-decay of U-238 impossible at present (but double beta decay has been seen in data). Energy cannot be created by a spontaneous decay, so U-238 cannot undergo beta-minus decay, at least at present. Accelerated decay might reverse this. The mass of U-238 is less than the mass of Np-238 by 0.000158 atomic mass units. Using $E = mc^2$, this converts to 0.148 MeV, which is very small.

Table I shows the beta-minus half-life and decay energy for the lightest isotope of each element that undergoes beta-minus decay. The average decay energy of these nuclei is 2.13 MeV, so the 0.148 MeV figure mentioned above is small compared to the average nucleus in Table I. This makes it seem likely that a change in the neutrino mass, and the associated change in the weak force, might alter the masses of neutrons and protons, and thus of U-238, and lead to beta-minus decay of U-238.

The value above is confirmed by a Japanese web site: http://wwwndc.jaea.go.jp/cgi-bin/nucltab14?92

93-Neptunium

| | | |
|---|---|---|
| Np-238 | 238.050947876 ± 0.000001983 | $2^+$ |
| U-238 | 238.050789466 ± 0.000002047 | $0^+$ |
| Pu-238 | 238.049561412 ± 0.000001977 | $0^+$ |

The ground state of U-238 has nuclear spin $0^+$, and Np-238 $2^+$. Np-238 undergoes beta-minus decay with a half-life of 2.117 days, and decay energy E = 0.144 MeV. This means that the hypothesized decay of U-238 would be first forbidden just like that of Np-238 and that the half-life should be of the same order of magnitude.

The idea of a forbidden decay was discussed before (Chaffin, 2005, pp. 563–567; Chaffin, 2008, pp. 179–180), and the above change from $0^+$ to $2^+$ or vice versa is a nuclear spin change of 2, signaling a forbidden transition. If the half-life for U-238 decay were to become of the order of two days, that would be long compared to many cases, but still small compared to the nominal alpha decay of U-238 with half-life of 4.47 billion years. Thus a small change in nuclear masses could be equivalent to accelerated decay for U-238.

| Nucleus | beta-minus half-life | Decay Energy (MeV) |
|---|---|---|
| Tritium | 12.32 y | 0.019 |
| He-6 | 807ms | 3.508 |
| Li-8 | 0.840 s | 16.004 |
| Be-10 | 1.5x106 y | 0.556 |
| B-12 | 20.20 ms | 13.369 |
| C-14 | 5715 y | 0.156 |
| N-16 | 7.13 s | 10.419 |
| O-19 | 26.9 s | 4.82 |
| F-20 | 11.0 s | 7.025 |
| Ne-23 | 37.2 s | 4.376 |
| Na-24 | 14.95 h | 5.516 |
| Mg-27 | 9.45 m | 2.610 |
| Al-28 | 2.25 m | 4.643 |
| Si-31 | 2.02 h | 1.492 |
| P-32 | 14.28 d | 1.711 |
| S-35 | 87.2 d | 0.167 |
| Cl-38 | 37.2 m | 4.917 |
| Ar-41 | 1.83 h | 2.492 |
| K-42 | 12.360 h | 3.525 |
| Ca-45 | 162.7 d | 0.257 |
| Sc-46 | 83.81 d | 2.367 |
| Ti-51 | 5.76 m | 2.471 |
| V-52 | 3.76 m | 3.976 |
| Cr-55 | 3.497 m | 2.603 |
| Mn-56 | 2.578 h | 3.695 |
| Fe-59 | 44.5 d | 1.565 |
| Co-60 | 5.271 y | 2.824 |
| Ni-65 | 2.517 h | 2.137 |
| Cu-66 | 5.10 m | 2.642 |
| Zn-69 | 56 m | 0.905 |
| Ga-70 | 21.14 m | 1.656 |
| Ge-75 | 1.380 h | 1.177 |
| As-76 | 26.3 h | 2.962 |
| Se-79 | <6.5x105 y | 0.151 |
| Br-82 | 1.471 d | 3.09 |
| Kr-85 | 10.76 y | 0.687 |
| Rb-88 | 17.7 m | 5.316 |
| Sr-89 | 50.52 d | 1.497 |
| Y-90 | 2.67 d | 2.282 |
| Zr-93 | 1.5x106 y | 0.091 |
| Nb-94 | 2.0x104 y | 2.045 |
| Mo-99 | 2.7476 d | 1.357 |
| Tc-98 | 4.2x106 y | 1.8 |
| Ru-103 | 39.27 d | 0.763 |
| Rh-104 | 42.3 s | 2.441 |
| Pd-107 | 6.5x106 y | 0.033 |
| Ag-108 | 2.29 m | 1.65 |
| Cd-113 | 9x1015 y | 0.316 |
| In-112 | 14.4 m | 0.663 |
| Sn-121 | 1.128 d | 0.388 |
| Sb-122 | 2.72 d | 1.978 |
| Te-127 | 9.4 h | 0.698 |
| I-128 | 25.00 m | 2.118 |
| Xe-133 | 5.243 d | 0.427 |
| Cs-134 | 2.065 y | 2.059 |
| Ba-139 | 1.396 h | 2.317 |
| La-140 | 1.678 d | 3.762 |
| Ce-143 | 1.377 d | 1.462 |
| Pr-142 | 19.12 h | 2.162 |
| Nd-149 | 1.73 h | 1.691 |
| Pm-147 | 2.6234 y | 0.224 |
| Sm-153 | 1.928 d | 0.808 |
| Eu-154 | 8.593 y | 1.968 |
| Gd-159 | 18.5 h | 0.971 |
| Tb-160 | 72.3 d | 1.835 |
| Dy-165 | 2.33 h | 1.286 |
| Ho-166 | 1.118 d | 1.855 |
| Er-169 | 9.40 d | 0.351 |
| Tm-170 | 128.6 d | 0.968 |
| Yb-175 | 4.185 d | 0.47 |
| Lu-176 | 3.78x1010 y | 1.192 |
| Hf-181 | 42.4 d | 1.027 |
| Ta-182 | 114.43 d | 1.814 |
| W-185 | 74.8 d | 0.433 |
| Re-186 | 3.718 d | 1.07 |
| Os-191 | 15.4 d | 0.314 |
| Ir-192 | 73.83 d | 1.46 |
| Pt-197 | 18.3 h | 0.719 |
| Au-198 | 2.6952 d | 1.372 |
| Hg-203 | 46.61 d | 0.492 |
| Tl-204 | 3.78 y | 0.763 |
| Pb-209 | 3.25 h | 0.644 |
| Bi-210 | 5.01 d | 1.163 |
| Rn-221 | 25 m | 1.2 |
| Fr-222 | 14.3 m | 2.03 |
| Ra-227 | 42 m | 1.325 |
| Ac-226 | 1.224 d | 1.116 |
| Th-231 | 1.063 d | 0.39 |
| Pa-232 | 1.31 d | 1.35 |
| U-237 | 6.75 d | 0.519 |
| Np-238 | 2.117 d | 1.292 |
| | | 2.13 |

**Table I. This table shows the lightest isotope that undergoes beta-minus decay for most of the known nuclei. The half-life and decay energy released are shown in columns two and three.**

## The Acceleron Field

A scalar field is a quantity that is defined and may vary from point to point in spacetime, which has no direction. Temperature is an example. Temperature can be negative on some scales but has no direction such as up, down, north, south, east, or west. An electric field is a vector field as opposed to a scalar field, having direction. The electric field is in the direction of the force on a small positive test charge at that point.

The acceleron field is the scalar field discussed by Fardon et al. (2004) and is similar but not the same as the Higgs field as interpreted in inflationary cosmology. It is also not the same as the "quintessence" field used to explain the observed acceleration of the expansion rate of the universe (Caldwell, Dave, and Steinhardt, 1998). The quintessence field is hypothesized to exist everywhere in our universe and to change with position and time in such a way to accelerate the expansion of the universe. It provides a form of so-called "dark energy." The acceleron field, on the other hand, couples to neutrinos and leads to variation of the neutrino mass with position and time.

In discussing a version of inflationary cosmology, Linde (1984) incorporated spontaneous symmetry breaking in gauge theories due to a scalar field, the Higgs field. The potential energy associated with the Higgs field is hypothesized to have a minimum for the case where the Higgs field is nonzero in empty space. The universe is hypothesized to begin with zero Higgs field but to transition to a phase where the Higgs field is nonzero in empty space. This new condition is called the "Higgs condensate." Neutrino physics is drastically changed when this condensate changes. All particles besides the Higgs particle that interact with the Higgs field also change their masses after the symmetry breaking. (See Linde's [1984] equations 2.4, 2.5, 2.6, and following.) Their masses depend on a proportionality constant, called their Yukawa coupling, and would change accordingly if the Higgs field changed.

Peebles (1993, p. 394) discussed the changes that inflationary cosmology has gone through:

> Guth (1981) produced the first fully assembled physical picture for inflation, though his version was imperfect because it assumed inflation ends with a first-order phase transition that creates entropy we observe in the thermal cosmic background radiation (while the CBR in turn produced the baryons). As Sato (1981b) anticipated, this has the problem that the nucleation rate is estimated to be too slow to allow inflation to end, because regions that have completed the phase transition grow in size more slowly than they move apart. This was soon remedied in the pictures developed by Linde (1982, 1983) and Albrecht and Steinhardt (1982), in which the transition from the inflation epoch to the classical Friedmann-Lemaitre model is continuous but rapid enough to produce the necessary entropy.

Ostriker and Steinhardt (2000) discussed the "quintessence" hypothesis, which introduces a quintessence field to explain why the expansion of the universe is accelerating. Quintessence may be translated from Greek as "fifth element." In the ancient Greek philosophy of Aristotle and others, it was suggested that the universe is composed of earth, air, fire, and water, plus an ephemeral substance that prevents the moon and planets from falling to the center of the celestial sphere. Aristotle also wrote many pages about the human soul as being a substance, but that is not our subject here. The term quintessence was reintroduced to refer to a changeable field, not unlike an electrical or magnetic field, that gravitationally repels and thus leads to an acceletated expansion of the universe.

One might ask why these scalar fields should exist? Douglas and Kachru (2007) pointed to the so-called moduli of the compactified extra dimensions of string theory as giving rise to scalar fields. Moduli are parameters present in the description of a shape, whether it be a surface in three dimensions or a collection of connected objects in a multidimensional space. The term "moduli" was introduced by Riemann in the 1850s (Riemann, 1857). A simple example of a modulus would be the radius R of the fifth dimension in Kaluza-Klein theory, discussed by the author in a previous paper

**Figure 3. The Vela supernova remnant. Picture by Harel Boren (Creative Commons Attribution-ShareAlike 4.0).**

(Chaffin, 2000). It is possible for a modulus to vary between different points of spacetime, and such variations are described as a scalar field. Thus, this line of reasoning provides one idea of why there might be scalar fields in physics.

Fardon et al. (2004) adopted an earlier idea of Kawasaki et al. (1991), which considered the neutrino mass as fixed by a Yukawa-type coupling to an extremely light scalar field, the "acceleron field." In their scenario, the neutrino mass would be density dependent. Fardon et al. consider the possibility of "neutrino clouds" inside which the mass of neutrinos would be different. They wrote:

> We consider regions of high neutrino density and find that the most likely place today to find neutrino masses which are significantly different from the neutrino masses in our solar system is in a supernova. The possibility of different neutrino mass in different regions of the galaxy and the local group could be significant for Z-burst models of ultra-high energy cosmic rays. (Fardon et al., 2004, p. 005)

Equations were developed giving the contribution of a neutrino background to the energy density and the dependence of the mass of the neutrino on the density of neutrinos plus antineutrinos. Under some assumptions about the energy density in the universe, the neutrino mass is inversely proportional to the neutrino density. That is, the neutrino mass decreases as the neutrino density increases. Absolute measurement of neutrino masses has yet to be made, but values in energy units of about 0.1 eV have not been ruled out. Fardon et al. (2004) considered the decrease in density that occurs as the universe expands and discussed a scenario in which the neutrino mass is about 0.6 eV at a redshift of about z=1 and 0.15 eV in our local group of galaxies. The neutrino density should decrease due to expansion by a factor of about 8 between z=1 and Earth, but they assumed an overdensity of neutrinos of about 30 in the local group. Other authors (Brookfield et al.,2006a, 2006b; Kawasaki et al., 1991) have considered models in which the neutrino mass *increases* with density, but the Fardon et al. model is more suited to our purposes. In this paper, contrary to the outlook of Fardon et al., we are not particularly interested in whether dark energy exists or not but whether variation of the neutrino mass and neutrino density could lead to accelerated nuclear decay on earth.

## A Nearby Supernova

A nearby supernova decreases the neutrino rest mass by a process described by Fardon et al. (2004). According to this scenario, an increase in neutrino density causes a change in the neutrino mass, which then may lead to further effects. We will explore this possibility below, looking for evidence from the radiocarbon record that energy from a nearby supernova may have reached Earth at the onset of the Genesis Flood. Figure 4 shows an outgoing shell of energy originating from the explosion site shown in part a of the figure. On Earth we do not see or detect the explosion until the expanding shell has time to reach us. In God's plan, accelerated decay may have been triggered by the supernova, or by supernovae if there was more than one. First, however, let us mention another puzzle that may relate to variable neutrino mass.

## Decay Heat

As noted in the RATE book (Vardiman, Snelling, and Chaffin, 2005), the accelerated decay hypothesis suffers from a heat problem. Producing a large amount of radioactive decay in a short time releases enough energy to endanger any life carried on the ark. Humphreys in his chapter provided a mechanism, rapid expansion of space, which serves as a secondary hypothesis for removing decay energy. However, if the uranium were to temporarily switch to beta-minus decay as discussed earlier and the neutrino mass were to decrease, the antineutrinos released in beta-minus decay could carry away a large fraction of the decay energy.

According to Wasserburg et al. (1964, p. 465),

> Data from a wide variety of igneous rock types show that the ratio of potassium to uranium is approximately $1 \times 10^4$. This suggests that the value of K/U $\sim 1 \times 10^4$ is characteristic of terrestrial materials and is distinct from the value of $8 \times 10^4$ found in chondrites. In a model earth with K/U ~ $10^4$, uranium and thorium are the dominant sources of radioactive heat at the present time.

The fraction of the decay heat carried off by the antineutrinos increases as a result of a decrease in neutrino mass. The heat problem is ameliorated. When we consider for simplicity a beta-minus decay in which the electron and antineutrino are emitted in opposite directions, momentum and energy con-

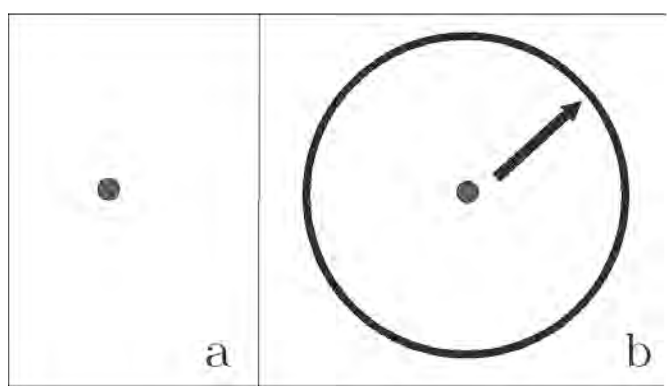



**Figure 4. In part a, the star explodes at some date in prehistory. In part b, the expanding sphere of light and neutrinos has traveled many light-years and eventually reaches Earth.**

servation can be used to show that the ratio of kinetic energies of the antineutrino to the electron is given by the ratio of the electron mass divided by the antineutrino rest mass. Hence, if the antineutrino mass decreases, then the antineutrino carries off more of the decay energy. Since antineutrinos have such small likelihoods of interaction, a large amount of the decay energy is carried off into space. Nuclei like U-238, which are alpha emitters, may become beta-decay nuclei during the accelerated decay. Acceleration of alpha decay may, in part, seem to occur when actually a branching to beta-decay was the actual reason, and as a by-product antineutrinos can carry off a large amount of decay heat.

## The Fardon *et al.* Theory

Fardon et al. (2004, p. 005) wrote:

> We derive a model independent relation between the neutrino mass and the equation of state parameter of the neutrino dark energy, which is applicable for general theories of mass varying particles. *The neutrino mass depends on the local neutrino density.* (Italics added)
>
> We also consider the cosmology of and the constraints on the "acceleron", the scalar field which is responsible for the varying neutrino mass.

They cite a paper by G. W. Anderson and S. M. Carroll (1997), which attempted to match the ages of globular clusters with the age of the universe using time-dependent mass. In discussing this scenario, Anderson and Carroll (1997, page 1) wrote:

> The particle mass is generated by the expectation value of a scalar field which does not have a stable vacuum state, but which is effectively stabilized by the rest energy of the ambient particles. As the universe expands, the density of particles decreases, leading to an increase in the vacuum expectation value of the scalar (and hence the mass of the particle). The energy density of the coupled system of variable-mass particles ("vamps") redshifts more slowly than that of ordinary matter. Consequently, the age of the universe is larger than in conventional scenarios.

Fardon et al. (2004) developed equations for the contribution of a neutrino background to the energy density and for the dependence of the mass of the neutrino on the density of neutrinos plus antineutrinos. Under certain assumptions, they found that the neutrino mass is simply inversely proportional to the neutrino density. In their theory, there is background of neutrinos left over from the big bang. Since the density cannot be lower than that of the background, neutrinos in a region dominated by this background have the heaviest mass possible. Thus, the presence of a uniform neutrino background density will lead to an effective potential that prevents the neutrino mass from becoming too large, leaving a homogeneous negative pressure fluid in the universe, a form of dark energy. Fardon et al. (2004) used the concept of a "sterile neutrino," a neutrino that interacts with ordinary matter only through gravity and makes itself known by oscillating (changing) into the ordinary electron, muon, and tau neutrinos. However, it is not necessary to follow their scenario in that respect, since they were concerned with explaining "dark energy" and we are not.

Schrempp (2007, p. 39) discussed these scalar fields and how they could cause a variation in neutrino mass with position in spacetime due to the variation in the scalar field with position and time. In quantum theory, we say that the neutrino masses $m_i$ (the index i is 1, 2, or 3, depending on which type of neutrino, electron neutrino, muon neutrino, or tau neutrino we refer to) are generated from the vacuum expectation value (which in quantum mechanics is a mathematical average obtainable if we know a particle's wave function) of the scalar field $\phi$ and become functions of $\phi$, $m_i(\phi)$, i = 1, 2, 3. On the other hand, the dependence of $m_i$ on $\phi$ turns the neutrino energy densities $\rho_i$ into implicit functions of $\phi$, since the energy densities $\rho_i(m_i(\phi))$ depend on the masses $m_i(\phi)$, i = 1, 2, 3.

On Earth, neutrinos are measured coming from the sun. The most numerous solar neutrinos are the pp neutrinos, with energies of order 0.1 MeV and a flux on Earth of $6\times10^{10}$ $cm^{-2}s^{-1}$ (Bahcall, 1989). Since they travel at the speed of light, we can find the density of these neutrinos as:

$$(6x10^{10}\ cm^{-2}\ s^{-1})/(3x10^{10}\ cm/s) = 2\ cm^{-3} \quad (2)$$

This is smaller than the background density that Fardon et al. assume to be about 100 per cubic centimeter. On page 12 of their paper, Fardon et al. (2004) stated: "In core collapse supernovae, the early neutrino number density can reach $10^{35}$ $cm^{-3}$."

Gando et al. (2011) considered the antineutrinos produced by uranium, thorium, and potassium inside the earth, finding it to be around $4.3x10^6$ $cm^{-2}$ $s^{-1}$ and the total active geoneutrino flux including all flavors as $7.4^{+2.1}_{-1.9} \times 10^6$ $cm^{-2}$ $s^{-1}$. Note that the geoneutrino flux is four orders of magnitude less than the solar neutrino flux, but this may not hold during accelerated decay.

Thus, to give a contribution to the neutrino density comparable to that of the cosmic neutrino background (100 $cm^{-3}$), the earth's radioactive neutrino flux at the earth's surface would have to increase to a factor of 100 more than the present solar neutrino flux and a factor of $10^6$ more than the present geoneutrino flux. This is thus comparable to the increase we would expect during our hypothesized accelerated decay episode. In the RATE book (Vardiman, Snelling, and Chaffin, 2005, p. 742), it was concluded: "The physical presence of high levels of He in these U-rich zircons, given the measured He diffusion rate in zircon, is a strong argument that 1.5 billion years worth of U decay, at presently measured rates of U decay, has actually occurred within the last 6000 years." Hence the RATE findings are consistent with a significant change in neutrino masses and associated parameters and will remain so should the Fardon et al. theory survive future experimental and observational tests. However, we still need to consider whether the increased flux from a nearby supernova might also be involved. Before returning to the neutrino flux from a supernova, we first need to discuss the evidence that nearby supernovae have occurred.

## Radiocarbon Evidence for a Nearby Supernova

The light from the first historically recorded supernova event arrived in AD 185 (Damon et al., 1995). However, according to Damon et al., it occurred at a distance of more than 6000 light-years. DeYoung (2008) discussed the crab nebula, the remnant of a supernova observed on Earth in AD 1054. Davies (1994, 2007) has been studying supernova remnants and relating their age to the biblical time frame. Evidence for prehistoric supernovae exists. Firestone (2014) discovered that the radiocarbon record can be used to reveal numerous other supernova candidates that occurred less than 1000 light-years from Earth.

Firestone (2014, p. 29) identified evidence:

> Four supernovae (SNe), exploding ≥ 300 pc from Earth, were recorded 44, 37, 32, and 22 kyr ago in the radiocarbon ($^{14}C$) record during the past 50 kyr. . . . SN22kyrBP [the supernova of 22 kiloyears Before Present], is identified as the Vela SN that exploded 250 ± 30 pc from Earth. These SN are confirmed in the $^{10}Be$, $^{26}Al$, $^{36}Cl$, and NO−3 geologic records.

Here a parsec (pc) is 3.26 light-years.

Evidence from the radiocarbon record is as follows. Explosions of near-Earth supernovae will deposit gamma-ray energy onto Earth by producing $^{14}C$ and other cosmogenic isotopes that are subsequently recorded in Earth's geological record. This suggests that Earth and its atmosphere can quantitatively record the cosmic gamma ray emission following nearby supernova explosions.

Damon et al. (1995) recorded that an increase of 0.61 ± 0.16% in tree ring radiocarbon followed the explosion of SN1006, which occurred 1.56 kiloparsecs from Earth.

Libby, the inventor of radiocarbon dating, originally assumed that the radiocarbon abundance, $^{14}C/C$, in living organisms was always constant so that the age of a fossil could be calculated simply by measuring the amount of $^{14}C$ remaining following its death and the subsequent decay since then. It soon became apparent, when comparing with alternate dating methods such as tree rings, that $^{14}C/C$ was much larger in the past. Recent dates are not altered, only very old ones. To accurately date older samples required the direct determination of earlier radiocarbon abundance *calibration* data in order to accurately date fossils. Firestone (2014) cited papers published in the journal *Radiocarbon* to establish this calibration (Reimer et al., 2002, 2003, 2009).

Firestone wrote: "The higher $^{14}C/C$ ratio indicates that the cosmic ray rate striking the atmosphere was larger at earlier times. . . . For example, a significant increase in global radiocarbon might be expected to occur following the explosion of the Vela supernova 250 ± 30 parsecs from Earth (Cha et al. 1999)" (Firestone, 2014, p. 30). Figure 5 shows a graph of the carbon-14 excess versus the date before the present. The excess radiocarbon, $\Delta^{14}C(\%)$ is the difference between the actual C-14 abundance and a standard; on the original relative normalization scale, $\Delta^{14}C(\%)$ was set equal to 0.0 for 1950. The figure, drawn after Firestone's figure, has peaks on it that are interpreted as excess carbon-14 produced when gamma-rays

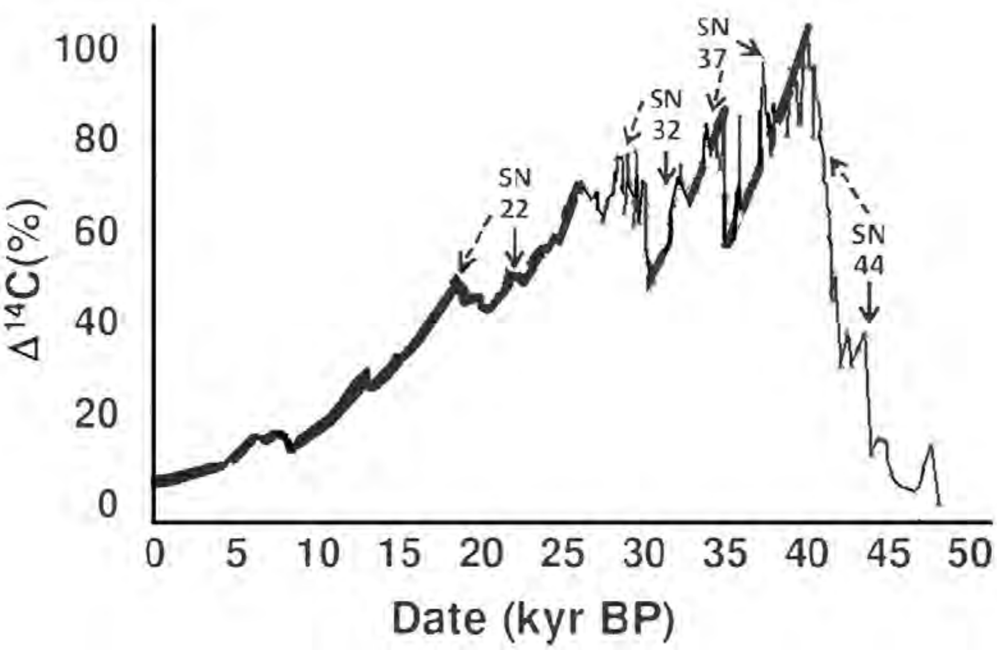



**Figure 5. A graph of the excess Carbon-14 versus date before present. Drawn after Firestone (2014).**

from a nearby supernova reached Earth. Firestone interpreted the 22 kiloyears before the present peak as the result of the Vela supernova. The remnant from this supernova is shown in Figure 3. However, more pronounced earlier peaks are shown at 32, 37, and 44 kiloyears before the present.

How does this fit into a young-earth scenario? Tabulated radiocarbon dates published in *Science* and *Radiocarbon* (up to 1970) led Whitelaw (1970) to a date for the Flood of about 5000 years before present (BP), corresponding to a published date of 5900 years BP. Also, published dates of 19,100 years and older would actually correspond to 6500 BP to Creation at 7000 BP, as show in the curve of Whitelaw's Figure 2. Whitelaw was professor of nuclear and mechanical engineering at Virginia Tech and a contemporary of Henry Morris.

Thus the 22,000-year date associated with the Vela supernova remnant would correspond to an actual date just over 6500 years, at least 1500 years before the Flood. However, there may be enough uncertainty in the 22,000-year date to allow it to correspond to the Flood. Also, Whitelaw did not consider the possible effects of accelerated decay in constructing the calibration curve. Hence, one does not have to accept Firestone's absolute dates. However, the relative ordering is definitely significant.

Firestone adopted the calibration of the IntCal working group (Reimer et al., 2002, 2003, 2009). He wrote, "The date of SN22kyrBP is consistent with the age of the Vela SN" (Firestone, 2014, page 31). Although there are other opinions for the Vela pulsar age present in the astronomy professional literature, we need not accept any of them since we follow Whitelaw's arguments cited above.

The data shown in Figure 5 were known to Godwin (1962) and are not new, but Firestone's interpretation in terms of nearby supernovae is new and seems to fit the facts better.

## Neutrino Flux from Supernovae (Again)

Neutrino fluxes from the 1987 Large Magellanic Cloud event, SN1987A, were measured by Hirata et al. (1987) and Bionta et al. (1987). SN 1987A was a supernova in the outskirts of the Tarantula Nebula in the Large Magellanic Cloud (a nearby dwarf galaxy). It occurred approximately 51.4 kiloparsecs (168,000 ly) from Earth. This was close enough that it was easily visible to the naked eye and could be seen from the Southern Hemisphere. The light from the new supernova reached Earth on February 23, 1987. As the first supernova discovered in 1987, it was labeled "1987A." It was the first opportunity for modern astronomers and experimental neutrino physicists to study the development of a supernova in great detail, and its observations have provided much insight into core-collapse supernovae. Since we have the neutrino data of Hirata et al. and Bionta et al., we do not have to concern ourselves with uncertainties in the theory, since we have observational data.

Hirata et al. (1987, p. 1493) wrote: "In supernovae of Type II almost all of the gravitational binding energy of the resultant neutron star, ~3x10$^{53}$ ergs, is radiated within a few seconds in the form of 10$^{58}$ neutrinos of all flavors with average energy in the vicinity of 10–15 MeV."

From this we may calculate the flux at any given radius from the center, although an oversimplified assumption of isotropic emission (which does no harm for an order of magnitude calculation) is made.

$$1 \text{ light-year} = (2.9979\text{x}10^{10} \text{ cm s}^{-1})(3600\text{x}24\text{x}365.25) =$$

$$= (2.9979\text{x}10^{10} \text{ cm s}^{-1})(3.15576\text{x}10^{7} \text{ s}) = 9.46\text{x}10^{17} \text{ cm}$$

$$\text{Flux} = (10^{58} \text{ neutrinos})/[(4\pi r^2)(10 \text{ s})]$$

$$= (10^{58} \text{ neutrinos})/[(4\pi \text{ x } 8.949\text{x}10^{35} \text{ cm}^2)(10 \text{ s})]$$

$$= 8.89\text{x}10^{19} \text{ neutrinos}/(\text{cm}^2 \text{ s}) \qquad (3)$$

Bionta et al. (1987, p. 1496) wrote:

> When corrected for dead-time and trigger losses, our observation corresponds to 22 events in the 6-s interval. If we assume, for simplicity, monoenergetic 32-MeV $\bar{\nu}_e$'s interacting via inverse beta decay on free protons with a cross section of 8x10$^{-41}$ cm$^2$, this corresponds to a total flux of 8x10$^8$ cm$^{-2}$. The total neutrino output from the supernova is then 3x10$^{56}$ corresponding to a luminosity of $\bar{\nu}_e$ of 1x10$^{52}$ ergs above our threshold; the flux and luminosity have an estimated uncertainty of a factor of 2.

Bionta et al. referred to a "total flux of 8x10$^8$ cm$^{-2}$." This is actually the flux integrated over time. The flux at Earth is thus (8x10$^8$ cm$^{-2}$ )/(6 s) = 1.3 x10$^8$ cm$^{-2}$ s$^{-1}$

The 1987A supernova was at a distance of 168,000 light-years. Therefore, the emissions will be spread over a spherical area of 4πr$^2$, where r is the distance.

$$(3\text{x}10^{56})/(4\pi\ (9.46\text{x}10^{17} \text{ cm})^2) = 2.66\text{x}10^{19} \text{ cm}^{-2}$$

$$(2.66\text{x}10^{19} \text{ cm}^{-2})/(6 \text{ s}) = 4.45\text{x}10^{18} \text{ cm}^{-2} \text{ s}^{-1} \qquad (4)$$

This is the flux at 1 light-year. At Earth, the inverse square law reduces this value considerably due to the huge distance involved. The flux is reduced by (168,000)$^2$. Thus, it is 1.58x10$^8$ cm$^{-2}$ s$^{-1}$. Multiplying by 6 seconds gives 9.46x10$^8$ cm$^{-2}$, which is in substantial agreement with Bionta et al.'s 8x10$^8$ cm$^{-2}$.

The 22 events in a 6-second interval could be consistent with this, depending on the density and cross section in the detector. Here we use cgs (centimeter-gram-second) units in order to compare with the figures given in those units in the Bionta et al. (1987) and other papers.

We have already seen earlier in this paper that the solar pp flux on earth is $6\times10^{10}$ $cm^{-2}s^{-1}$ and that to be effective the flux on Earth must be a factor of 100 more than this, so it must be at least $6x10^{12}$ $cm^{-2}s^{-1}$. Thus Bionta et al. 's (1987) value $4.45x10^{18}$ $cm^{-2}$ $s^{-1}$ can be effective for a candidate supernova provided that:

$$4.45x10^{18}\ cm^{-2}\ s^{-1}/r^2 > 6x10^{12}\ cm^{-2}\ s^{-1},\ \text{thus}$$

$$r^2 < 7.42x10^5 \text{ or } r < 861 \text{ light-years}$$

$$(\text{or } 861/3.26 = 264 \text{ parsecs}). \quad (5)$$

Thus, the Vela SN that exploded 250 ± 30 pc from Earth is marginally within this limit, but a closer one (possibly SN44 kyr) would be better.

## Conclusion

Thus, we find that it is possible that these few supernovae would have sent out neutrinos that reached Earth at the time of the Genesis Flood and could have triggered a change in neutrino mass. This in turn would be associated with accelerated decay. The possible change in neutrino mass still needs to be confirmed experimentally.

## Acknowledgment

Thanks to Dr. Ron Samec for answering my email and for his comments about the Vela supernova remnant. I also thank two unknown reviewers for their diligent consideration of this paper.

## References

Anderson, G.W., and S.M. Carroll. 1997. Dark matter with time-dependent mass. arXiv:astro-ph/9711288. https://arxiv.org/abs/astro-ph/9711288.

Bahcall, J.N. 1989. *Neutrino Astrophysics*. University Press, Cambridge, UK.

Bionta, R.M., *et al.* 1987. Observation of a neutrino burst in coincidence with supernova 1987A in the Large Magellanic Cloud. *Physical Review Letters* 58:1494–1496.

Brookfield, A.W., C. van de Bruck, D.F. Mota, and D. Tocchini-Valentini. 2006a. Cosmology of mass-varying neutrinos driven by quintessence: theory and observations. *Physical Review* D 73: 083515.

Brookfield, A.W., C. van de Bruck, D.F. Mota, and D. Tocchini-Valentini. 2006b. Cosmology with massive neutrinos coupled to dark energy. *Physical Review Letters* 96: 061301.

Caldwell, R.R., R. Dave, and P.J. Steinhardt. 1998. Cosmological imprint of an energy component with general equation of state. *Physical Review Letters* 80(8): 1582–1585.

Cha, A.N., K.R. Sembach, and A.C. Danks. 1999. The distance to the Vela supernova remnant. *Astrophysical Journal Letters* 515: L25-L28.

Chaffin, E.F. 2000. A mechanism for accelerated radioactive decay. *Creation Research Society Quarterly* 37:1–7.

Chaffin, E.F. 2005. Accelerated decay: theoretical considerations. In Vardiman, L., A.A. Snelling, and E.F. Chaffin (editors), *Radioisotopes and the Age of the Earth: Results of a Young-Earth Creationist Research Initiative*, pp. 525–586. Institute for Creation Research, El Cajon, CA and Creation Research Society, Chino Valley, AZ.

Chaffin, E.F. 2008. Studies of the dependence of nuclear half-lives on changes in the strength of the nuclear force. In A.A. Snelling (editor), *Proceedings of the Sixth International Conference on Creationism*, pp. 179–192. Creation Science Fellowship, Pittsburgh, PA, and Institute for Creation Research, Dallas, TX.

Damon, P.E., D. Kaimei, G.E. Kocharov, I.B. Mikheeva, and A.N. Peristykh. 1995. *Radiocarbon* production by the gamma-ray component of supernova explosions. *Radiocarbon* 37:599–604.

Davies, Keith. 1994. The distribution of supernova remnants in the Galaxy. In Walsh, Robert E. (editor), *Proceedings of the Third International Conference on Creationism*, pp. 175–184. Creation Science Fellowship, Pittsburgh, PA.

Davies, Keith. 2007. The range of sizes of Galactic supernova remnants. *Creation Research Society Quarterly* 43:242–250

DeYoung. D.B. 2008. The crab nebula. *Creation Research Society Quarterly* 43:140–146.

Douglas, Michael R., and Shamit Kachru. 2007. Flux compactification. *Reviews of Modern Physics* 79:733–796.

Fardon, R., A.E. Nelson, and N. Weiner. 2004. Dark energy from mass varying neutrinos. *Journal of Cosmology and Astroparticle Physics* 10 (2004): 005. astro-ph/0309800.

Firestone, R.B. 2014. Observation of 23 supernovae that exploded < 300 pc from Earth during the past 300 kyr. *Astrophysical Journal* 789:29–40.

Gando, A., et al. (The KamLAND Collaboration). 2011. Partial radiogenic heat model for Earth revealed by geoneutrino measurements. *Nature Geoscience* 4:647–651.

Godwin, H. 1962. Half-life of radiocarbon. *Nature* 195:984.

Hirata, K., et al. (KAMIOKANDE-II Collaboration). 1987. Observation of a neutrino burst from the supernova SN1987a. *Physical Review Letters* 58:1490–1493.

Kawasaki, M., H. Murayama, and T. Yanagida. 1991. Neutrino dark matter with a galactic-range new force. *Modern Physics Letters* A 7:563–570.

Linde, A.D. 1984. The inflationary universe. *Reports on Progress in Physics* 47:925–986.

Ostriker, J.P., and P.J. Steinhardt. 2000. The quintessential universe. *Scientific American* 284:46–52.

Parrington, J.R., H.D. Knox, S.L. Breneman, E.M. Baum, and F. Feiner. 1996. *Nuclides and Isotopes; Chart of the Nuclides, 15th Edition.* Knolls Atomic Power Laboratory, Schenectady, NY.

Peebles, P.J.E. 1993. *Principles of Physical Cosmology.* Princeton University Press. Princeton, NJ.

Raya, A. 2009. The origin of mass. Letures given at the XIII Mexican School on Particles and Fields, Sonora, Mexico, Oct. 2–11, 2008. arXiv:0902.1791v1. available at arXiv.org.

Reimer, P.J., K.A. Hughen, T.P. Guilderson et al. 2002. Preliminary report of the first workshop of the INTCAL04 calibration/comparison working group. *Radiocarbon* 44:653–651.

Reimer, P.J., M.G.L. Baillie, E. Bard, et al. 2003. INTCAL04 terrestrial radiocarbon age calibration, 0–26 cal kyr BP. *Radiocarbon* 46:1029–1058.

Reimer, P.J., M.G.L. Baillie, E. Bard, et al. 2009. INTCAL09 and MARINE09 radiocarbon age calibration curves, 0–50,000 years cal BP. *Radiocarbon* 51:1111–1150.

Riemann, B. 1857. Theorie der Abel'schen Functionen. *Journal für die reine und angewandte Mathematik* 57:115–155.

Schrempp, L. 2007. Neutrinos and dark energy. Unpublished doctoral dissertation, Universität Hamburg, Hamburg, Germany.

Thomson, J.J. 1881. On the electric and magnetic effects produced by the motion of electrified bodies. *Philosophical Magazine* 11:229–249.

Vardiman, L., A.A. Snelling, and E.F. Chaffin (editors). 2005. *Radioisotopes and the Age of the Earth: Results of a Young-Earth Creationist Research Initiative.* Institute for Creation Research, El Cajon, CA, and Creation Research Society, Chino Valley, AZ.

Wasserburg, G.J., G.J.F. MacDonald, F. Hoyle, and W.A. Fowler. 1964. Relative ccontributions of uranium, thorium, and potassium to heat production in the earth. *Science* 143 (3605): 465–467.

Weinberg, S. 1972. Electromagnetic and weak masses. *Physical Review Letters* 29:388–392.

Whitelaw, R.L. 1970. Time, life, and history in the light of 15000 radiocarbon dates. *Creation Research Society Quarterly* 7:56–71, 83.

Wilczek, F. 2000. Mass without mass II: the medium is the mass-age. *Physics Today* 53(1): 13–14.

Wilczek, F. 2006. The origin of mass. *Modern Physics Letters* A21(9): 701–712.

Wilczek, F. 2008. *The Lightness of Being: Mass, Ether, and the Unification of Forces.* Basic Books, New York, NY.

# Call for Research Proposals in Flood Geology

The Creation Research Society is issuing a call for research proposals in Flood Geology. Grants will be awarded in amounts of up to about $5,000 until all monies are exhausted. The proposal application and budget forms can be downloaded from the CRS website or can be requested from the Society at crsvarc@crsvarc.com. Deadline for submission of proposals is December 31, 2017.

The following topics will be given highest priority:

A) Flood hydrology, which could include the potential sources of Floodwater, the effects of water on sedimentation, and other hydrogeological and/or hydrothermal effects.

B) Depositional studies of massive fossil beds, rapid cementation, and rapid fossilization (including taphonomy studies) at rates not observed in the present.

C) Post-Flood catastrophism, which could include effects of the Ice Age, studies of landslides and geologic instability, and erosion during and immediately after Flood drainage.

D) Climate change during the Flood and models of atmospheric changes that may have occurred from the pre-Flood world to the post-Flood world.

E) Asteroid/meteorite activity as part of the Flood and any possible connection to the cause of the Flood.

F) Studies of Flood tectonics and structural geology, including crustal and mantle research, and causes of basement uplift, subsidence, and thin-skinned tectonism.

Creation Research Society Quarterly 2017. 53:191–205.

# Cratering and the Earth: Clues in Lineaments

W. R. Barnhart*

## Abstract

Lineaments are a well-recognized landform. They have been connected with basement shear zones that affect topography. Using satellite mapping, I examine circular lineaments, which show defined centers and concentric expressions at the surface. They are expressed geomorphically in both raised and lowered zones of elevation. Symmetry, repetition, and regularity can be used to discriminate lineaments from random features. Circular lineaments at Unaweep Canyon and the TONCK Structure are mirrored by topographic and gravity anomalies that display the physics of shock and release waves produced by impacts. It is possible that these features were produced by impacts, and that this hypothesis may allow a better interpretation of landforms.

*Note from the Editor*:
*This paper is sure to be controversial. The author brings up some important issues, such as impacts and lineaments. I encourage further discussion on the topics the author raises.*

## Introduction

With the first release of satellite images to research institutions in 1972, the NASA symposium of 1973 had a majority of the papers centered on lineaments (Short, 1973). In 1977, Norman and Chukwu-Ike published "The World Is a Bit Cracked," recognizing large circular lineament in Africa and South America. Saul (1978) published "Circular Structures of Large Scale and Great Age at the Earth's Surface," concerning circular lineaments in Arizona. Byler (1983) presented a paper, "Circular Structures of Earth," concerning over a hundred circular lineaments he had mapped over North America. Burgener (2013) published "Massive Impact Craters and Basins on Earth: Regarding the Amazon as a 3500 km Multi Ring Impact Basin."

Daubree (1879) noted sections of coastlines that were parallel or concentric across the Atlantic. Similar patterns were mapped worldwide by De Kalb (1990). Lapworth (1892) mapped parallel elements in the dendritic paths of European rivers, as did Twidale (2004) in Australia. Hobbs (1904, 1911) noted significant patterns of lines on Earth's surface, and in 1911 first used the term "lineaments" to label these forms.

During the years before and in between, published maps of various specific areas were filled with traced lines of linears—short lineaments—traced from topographic features or gravity anomalies that show no clear pattern at a small scale but often show discernable straight or curvilinear patterns at larger scales. Lineaments are now such a part of geology that Gay (2012, p. 3) stated, "To not attempt to understand lineaments is to ignore one of the most common and basic features in geology."

Gay (2012) shows a direct relationship between mapped linears and lineaments in the Paradox Basin of Utah and the mapped crest of the Comb Monocline, which steps from one linear to another. He quoted Kelly and Clinton, field geologists with the USGS, who stated that the monocline exhibited "straight line segments with corners" that matched crossings of the linears, and then concluded: "On cratons, joints, linears and lineaments, as well as fractures and faults, result from reactivation of pre-existing faults/shear zones in the underlying Precambrian

* W. R. Barnhart, Pismo Beach, CA, shinumonow@gmail.com
Accepted for publication April 5, 2017

basement" (Gay, 2012, pp. 6, 10), a conclusion supported by Kreis and Kent (2000) and Penner and Cosford (2006).

A *lineament* is a mappable "simple or composite feature of a surface, the parts of which are aligned in a rectilinear or slightly curvilinear relationship, and which differs distinctly from the pattern of adjacent features and presumably reflects a subsurface phenomenon" (O'Leary and Friedman, 1978, quoted in Tiren, 2010). This definition was derived in the context of satellite imagery. Interpretation begins with recognition of short segments, called linears, each tracing a single topographic element. Linears stand out by contrast with the surrounding patterns. Geologists believe that lineaments reflect deep structural and tectonic features, and this is often validated by comparison with gravity and magnetic maps. Two types are described: rectilinear and *slightly* curvilinear (O'Leary and Friedman, 1978, quoted in Tiren, 2010). Lineaments inferred from *strongly* curvilinear elements form arcs or even circular patterns, depending on the scale used. This paper will focus on the recognition of *strongly* curvilinear lineaments, typically at a regional scale.

Scale and perspective are crucial to interpreting lineaments from satellite imagery. Inferred lineaments must be seen at various scales, and patterns are clarified by zooming in or out. Details of linears require closer views; gross features require more distance. An interpreter must take all the information, comprehend it at each level, and incorporate it with a regional picture (Appendix). It is possible that some features will be understood only at a global scale.

## Impact Features: Earth vs. Celestial Bodies

Recognizing large-scale features depends on the height of the view and the portion of Earth's surface seen. Additional perspective can now be gained from our solar system. Other rocky bodies, such as the Moon, Mars, and Venus, show very high concentrations of surface impacts relative to Earth. Osinski and Pierazzo (2013, p. 1) note, "Meteor impact structures are one of the most common geological land forms on all the rocky terrestrial planets, except Earth." Less than 200 impact craters have been confirmed by the Earth Impact Database (2016). Part of this is attributed to soil and vegetation cover, erosion, and sedimentation, but the *recognition of lineaments can help find many of these*.

Finding patterns in Earth's landscapes has long been the goal of many, despite the lack of clarity. We are like Galileo (2004), who mapped the Moon's surface, observing mountains surrounding circular forms. He called them "protuberances and hollows" (p. 8a) or "prominences and depressions" (p. 9b) or "summits and cavities" (p. 10b). He compared them to Earth's valleys and mountains, but recognized the unique circularity of Moon's "cavities," "perfectly round and circular, as sharply defined as if marked out with a pair of compasses" (p. 12b) and later assigned them the name "crater," for the larger Greek cuplike bowl, a krater.

Many authors (Table I) have traced curved linears that combine to suggest circular lineaments; some extend to complete circles. This paper will do the same for two examples and argue that they are the result of impacts.

## History of Lineament Studies

John Tuzo Wilson (1962), an early advocate of plate tectonics, saw two basic orientations of mountains. The first was circum-Pacific, extending from the extreme southern tip of South America through North America in an arc through Alaska, Siberia, Mongo-

| Year | Author | Location |
|---|---|---|
| 1973 | Gintov | Ukraine |
| 1977 | Ramberg et al | Norway |
| 1977 | Norman and Chukwu-Ike | Africa, South America |
| 1977 | Norman et al | World Wide |
| 1977 | Van de Graaff et al | Australia |
| 1978 | Glukhovskiy | Siberia |
| 1978 | Saul | United States |
| 1979 | Eggers | New Zealand |
| 1981 | Moralev and Glukovskiy | Baltic and Siberia |
| 1984 | Witschard | Australia |
| 1987 | Byler | United States |
| 1998 | Kutina | South Africa |
| 2004 | Twidale | Australia |
| 2011 | Papadaki et al. | Crete, Greece |
| 2013 | Seleem | Sinai, Egypt |

**Table I. A date-ordered list of papers suggesting a significance to straight (megashears) and circular (craters) lineaments. Assembled largely from Twidale (2007) with many additions.**

lia, China, and Indonesia. The other ran roughly concentric to the equator through southern Europe, south of the Black Sea, north of the Persian Gulf and India, through Indochina, and into Indonesia. Though linear on a global scale, Wilson saw that they were composed of arcuate segments. Neither of those trends corresponded with megashears, yet they showed the reality of small-circle and arcuate lineaments. Wilson also observed that "many young mountain ranges and island chains are arcuate in plan and that the dominate sense of over thrusting or structural vergence is in the convex direction of the arc" (Hoffman 2014, p. 201). This influenced his tectonic views of colliding fore arcs or island arcs (DeCourten, 2015).

A major problem with lineaments has always been the human factor; some individuals can see the patterns, even using them to find ore deposits or other economic minerals, yet other scientists cannot. Saul, a proponent of circular lineaments being craters, related a lecture where a well-known scientist told him: "It was fascinating, absolutely fascinating, wonderful stuff… *of course it can't be true*" (Saul, 2015, p. 59).

Others disagree (Burgener, 2013; Norman et al. 1977; Saul, 2015) but explain them primarily in the context of plate tectonics (e.g., Burgener, 2013; Byler, 1987; Neev et al. 1982; Norman and Chukwu-Ike, 1977). If any of these features are impacts, we should find craters at the centers of these features. Saul (2015) and Norman and Chukwu-Ike (1977) both suggested that the paucity of obvious craters is caused by collision and overthrusting. However, understanding geological expression depends on knowing the mechanics of cratering.

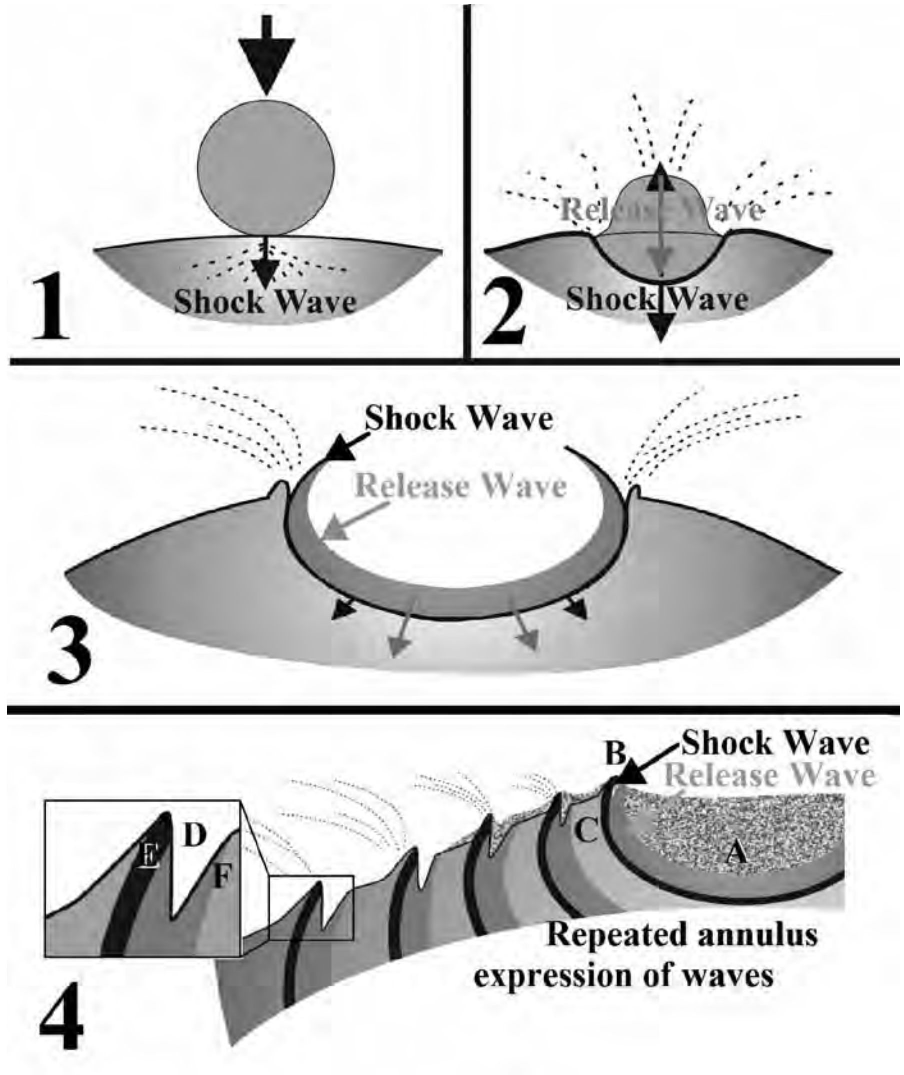



**Figure 1. Diagram of an impact. (1) Impactor strikes the surface of the earth, and speed and mass are converted to work as a shock wave starts to penetrate into the substrate. (2) Energy is reflected back into the impactor, vaporizing it. (3) This produces the release/rarefaction wave that propagates after the shock wave, creating a paired shock-release wave. (4) The shock and release waves continue outward, interacting with the boundary layer of the crust surface according to the law of the wall.**

## Mechanics of Impacts and Cratering

The first studies of impact mechanics were modeled on underground explosions, done to test the effects of bombs on population centers. Norman et al. (1977) reported on work done by G. H. S. Jones of the Canadian Defense Research Board. In the test, 500 tons of TNT were detonated at the surface and the resulting shock waves observed. Though informative, the test was only partly helpful; actual impact mechanics are quite different.

Osinski and Pierazzo (2013) described the sequence of events during an impact. When a body strikes Earth, it produces a shockwave that propagates into the substrate. The energy of a shock wave depends on the speed and mass of the impactor, and since impactor velocities can exceed 25 km/sec and large impactors can measure tens to hundreds of kilometers in diameter, energy levels are very high—sometimes exceeding 100 GPa. When the impactor strikes (Figure 1.1), a shock wave both propagates outward at supersonic speed and rebounds back into the projectile (Figure 1.2). When it reaches the far surface of the projectile, it is reflected as a rarefaction or release wave, usually vaporizing the impactor. Since this happens before the body can penetrate more than 2–3 diameters into the substrate, relatively little energy is transferred in its destruction. Instead, the crater forms through the displacement of a paired shock and release wave that moves outward through the matrix (Figure 1.3).

Jones et al. (2002) modeled this release wave (Figure 2); where the shock portion reaches pressure of over 3.0 Gigapascals above normal, the release portion sees a dramatic pressure drop to more than 2.0 Gigapascals below normal, resulting in a wave form on the surface that reflects the alternating topography predicted by law-of-the-wall interactions. Figure 3 shows an energy-vs.-time cross section of the same phenomenon.

Energy waves from impacts thus have three parts: the *shock wave*, with its sudden spike of pressure, the *release wave,* which moves into and out of negative pressure, and the *rebound*, which appears as a more even pressure wave.

## Law of the Wall

Boundary effects are important in many physical processes. In sedimentation, this interaction is called "the law of the wall" (Julian, 1998; Pope, 2000). Where two objects are moving relative to each other, a thin layer against one boundary is affected by the friction of the nonmoving boundary. This is seen in something as simple as dust on a country road. In slow motion, there is a stuttering at the wave edge shown by the "puffs" of dust coming out from under a tire. Likewise, in a flowing stream, dye near the stream boundary will "puff" outwards, reflecting a continuous stream of intermittent turbulence.

I propose that this principle can be applied to shock-release waves. When a high-energy impact wave encounters lithologic boundaries, the rock is sufficiently brittle and the boundary so thin that when the stress from the pull of the

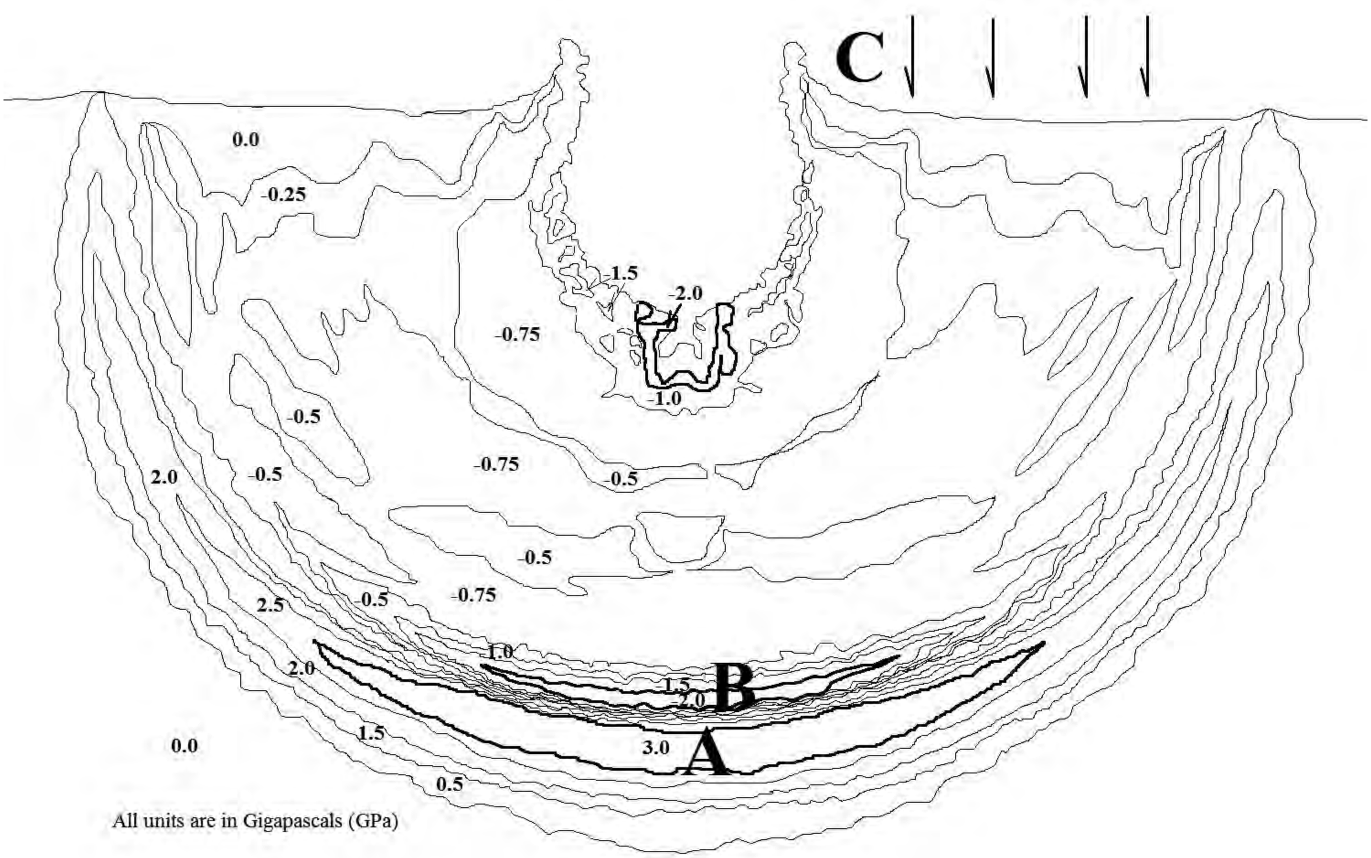



**Figure 2. Diagram of a mathematical simulation of an impact shock-release wave, showing the alternating pulse caused by the shock (A) and release (B) portions. All units in Gigapascals (GPa). Arrows at (C) show repeating alternation of shock and release pulses at the boundary interaction.**

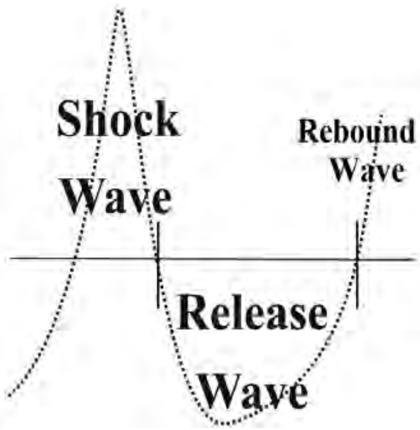



**Figure 3. Proposed structure of a shock/release wave, with pressure energy over time as modeled by the author, based on the configuration of waves in Figure 2. Time is usually expressed in microseconds and pressure in gigapascals.**

wave motion exceeds that of friction, the wave will release and jump ahead. We see the effect in Figure 2 in the bumps into the 1.75 GPA layer at (C).

Since a shock wave is continuous passing through the surface of the Earth, I propose that the shock wave would show turbulence at lithologic boundaries, pushing and pulling at semi-regular intervals, leaving a more pronounced imprint (Figure 1.4). This can be viewed as recurring annuli around craters of all scales as we will see in our examples. At a large enough scale, these would form mountains and valleys (Figure 1.4, D, E, F, and Figure 7A). In the case of multiple impacts, interference would be expected as cumulative affect (Figure 6a, b and c).

## Examples: Lineaments as Impact Imprints

An impact produces an original crater rim (OCR) that is rapidly filled (up to 80%) by falling ejecta (French, 1998). Additional infill is typically vapor condensate and the fallback from other craters. The OCR is the first expression of the shock and release wave in the surface. These waves then leave a continuing signature in the surrounding countryside of concentric lineaments, annulus (Figure 1.4).

This imprint is expressed at the surface with a sharp topographic rise on the leading edge, a trough or "release valley," and a smaller rise exterior to both (Figure 1.4D). The release valley may look like a gap between the two elevations (Figure 3), or it may be manifested by strata dipping into a low spot. There is evidence for both at different locations. Variations may result from interference from multiple shock-release waves, accompanying deformation that can be either plastic or brittle. Two examples of these features are seen at Unaweep Canyon and the TONCK lineament.

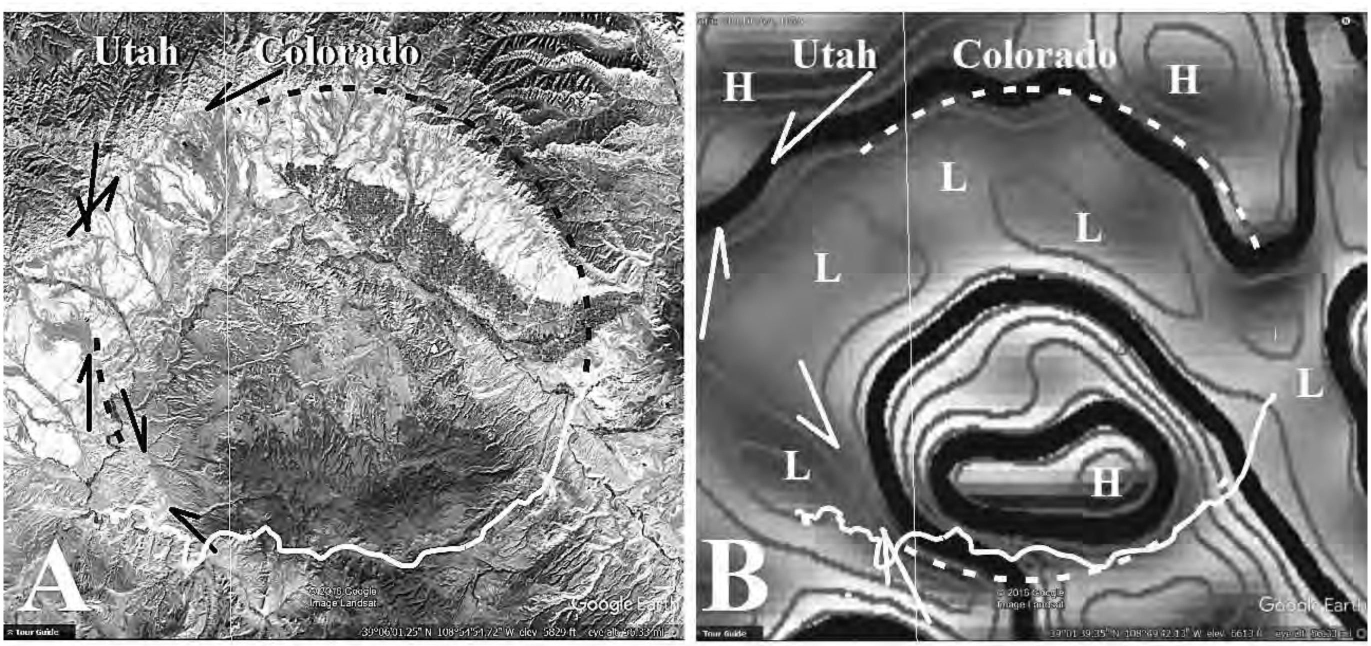



**Figure 4. (A) Google Earth images of the northern Uncompahgre Plateau (Pinon Mesa) with Unaweep Canyon at the border between Utah and Colorado. Irregular white line (lower right) shows path of canyon. Dashed path are linears that follow circular lineament. Arrows show locations where color changes show linears that are concentric to lineament. Lineament is continuous to canyon. (B) Global Gravity Anomaly (GGA) map of same area. Location of Unaweep Canyon mirrors the gravity low cutting through general high of the Uncompahgre. (A: 2015. 39°06'01.25"N, 108°54'54.72"W. December 13, 2015. Accessed 09/28/2016. B: 2016. 39°01'39.35"N, 108°49'42.13"W. Accessed 09/28/2016.)**

## Unaweep Canyon

Located in the north end of the Uncompahgre Plateau, Unaweep Canyon runs northeast to southwest. There are no associated faults or rivers to explain its origin. Two small, underfit streams currently drain the canyon, flowing in opposite directions. The northeast terminus intersects the outflow location of the deeply-entrenched Gunnison Canyon, dropping 1,400 ft. (427 m) over the last 3.8 miles (6 km), and only 10 miles (16 km) in a straight line from Palisades, Colorado (Figure 4A), where the Colorado River exits Grand Mesa. Geologists believe that both the Unaweep and Gunnison were eroded by ancestral rivers (Hood et al., 2008).

Unaweep canyon cuts into basement gneiss and granite, overlain by sandstone and shale of the Cutler Group and Chinle Formation. The Cutler Group was apparently cut with the forming of the canyon, but the Chinle was deposited *after the Cutler, gneiss, and granite surfaces inside the Canyon were shaped* (Hood et al., 2008; cf. their figure 8). The crater that formed Unaweep Canyon contacted Earth after the deposition of the Cutler and affected the deposition of the Chinle Group.

A satellite view of the area shows many apparent arcuate lineaments (Figure 4A). In addition, a roughly circular gravity anomaly (Scripps Institute of Oceanography, 2014; Figure 4B) underlies the area (Figures 4B and 5B). The scale of the map is large, but the scale of the apparent impact feature is, too. A free-air gravity anomaly can represent changes in topography as well as changes in density in the upper crust (Figure 9). As such, gravity maps can be used to support geomorphic interpretations of lineaments.

The alignment of Unaweep Canyon suggests that it may be the result of a release wave (Figure 4). Another segment of the same circle corresponds with the Grand Valley of the Colorado (Figure 5B). This release wave may be reflected by the low gravity anomaly of Figure 5B and Figure 6, although other lineaments have modified the crust there.

If this represents an impact, there should be concentric expressions of the shock and release paired wave in the surface layer. Four such features were noted across the top of the Uncomphagre Plateau southeast of Unaweep Canyon (Figure 7B). These segments appear as topographic variations in the Chinle Formation and would have been formed about the same time as the canyon, shaping the landscape of

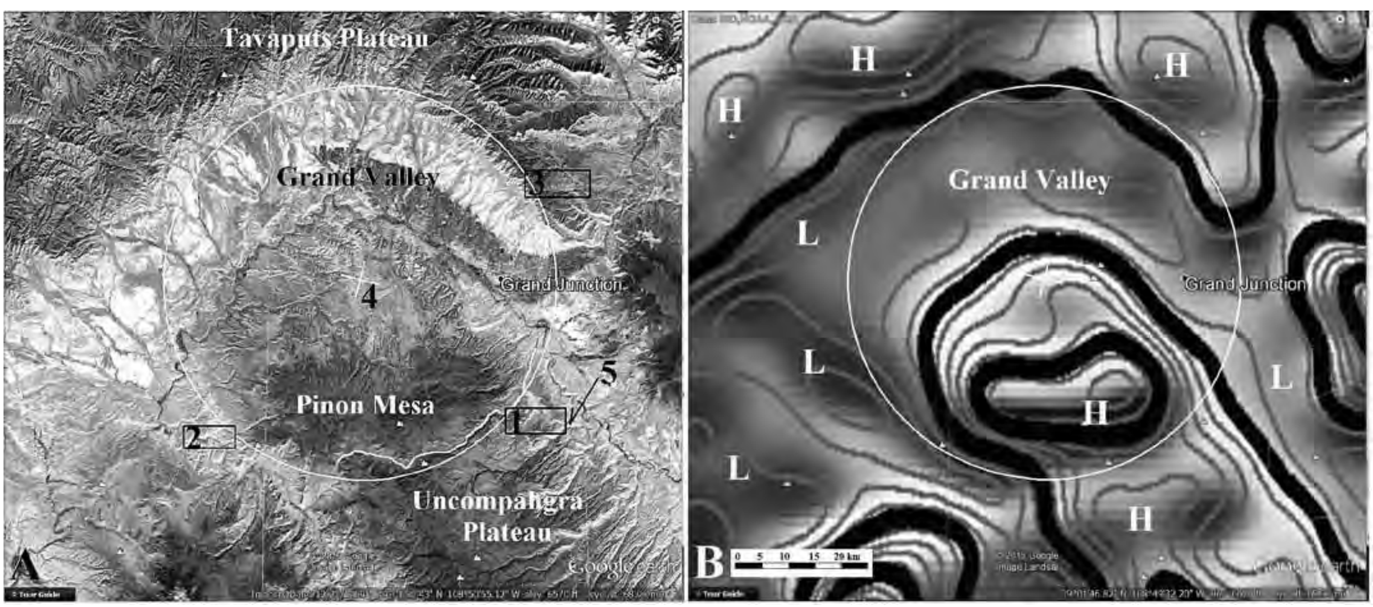



**Figure 5. Possible large-scale circular feature on Google Earth and GGA map. Unaweep Canyon is traced in white just inside the inferred circular lineament in lower right of (A). Northern half of circle follows the edge of Grand Valley, with the Colorado River located along the valley's inner edge. Rectangles 1–3 are shown in detail in Figure 7. Arrow (5) indicates recurring concentric linears. (B) Circle in A overlaid on GGA map reflects both topography and lithology. L = low gravity and H = high gravity. As the isochronal pattern for the northern end of the Uncompahgre Plateau does not reflect the same shape as the topography, it is evident that some differences in near surface rock density is reflected too. This suggests that Grand Valley may be underlain by lower density rock. Center (4) is plotted at 39.063028°N, -108.855744°W. If it represents an OCR, the diameter would measure 45.23 miles (72.79 km). (A: 1969. 39°06'01.25"N, 108°54'54.72"W. December 31, 1969. Accessed 07/20/2016. B: 2016. 39°01'46.82"N, 108°49'32.20"W. Accessed 07/20/2016.)**

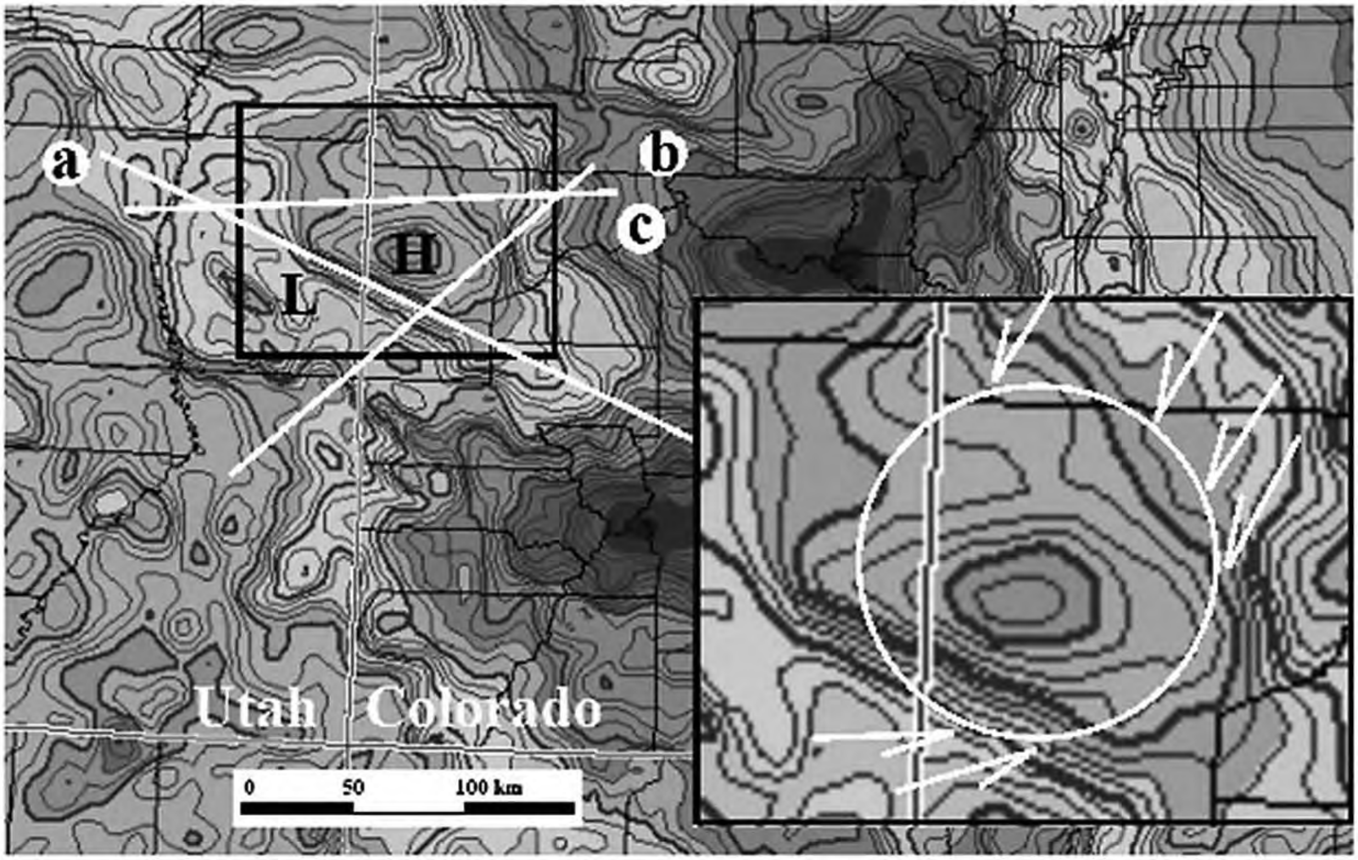



**Figure 6. Bouguer gravity anomaly (BGA) map of the border between Utah and Colorado. Inset (approximately same scale as Figure 5B) shows detail. BGA reflects upper crust lithology and thickness, not surface elevation. High (H) and low (L) anomalies marked to left. The pattern differs from the anomaly in Figure 5, with gravity rise in center of circular lineament. The section between the lower right pair of opposing arrows and at the points of the remaining three arrows identify locations of abrupt gravity change, indicating displacement in crustal lithology inside the circle. White lines (a), (b) and (c) indicate prominent straight lineaments from Bouguer map, suggesting their influence on the gravity high. Modified from Dutch (2013).**

the plateau. A total of five concentric lineaments were noted, labeled 1–5 on Figure 7A.

Figure 7 shows locations of five concentric lineaments, determined by alternating valleys and ridges in the Chinle Formation and indicated by arrows in Figure 7A. While the specific path of the five linears are not repeated in the other images, abundant concentric linears are continuous around the inferred circular lineament. Discontinuity suggests interference with other shock-release wave sets, but the concentric arcuate nature of the entire lineament structure is clear.

## TONCK Circular Lineament

If the law of the wall applies to impact shock and release waves, annulus, circular linears concentric to an impact crater would occur outwards as shown in the Unaweep, but linears may also show within the crater as a result of additional waves generated by the fallback of material in the loose regolith of the crater. These return waves may be visible in topography or only as denser bands that show in gravity anomaly. These inner features would range from ridges of lithified sediments to density deformation within the crust itself.

An example of a very large circular feature is the TONCK structure in Texas, Oklahoma, New Mexico, Colorado, and Kansas. "TONCK" is an acronym for these states. Centered at 33.420389°N, -100.651483°W, a concentric pattern of topography and gravity changes show

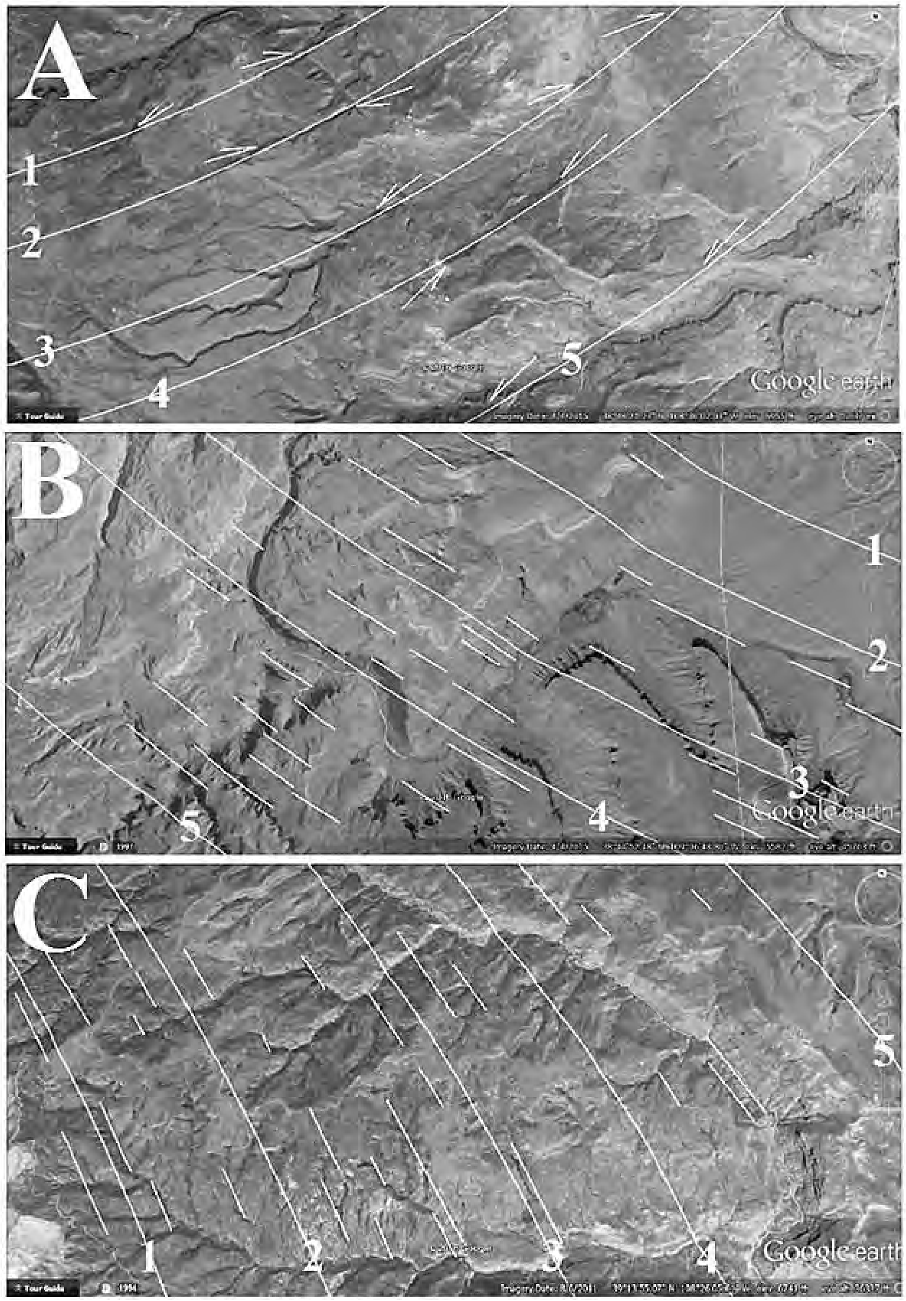



**Figure 7. Google Earth detail of Figure 5A. (A) Lineaments showing five concentric rings. Arrows point to elevation changes from which lineaments were inferred. (B) Box 2 from Figure 5A. Linears are concentric to inferred lineaments. (C) Box 3 from Figure 5A. (A: 2015. 38°48'21.23"N, 108°30'02.03"W. April 4, 2015. Accessed 07/20/2016. B: 2015. 38°44'52.48"N, 109°06'48.80"W. April 4, 2015. Accessed 07/20/2016. C: 2011. 39°13'55.07"N 108°26'05.01"W. August 6, 2011. Accessed 07/20/2016.)**

circular lineaments. With a diameter of 539.81 miles (868.73 km), it is much larger than the Unaweep Crater.

I consider 1a (Figure 8) to be the outer edge of the OCR, and 1b to be the ridge of the tilted block from the blowout, slumping at the crater rim. As an early crater, TONCK was affected by later impact structures. One shock-release wave will express itself in a circular lineament, but once additional wave pairs cross it (Figure 8B), the cumulative effect will be to produce a series of high and low points. Therefore, the topographic and gravitational relief expected would be points of abrupt change where multiple lineaments interact.

In Figure 8B, GGA shows 1a is the outer edge of a band of very low gravity. The Landsat image shows topography to be 800–900 ft. As Figure 9B, BGA, does not show this same low, this would be the manifestation of the release portion of the wave, as at Unaweep Canyon. If circle 1 is the OCR, then 1b would also represent the ring of tilted crustal blocks whose upturned outer edge would form the OCR. Circle 1a would be the high point of those tilted blocks.

The number of concentric linears in Figure 9A shows repeated, regular elements (Appendix). The BGR in Figure 9B shows differences in near surface lithology that agree with the general trend seen in Landsat. Few of the outer rings (Figure 10) show extensively continuous expression, which makes identification of a specific annulus more tentative. The juxtaposition of lithologic denser substrate (Figure 11) and topographic rises (Figure 10) are interpreted as the cumulative energy expression from multiple impacts' shock-release waves producing multiple intersecting linears (Figure 9B).

With circle 1 designating the OCR, lineaments A-C are interpreted as ripples inside the crater, reflected in the infill of ejecta. Such material would be pushed into concentric rings by reflected pressure waves produced by fallback and the transient crater being pushed upwards and/or breaking loose from the main body of the craton substrate. This motion would have been initiated within minutes after the emplacement of the transient crater. This gives an indication

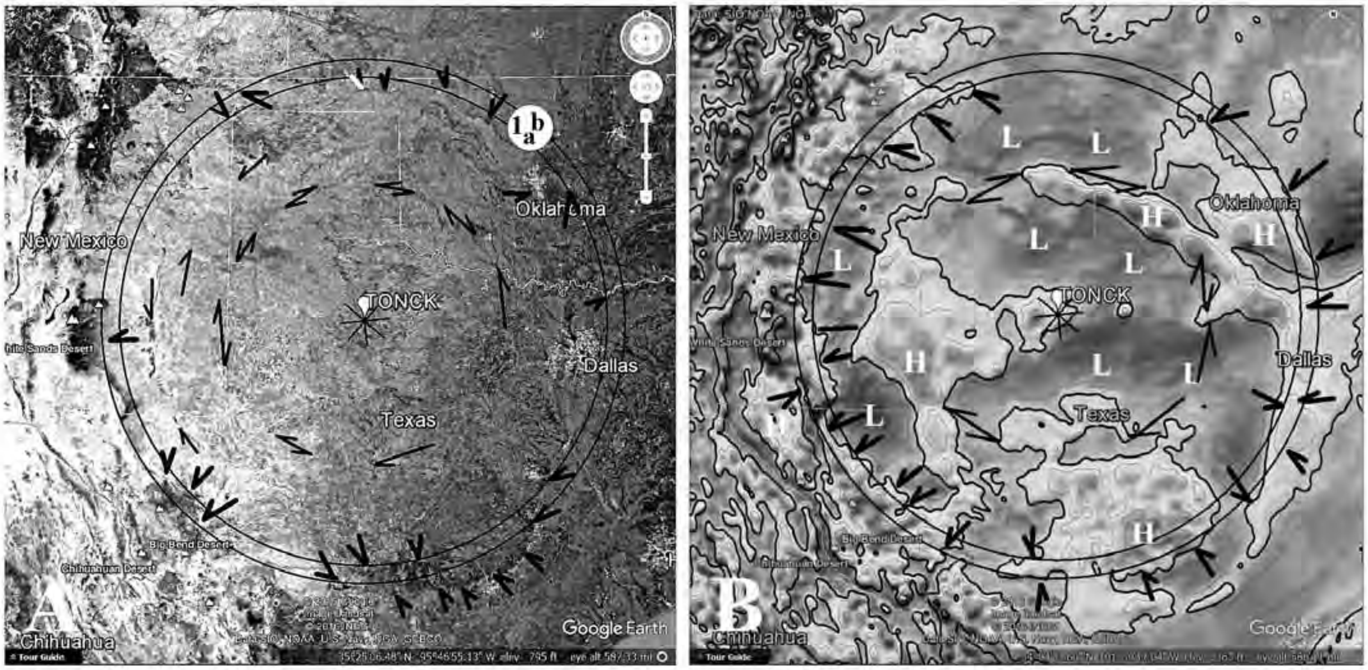



**Figure 8. (A) Google Earth and (B) GGA of central United States showing the center and first circle lineaments of the TONCK structure. Heavy black arrows indicate abrupt topographic changes concentric to center. Thin arrows indicate concentric linears. (A: 2015. 35°25'06.48"N, 95°46'55.13"W. April 4, 2015. Accessed 09/30/2016. B: 2016. 34°04'37.60"N, 101°39'17.04"W. Accessed 09/30/2016.)**

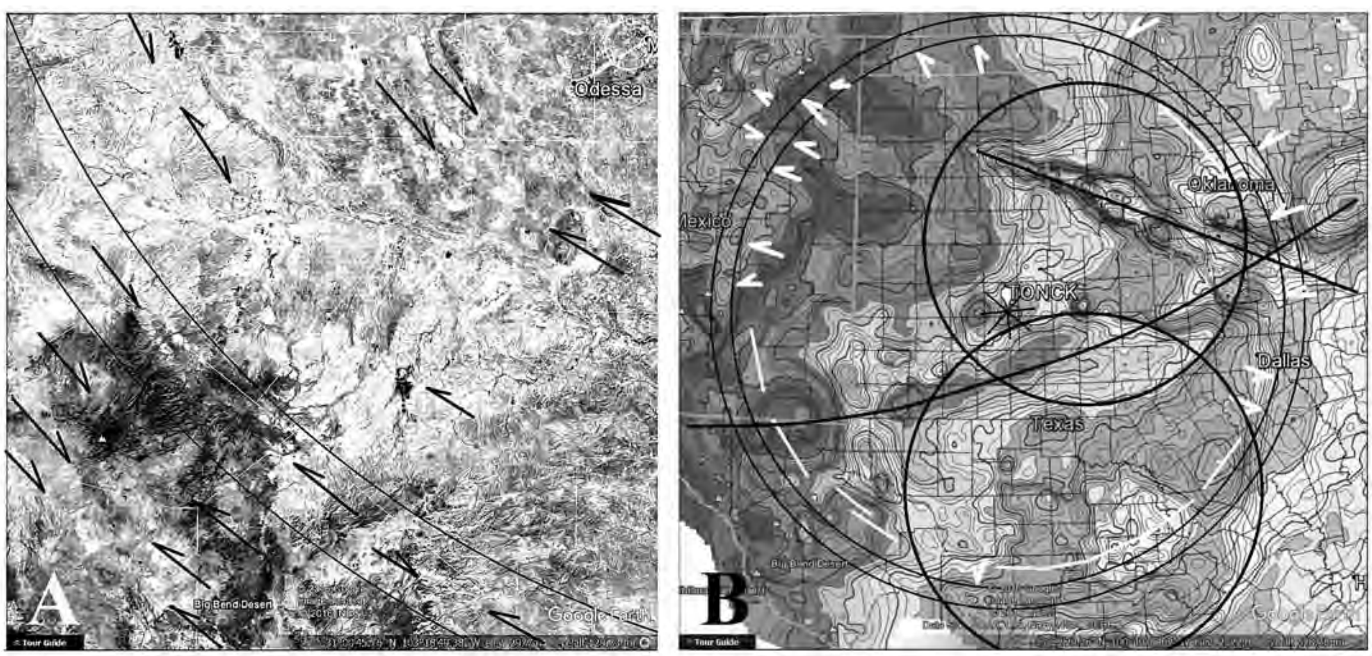



**Figure 9. (A) Google Earth detail of the southwest portion of the TONCK structure concentric lines between pairs of arrows. (B) BGA with thick arrows pointing to gravity change locations. Thin white lines concentric to lineaments. Black lines show other prominent linears. (A: 2015. 31°00'45.76"N, 103°18'49.38"W. April 4, 2015. Accessed 09/30/2016. B: from Dutch, 2016.)**

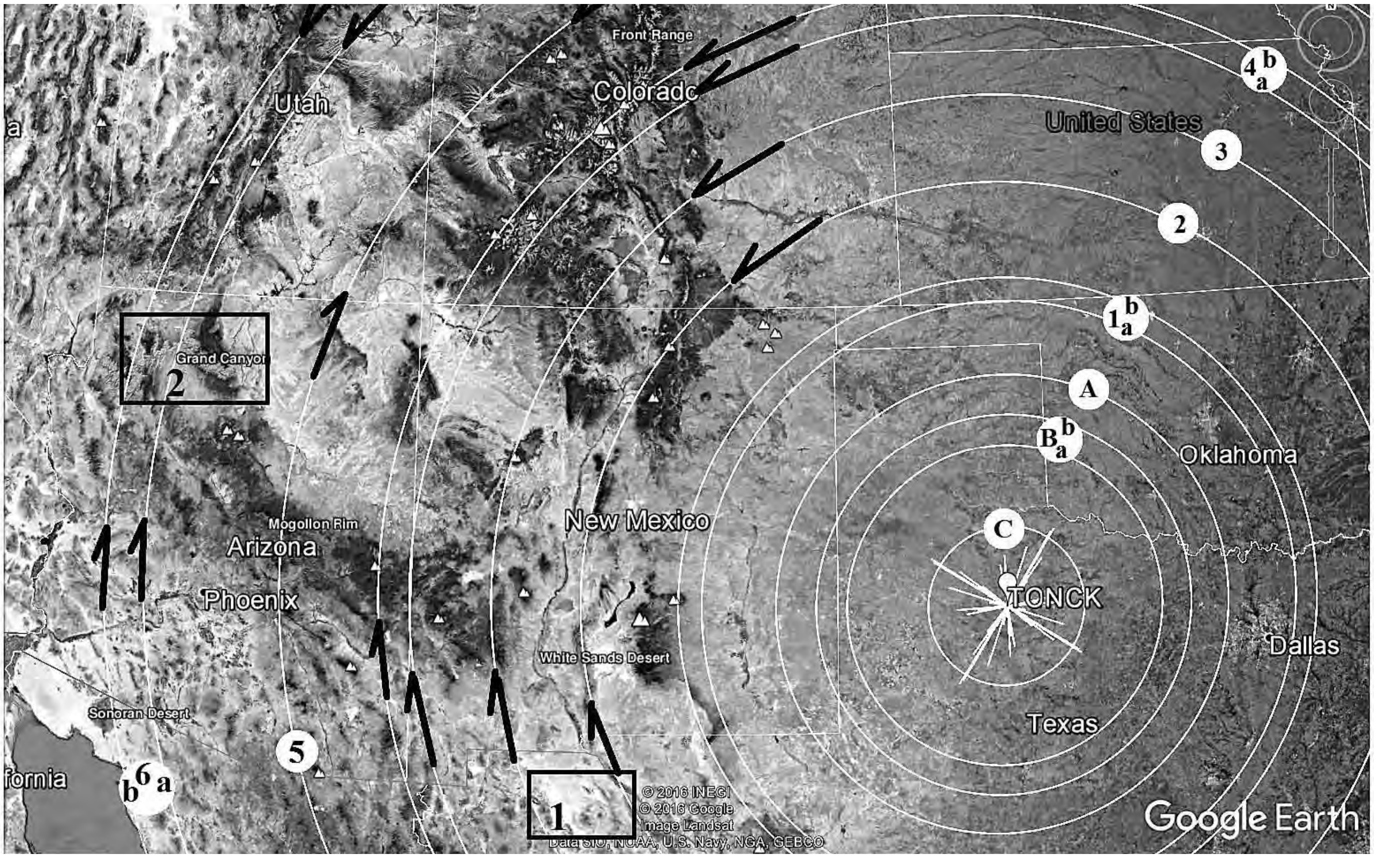



Figure 10. Google Earth image of central United States, showing the TONCK structure with concentric features consistent with shock-release waves. Arrow pairs show sections of topography concentric to TONCK center. Detail 1, see Figure 12. Detail 2, see Figure 13. (2015. 35°45'07.91"N, 104°46'39.03"W. April 4, 2015. Accessed 09/28/2016.)

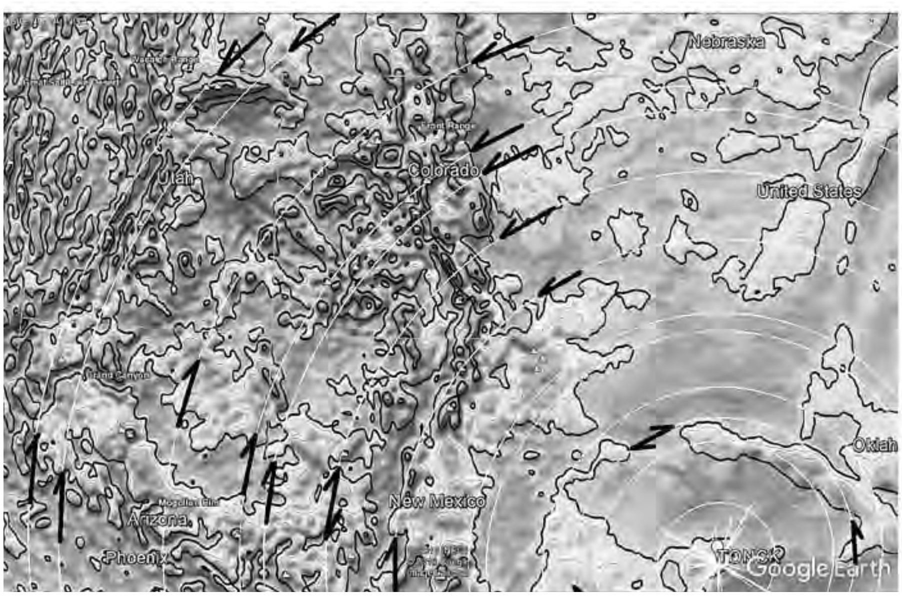



Figure 11. GGA image of northwest portion of Figure 10. Arrow pairs show lines of gravity reading changes consistent with shock-release wave expression. (2016. 37°34'52.70"N, 106°42'10.89"W. Accessed 09/28/2016.)

of how rapidly the ejecta settled back into the crater, and since the rings can still be traced as lineaments, all crater fill (including all contained fossil material) had to arrive within that time period.

Figures 12 and 13 show two details of the TONCK structure. While specific impact annulus may no longer be visible, concentric linears to that center are expressed. Some of these are seasonal stream paths in ravines. Others are cliff scarps. Some may be related to volcanism, based on the black earth around them. Lineaments have all kinds of expression in both topography and gravity anomalies. In the Grand Canyon area (Figure 13), major portions of the Colorado River and faults are concentric to TONCK. Where vegetation and cultivated land are sparse, the natural landscape still carries many traces of the

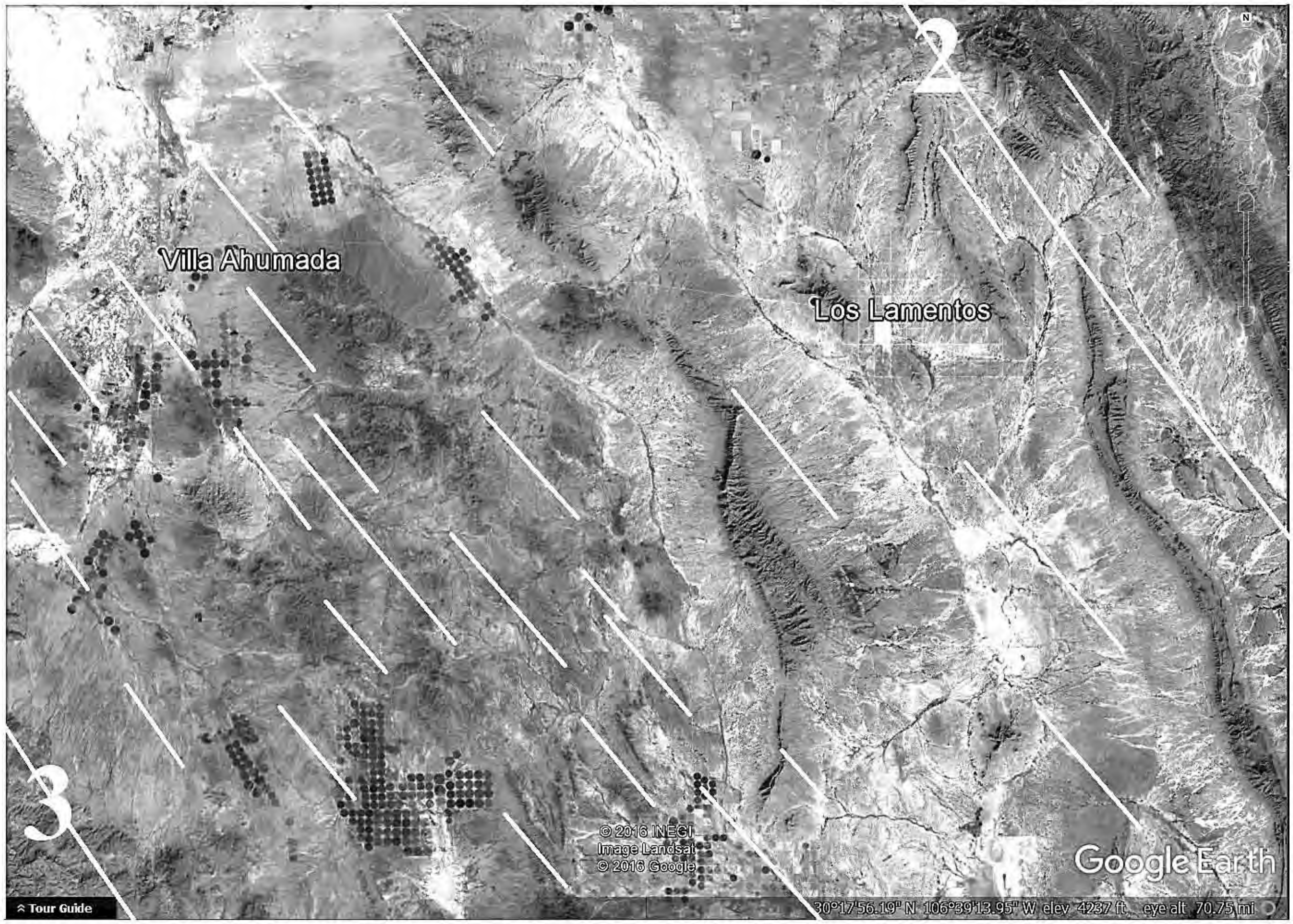



**Figure 12. Detail 1, Google Earth image of TONCK detail from Chihuahua Desert, just south of Texas border. Lines 2 and 3 are annulus shown in Figure 10. Short white lines are linears concentric to the annulus and visible in this more detailed view. (2013. 30°32'50.69"N, 105°55'16.05"W. April 9, 2013. Accessed 08/08/2016.)**

impact pattern. Zooming in and out using Google Earth makes it clear that *the expression of concentric lineaments is almost continuous across a given area based on the detail at which they are studied*.

## Discussion

Landsat images reveal apparent lineaments that are circular at very large scales. These lineaments exhibit three characteristics: concentric elements, regular shape, and repetition. The cause of the circular linears around Unaweep Canyon and TONCK appear to be impact related. While clarity of the circular lineament of TONCK is not as clear as the smaller Unaweep structure, the TONCK is a much larger structure, obscured by later, smaller impacts. This overprinting suggests that it was an early impact. These structures appear to be impacts because their circular forms are *perfect* circles, marred only by natural irregularities at the smallest level. It is difficult to conceive of any other natural process that would create such regularity at this scale. Many of the authors listed in Table I used the same criterion to propose impacts in their study areas.

If impact structures of the scale described in this paper exist, they would have global reach and effect. The inferred TONCK structure is many times the size of recognized terrestrial impact structures.

Gay (2012) concluded that satellite imagery linears were connected to "Precambrian basement" and O'Leary and Friedman's (1978) definition connected them to "subsurface phenomenon." Following those authors, I propose that some lineaments reflect deep basement structure, but others appear to have no such connection. If impact related, larger lineaments should exhibit deep roots.

The inferred circular lineaments of the Unaweep Canyon Crater and the

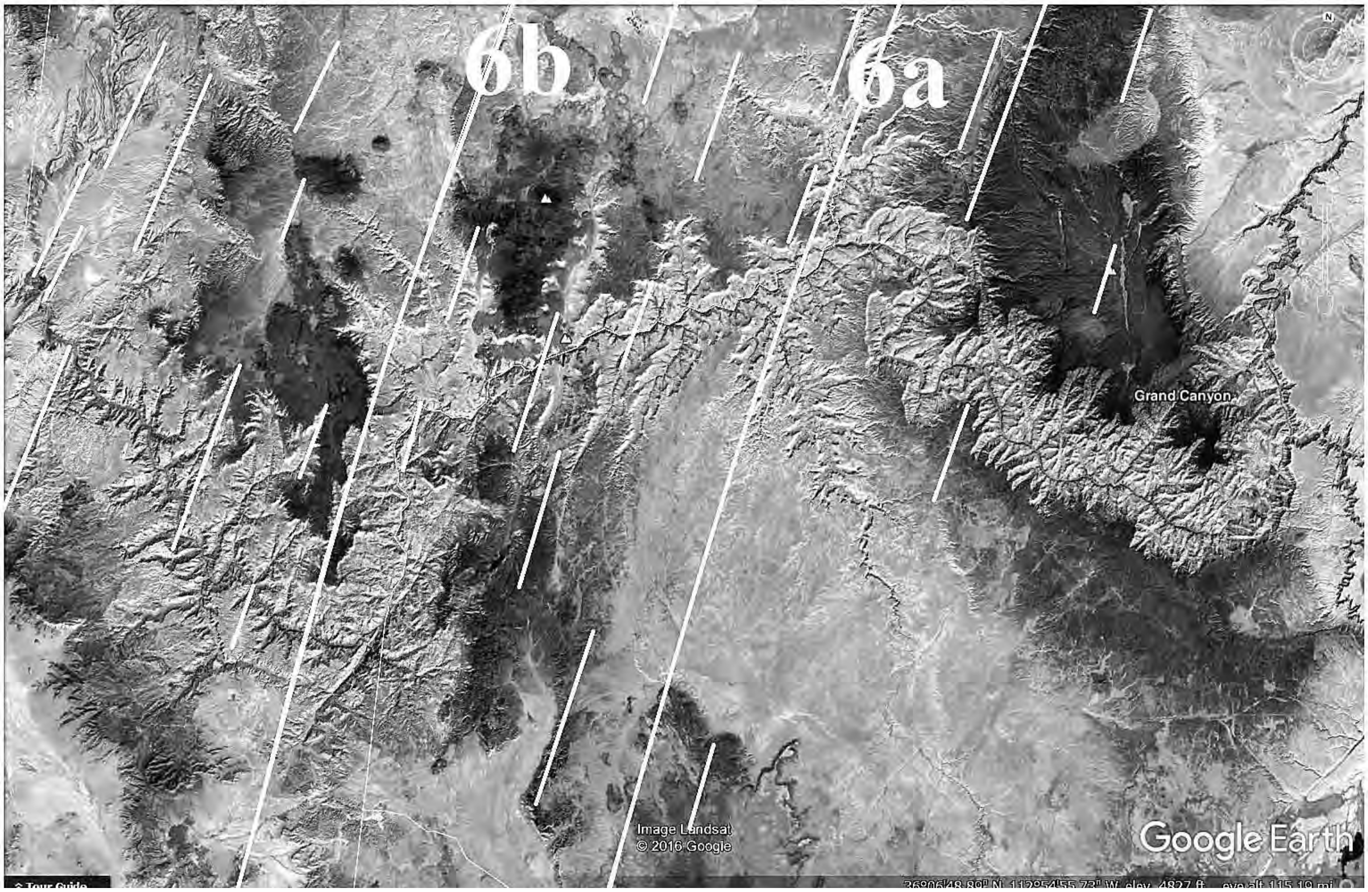



**Figure 13. Google Earth image of detail 2, Figure 10, where the TONCK crosses the Grand Canyon. Direction of Linears is consistent with a significant portion of the Hurricane, Toroweap, West Kaibab Faults, and portions of the Colorado River through the canyon, suggesting the source for these faults is the TONCK crater. (2015. 33°22'29.26"N, 100°40'05.02"W. April 4, 2015. Accessed 09/30/2016.)**

TONCK Crater appear to fit the four requirements as set forth in the Appendix, with the fourth being a center for impact for each. While that definition as impact craters has not been fully defended at this time, there is no known source of energy on Earth or in our solar system that would produce a crater of this shape and size, especially for the TONCK, other than an impact.

## References

Burgener, J.A. 2013. Massive impact craters and basins on Earth: regarding the Amazon as a 3500 km multi ring impact basin. 76th Annual Meteoritical Society Meeting 5051. http://www.hou.usra.edu/meetings/metsoc2013/pdf/5051.pdf (accessed October 2015).

Byler, W.H. 1983. Circular structures of Earth. In *Technical Papers of 49th Annual Meeting, ASP-ACSM*, pp. 471–480. ACSM, Falls Church, VA.

Byler, W.H. 1987. Evidence of large horizontal Earth movement. Paper presented at the 7th International Conference on Basement Tectonics, August 17.

Daubree, A. 1879. *Etudes Synthetique de Géologie Experimentale*. Dunod, Paris, France.

DeCourten, F. 2015. *Geology of Northern California*. Cengage Learning, Independence, KY. http://www.cengage.com/custom/regional_geology.bak/data/DeCourten_0495763829_LowRes_New.pdf (accessed December 2015).

De Kalb, H. 1990. *The Twisted Earth*. Lytel Eorthe, Hilo, HI.

Dutch, S. 2013. Bouguer Gravity Anomaly Map, Colorado. https://www.uwgb.edu/dutchs/StateGeophMaps/ColoGphMap.HTM (accessed June 2016).

Dutch, S. 2016. Gravity and Magnetic Maps of Texas. https://www.uwgb.edu/dutchs/StateGeophMaps/TexasGphMap.HTM (accessed December 2016).

Earth Impact Database. 2016. http://www.passc.net/EarthImpactDatabase/ (accessed January 2016).

Eggers, A.J. 1979. Large-scale circular

features in North Westland and West Nelson, New Zealand: possible structural control for porphyry molybdenum-copper mineralization? *Economic Geology* 74:1490–1494.

French, B.M. 1998. *Traces of Catastrophy: A Handbook of Shock-Metamorphic Effects in Terrestrial Meteorite Impact Structures*. LPI Contribution 954. Lunar and Planetary Institute, Houston, TX.

Galileo. (1610) 2004. *Sidereus Nuncius*. Translated by E.S.Carlos. Reprint, Byzantium Press, Oklahoma City, OK.

Gay, S.P. 2012. Joints, linears, and lineaments—the basement connection. *Search and Discovery Article #41083*. http://www.searchanddiscovery.com/pdfz/documents/2012/41083gay/ndx_gay.pdf.html (accessed July 2016).

Gintov, O.B. 1973. Ring structures in the Precambrian of the Ukraine. *Geotectonics* 7:288–292.

Glukhovskiy, M.Z. 1978. Ring structures and linear faults in the Alden shield and Stanovoy region (as interpreted from satellite photographs). *Geotectonics* 10:326–332.

Hobbs, W.H. 1904. Lineaments of the Atlantic border region. *Geological Society of America Bulletin* 15:483–506.

Hobbs, W.H. 1911. Repeating patterns in the relief and structure of the land. *Geological Society of America Bulletin* 22:123–176.

Hoffman, P.F. 2014. Tuzo Wilson and the acceptance of pre-Mesozoic continental drift. *Canadian Journal of Earth Science* 51:197–207.

Hood, W., T. Oesleby. A. Aslan, R. Cole, C. Betton, and M. Benage. 2008. *Geological history of Unaweep Canyon: a re-appraisal*. Grand Junction Geological Society, Grand Junction, CO.

Jones, A.P., G.D. Price, N.J. Price, P.S. DeCarli, and R.A. Clegg. 2002. Impact induced melting and the development of large igneous provinces. *Earth and Planetary Science Letters* 202(3–4): 551–561.

Julian, P.Y. 1998. *Erosion and Sedimentation*. Cambridge University Press, Cambridge, UK.

Kanizsa, G. 1976. Subjective Contours, *Scientific American* 234(4): 155–163.

Kellman, P.J., and T.F. Shipley. 1991. A theory of visual interpolation in object perception. *Cognitive Psychology* 23:141–221.

Kreis L.K., and D.M. Kent. 2000. Basement controls on Red River sedimentation and hydrocarbon production in southeastern Saskatchewan. In Christopher, J.E., C.F. Gilboy, F.M. Haidl, and C.T. Harper (editors), *Summary of Investigations 2000*, vol. 1, pp. 21–42. Saskatchewan Geological Survey, Regina, SK.

Kutina, J. 1998. A major structural intersection in the basement of the Okavango Basin, NE of Tsumeb, Namibia, indicated by satellite magnetometry and other data. *Global Tectonics and Metallogeny* 6:205–213.

Lapworth, C. 1892. The heights and hollows of the earth's surface. *Proceedings of the Royal Geological Society* 14:688–697.

Moralev, V.M., and M.Z. Glukhovskiy. 1981. Circular features of Precambrian shields as recognized on space photographs. *Soviet Journal of Remote Sensing* 3:356–362.

Neev, D., K. Hall, and J.M. Saul. 1982. The Pelusium meg-shear system across Africa and associated lineament swarms. *Journal of Geophysical Research* 87(B2): 1015–1030.

Norman, D.J., and M. Chukwu-Ike. 1977. The world is a bit cracked. *New Scientist* 73:320–322.

Norman, D.J., N. Price, and M. Chukwu-Ike. 1977. Astrons—the earth's oldest scars? *New Scientist* 73:689–692.

O'Driscoll, E.S.T. 1980. The double helix in global tectonics. *Tectonophysics* 63: 397–417.

O'Leary, D.W., and J.D. Friedman. 1978. Towards a workable lineament symbology. *Proceedings of the Third International Conference on the New Basement Tectonics, Basement Tectonics Committee Publication #3*, pp. 29–31. Basement Tectonic Committee, Inc., Denver, CO.

Osinski, G.R., and E. Pierazzo. 2013. Impact cratering: process and products. In Osinski, G.R., and E. Pierazzo (editors), *Impact Cratering: Process and Products*, first edition, pp. 1–20. Blackwell. Publishing Ltd, West Sussex, UK.

Papadaki, E.S., S.P. Mertikas, and A. Sarris. 2011. Identification of lineaments with possible structural origin using Aster images and DEM derived products in Western Crete, Greece. *EARSeL eProceedings* 10(1): 9–27.

Penner L.H., and J. Cosford. 2006. Evidence linking surface lineaments and deep-seated structural features in the Williston Basin. *Saskatchewan and Northern Plains Oil & Gas Symposium*, Saskatchewan Geological Society, pp. 19–39.

Pope, S.B. 2000. *Turbulent Flows*. Cambridge University Press, Cambridge, UK.

Ramberg, I.B., R.H. Gabrielson, B.T. Larson, and A. Solli. 1977. Analysis of fracture pattern in southern Norway. *Geologie en Mijnbouw* 56:295–310.

Saul, J.M. 1978. Circular structures of large scale and great age at the earth's surface. *Nature* 271:345–349.

Saul, J.M. 2015. *A Geologist Speculates*, second edition, online version. Les 3 Colonnes, Paris, France. http://www.lotusgemology.com/files/pdf/Saul-2015-A-Geologist-Speculates-2ndEd.pdf (accessed December 2015).

Scripps Institute of Oceanography. 2014. Global [Marine] Gravity Anomaly download. http://topex.ucsd.edu/grav_outreach/ (accessed November 2014).

Seleem, T.A. 2013. Analysis and tectonic implication of DEM-derived structural lineaments, Sinai Peninsula, Egypt. *International Journal of Geosciences* 4:183–201.

Short, N.M. 1973. The view from 570 miles. *Geotimes* 18(5): 16–20.

Tirén, S. 2010. Lineament interpretation short review and methodology. GEOSIGMA AB. Report 2010:33. Swedish Radiation Safety Authority, Stockholm, Sweden.

Twidale, C.R. 2004. River patterns and their meaning. *Earth-Science Reviews* 67:159–218.

Twidale, C.R. 2007. E.S.T. O'Driscoll, lineaments and ring structures. In Bourne, J., and R. Twidale (editors), *Crustal structures and mineral deposits: E.S.T. O'Driscoll's contribution to mineral exploration*, pp. 12–21. Rosenberg, New South Wales, Australia.

Van de Graaff, W.J.E., R.W.A. Crowe, J.A. Bunting, and M.J. Jackson. 1977. Relict Early Cainozoic drainage in arid Western Australia. *Zeitschrift für Geomorphologie* 21:379–400.

Wilson, J.T. 1962. The effect of new orogenic theories upon ideas of the tectonics of the Canadian Shield. In Stevenson, J.S. (editor), *The Tectonics of the Canadian Shield*, pp. 174–180. Royal Society of Canada Special Publication 4. University of Toronto Press, Toronto, Canada.

Witschard, F. 1984. Large-Magnitude ring structures on the Baltic Shield—Metallogenic significance. *Economic Geology* 79:1400–1405.

Zeller, E.J. 1964. Cycles and psychology. *Kansas Geological Survey Bulletin* 169:631–636.

## Appendix: Seeing, Understanding and Interpreting Lineaments

Seeing inferred patterns in nature is a human preoccupation, yet pattern recognition is often subjective and difficult (Zeller, 1964). O'Driscoll (1980) proposed the existence of a "Double Helix in global tectonics" to explain Earth's lineament patterns. His conclusion was questionable, but his goal of finding a common cause behind lineaments remains important. Before lineaments can be interpreted, they must be identified. Some are obvious; most are not. How much must we see to define an inferred lineament? An *inferred lineament* is one that is extrapolated outwards from individual linears. This is a problem in "partial occlusion" (Kellman and Shipley, 1991). One person may see a feature; another randomness. Clearly, training enhances that ability, as demonstrated by those who professionally interpret satellite photographs.

This problem touches on human perception. Do these subjective or illusionary lines really exist? In the language of perception, Kanizsa (1976) and Kellman and Shipley (1991) tell us it all depends on whether we can see a purpose in our interpretation. The study of illusionary or subjective figures goes to how the human mind processes visual cues; understanding such images hinges on a perception of the whole rather than the parts (Kanizsa, 1976). Can we lead our mind to see beyond the few visual clues to a pattern or purpose behind those linears?

If all we saw of Figure A1 was the inside of the circle in A, an observer might think it was interesting short linears but without any connection. However, if the total of A was observed, all the short linear segments start to take on a larger pattern. We infer the existence of larger linears based on a recognized possible connection. Emphasizing those inferred linears may lead us to C, where a very different pattern can be recognized.

### How Much Is Enough?

You view Mount Rushmore through a grove of large pines. You see a bit of

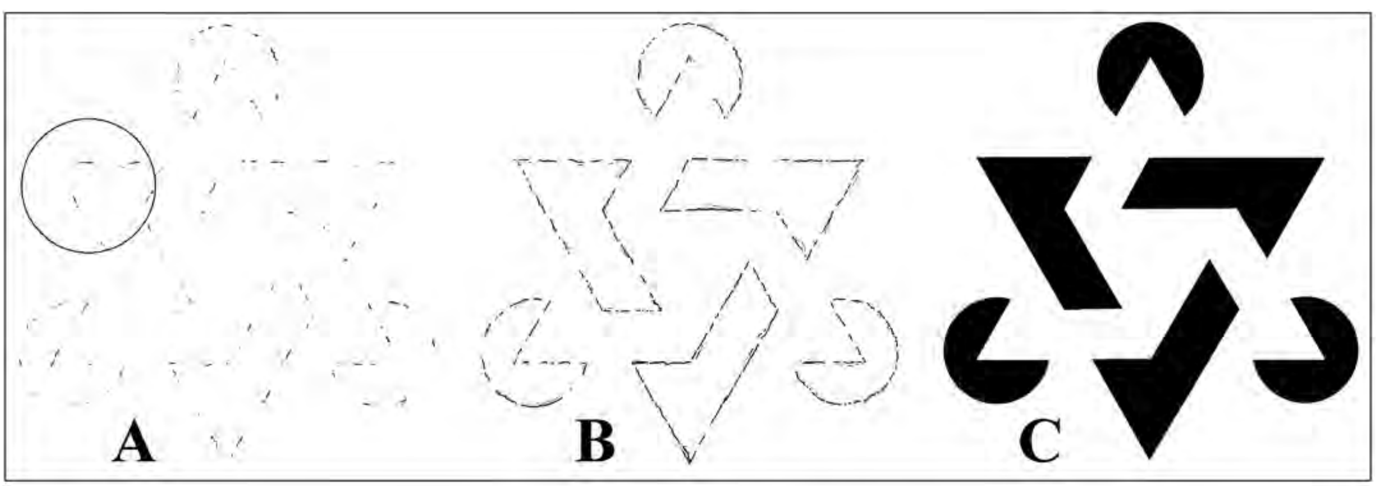



**Figure A1. Progression to complex pattern. Likewise, interpretation of linears is complete only when they can be placed in the context of a larger pattern.**

smooth carved rock here, the curve of a lip there, the indent of an eye elsewhere. You instinctively see even this much of a pattern to be artificial, not a result of erosion. Knowing that you are near the presidential monument, you infer the carving's presence. Partial occlusion works this way. The more familiar you are with a possible purpose, the readier you are to see the inferred pattern.

Like these patterns, lineaments are usually represented by small segments (Figure A1), linears. The human eye must fill in the pattern, which is a source of disagreement in both identification and interpretation.

One person sees a white triangle but with no edges; it is the contrasts of its absence that defines its existence. In part, it is perception of a pattern that enables additional details to be added that reinforce the larger pattern. The figure can only be viewed *as a complete understandable pattern when we see the whole and accept the existence of constituent forms we really cannot define, except in their absence*. With lineaments, the lack of specific segments may be a problem. Yet, *that void may be a clue to a larger pattern*.

## Reliability

Understanding lineaments, then, requires a pattern and details that mutually reinforce each other. While the risk of circularity is a source of uncertainty, without it, lineament studies remain simplistic and confined to human scale. It is only when enough of the entire figure can be seen that the more complex pattern will be revealed. Sometimes *it is the voids that define the total picture*. The individual parts are important, but the total picture often requires an intuitive leap to the whole in order to explain the parts.

(1) *Does the figure contain repeated elements?* Cut figure A1.C through the Pac-Man shapes, and it will produce three repeated units. Natural arrangements lack symmetrical repetition without purpose or cause.

(2) *Do regular elements occur at regular intervals?* Random arrangements seldom provide regularity. This figure provides regularity in that the three circles are equal size, the two triangles are equal size, and they are equilateral triangles—having equal length legs.

(3) *Are concentric or parallel elements repeated?* Parallel elements are not a part of random arrangements without cause.

If lineaments can be used to explore ancient impacts, then we should be able to see several elements. These include arcuate to circular lineaments and parallel, concentric lineaments. Once a potential structure is defined, geological and geophysical data, such as the gravity anomaly maps discussed in this paper, can add understanding.

*Creation Research Society Quarterly* 2017. 53:206–216.



# The Bighorn Basin, Wyoming—Monument to the Flood

## Part I: The Flooding Stage

**Michael J. Oard***


## Abstract

**The relatively small Bighorn Basin and its surrounding mountains are a striking display of every phase of the Flood, as well as pre-Flood rocks and post-Flood glaciation. The Great Unconformity is seen at several locations; the granite and gneiss beneath it are Creation Week rocks. Many thousands of feet of sedimentary rocks were laid above it during the ascending phase. This event can be called the *Great Deposition.* Many of these strata can be traced for up to thousands of miles and show little or no internal erosion. Both features support Flood deposition but contradict uniformitarianism. Dinosaur bones and tracks, commonly found along the edge of the Bighorn Basin, can be explained as having formed between Day 40 and Day 120 of the Flood.**


### Introduction

The Bighorn Basin is a semiarid area in north-central Wyoming surrounded by the Absaroka Mountains on the west, the Owl Creek Mountains on the south, and the Bighorn Mountains on the east (Figure 1). The basin is 120 miles (193 km) north to south and 70 miles (112 km) east to west. It probably demonstrates more of the Flood than any similarly sized area of the world. The Great Unconformity marks the divide between Creation Week rocks and early Flood rocks. The Bighorn Basin also displays the effects of a post-Flood ice age along with a possible dam-breach feature. The Clarks Fork Basin, northwest of the Bighorn Basin and northeast of Clarks Fork Canyon (Figure 1), is separated from the Bighorn Basin by a very low divide. For all practical purposes, the entire area can be considered the Bighorn Basin.

Cenozoic rocks of the two basins are classic type areas for mammal fossils, especially for the Wasatchian Land-Mammal Age (Bown et al., 1994; Clyde et al., 1994, 2007; Wei, 1995), but there are several problems with uniformitarians' proposed mammal sequence. Most of the fossils are jaw and teeth fragments from a wide variety of mammals. Some of the deposits are claimed to have been "reworked" to make them fit a preconceived fossil order. Sediment accumulation was asymmetric, so it is difficult to correlate the fossils between distant parts of the basin. And, lastly, there are differing biostratigraphic zonations.

### The Biblical Geological Model

To describe the geology and geomorphology of the basin, I will apply Walker's biblical geological model (1994) with its two stages and five phases and

* Michael J. Oard, M.S. Atmospheric Science, Bozeman, Montana
Accepted for publication February 7, 2017

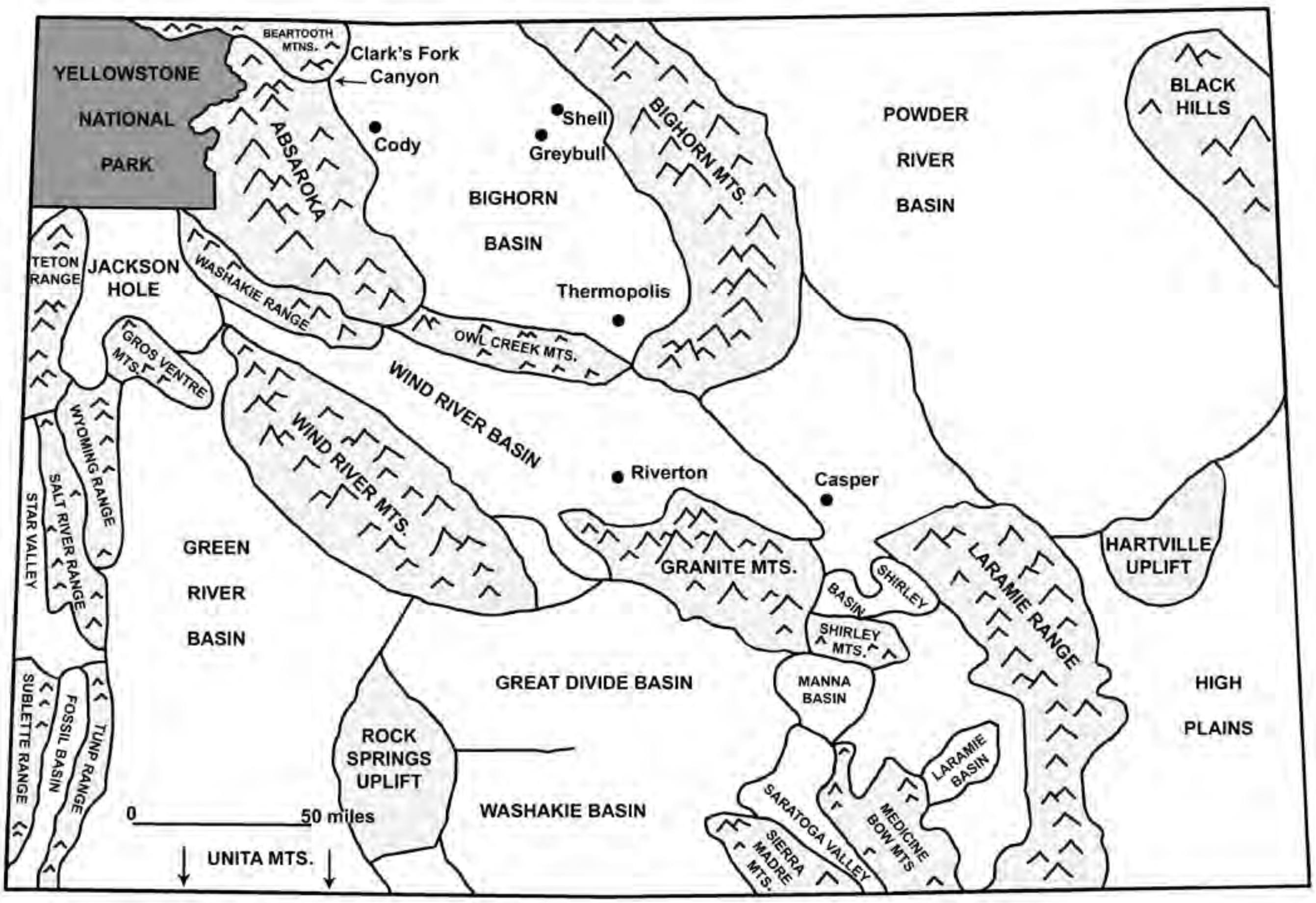



**Figure 1. Map of major basins and mountain uplifts in Wyoming (drawn by Mrs. Melanie Richard).**

defining criteria (Figure 2). Dinosaur tracks, eggs, and scavenged bonebeds, which were made by live dinosaurs in Flood sediments, are a defining criterion of sediments deposited in the first half of the Flood, during the *inundatory* or *flooding stage*, based on the biblical narrative, which states that all air-breathing land animals were dead before the Flood covered the land on Day 150 (Oard, 2002, 2011).

I use Walker's model because it classifies rocks in the field according to the *mechanism* that deposited the layers of sediment. Genesis 6–9 describes a global flood that lasted about one year. A flood is an event in which water rises above its normal levels and then retreats back to those levels. The same would be true on

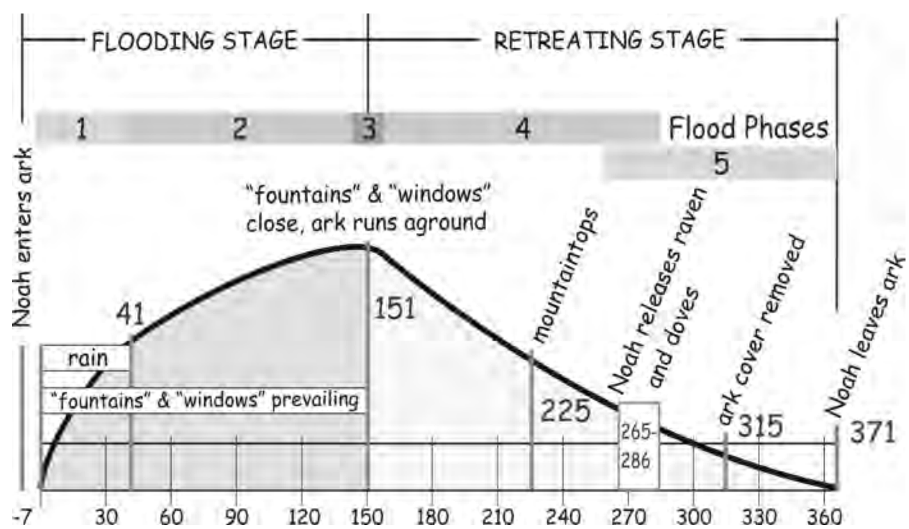



**Figure 2. Graph of relative sea level for the two stages and five phases in Walker's model (drawn by John Reed). This graph assumes a 360-day year and that the Flood peaked at Day 150, both assumptions controversial.**

any scale with any flood. Therefore, in the biblical Flood, we would also expect a *flooding stage*, which corresponds to Walker's *inundatory stage* or the 21 weeks of *prevailing* in the Whitcomb-Morris model (Whitcomb and Morris, 1961). This stage is logically followed by the retreating stage, or the *recessive stage* in Walker's model, which corresponds with the 31 weeks of *assuaging* in the Whitcomb-Morris model. The first part of this article will cover the effects of the flooding stage of the Genesis Flood on the Big Horn Basin. Part II will describe how the retreating stage changed the geology of the area.

**Figure 3. The Great Unconformity (upper arrow) with a second unconformity (lower arrow) below Precambrian sedimentary rocks in the eastern Grand Canyon (view north).**

## Similarities to Flash Floods

Floods of all sizes exhibit many of the same characteristics, but the rapid rise unique to flash floods likely occurred during the Genesis Flood. That rapid rise is the main difference between a river flood and a flash flood. Walker (1994) concluded that after an initial rapid rise, the Genesis Flood continued to rise at a slower rate before it peaked and began to abate. At first, because of its depth, the abating water flowed freely, with few if any obstacles to impede its rush to sinking ocean basins. As the water continued to subside, land features were exposed, gradually forcing the flow into channels. As with the flash flood, the final stage ended with rivers and streams flowing down their newly excavated paths.

As the biblical Flood began, God unleashed a powerful mechanism that triggered a rapid rise in the water level. According to Genesis 7:11, "on the same day all the fountains of the great deep burst open, and the floodgates of the sky were opened" (NASB). The violence of these two mechanisms was so great that together they resulted in 40 days and nights of global rain. Walker calls this the *eruptive phase* of the Flood. This global rain abated at the end of the eruptive phase, although the biblical mechanisms continued another 110 days, implying a continued, slower rise of the Floodwater until Day 150. The time between Day 40 and Day 150 would have been similar to the rise of a flash flood after the initial rush. Walker (1994) called it the *ascending phase*. As with flash floods, the great biblical Flood reached a peak and began to subside, slowly at first with sheet flow that gradually became channelized.

## Creation Week Rocks and the Great Unconformity

The Great Unconformity is an erosion surface with residual erosional remnants. It can be called a *planation* surface, since on the broad scale it is quite flat. It represents a considerable amount of erosion. The Great Unconformity is seen near the bottom of the Grand Canyon (Figure 3). It is also in Wyoming, separating upper crustal igneous and metamorphic rocks from overlying sedimentary rocks. At the Grand Canyon, the Great Unconformity cuts across dipping Precambrian sedimentary rocks in some places. Flood geologists disagree as to whether they represent pre-Flood or early Flood deposits. It is unlikely that large amounts of widespread sediment were laid very early in the Flood due to powerful, turbulent currents. But in deep basins within the continental crust, quieter waters would have allowed such deposition (Froede and Oard, 2007; Oard and Froede, 2008; Oard and Reed, 2017).

The Great Unconformity represents violent erosion very early in the Flood from these currents. The Unconformity is observed or inferred by seismic methods over much of the continents. A planation surface of this magnitude is difficult to explain by uniformitarian geology, since observed erosion today tends to furrow, not plane, rock over

**Figure 4. The top of the granitic Beartooth Mountains, which represent a large faulted planation surface, showing two levels of planation surfaces. The higher level in the background is at about 12,000–13,500 feet (3,660–4,115 m), while roughened lower level (foreground) is at 10,000–11,000 feet (3,050–3,350 m).**

**Figure 5. Planation surface on top of the granite and gneiss of the northern Bighorn Mountains. Hills in the background are Paleozoic erosional remnants.**

a considerable distance (Crickmay, 1974).

The Great Unconformity generally is underlain by granite of the upper continental crust, which likely represents the Creation Week. It is observed at a number of places in northwest and north-central Wyoming. Granite tops the Beartooth Mountains (Figure 4), the Bighorn Mountains (Figure 5), the Wind River Mountains (Figure 6), and even the northern Teton Mountains on Mount Moran (Figure 7) (Oard, 2014). You can drive across Creation Week rocks in the Beartooth Mountains, on the Red Lodge-Cook City Highway. It is one of the most beautiful routes in North America. The Great Unconformity has been faulted upward to different levels with some roughening of the lowest surface at about 10,000–11,000 feet (3,048–3,353 m). West of Cody, Wyoming, in the Rattlesnake Mountains, you can see the Great Unconformity with Creation Week rocks below (Figure 8).

As in Grand Canyon, the Great Unconformity in this area of Wyoming shows thick sedimentary rocks overlying granite (Figure 9). These rocks were originally deposited in horizontal layers in great thicknesses, but many were subsequently eroded during the retreating stage of the Flood, leaving erosional remnants. Therefore, the exposed planation surface is an *exhumed* planation surface. In the Beartooth Mountains, Beartooth Butte is a 1,400-foot (427-m) erosional remnant, apparently protected by a low spot on the Great Unconformity (Figure 10). Erosional remnants are more extensive in the Bighorn Mountains. A 50-foot (15 m) thickness of the lower Flathead Sandstone tops Mount Moran (Figure 7). Sedimentary rocks eroded during the later stage of the Flood make up part of the 10,000–20,000 feet (3,049–6,096 m) of fill in the Bighorn Basin. Other basins exhibit similar thicknesses of sedimentary rocks.

About mid-Flood, the Great Unconformity was uplifted. Psalm 104:8 refers to this when it states that the mountains rose and the valleys sank down. The Great Unconformity surface sank in the valleys and basins between mountain ranges. The difference between the lowest elevation of the Great Unconformity in Wyoming, the bottom of the Hanna Basin (31,000 ft; 9,449 m below sea level), and its peak high in the Wind River Mountains (14,000 ft; 4,267 m) shows a vertical difference of 45,000 feet (13,716 m)! If the unconformity was once level, this difference represents the vertical movement mentioned in Psalm 104:8.

This tectonic combination of uplift and downwarping invalidates the objection of old-earth creationists and theistic evolutionists that the Flood's waters

**Figure 6. The Wind River Mountains showing the flat-topped mountains (view west from northern Green River Basin).**

**Figure 7. Flat-topped Mount Moran, northern Teton Mountains, Wyoming showing 50 feet (15 m) of Flathead Sandstone on top (from Hergenrather et al., 2012).**

could not have covered Mount Everest (Walton, 2001). Mount Everest was once covered by marine waters, since geologists have found marine fossils encased in limestone at the peak (Gansser, 1964). The Floodwater did not have to rise over Mount Everest; Mount Everest was pushed up over 30,000 feet (9,144 m) out of the Floodwater (Oard, 2009).

## Early Flood Rocks

Scripture states the heavy rain abated after 40 days, which suggests a lessening of the Flood mechanisms. Large volumes of

**Figure 8. The Great Unconformity (arrow) with the Flathead Sandstone above, just west of Cody, Wyoming.**


**Figure 9. The Precambrian granite and sedimentary rocks below Paleozoic and Mesozoic sedimentary rocks in Wyoming were generally horizontal at the end of the Mesozoic (drawn by Mrs. Melanie Richard).**

**Figure 10. Beartooth Butte with marine fossils in a low spot on top of the Beartooth Mountains, 1,600 feet (490 m) above the adjacent Beartooth Lake, south-central Montana and north-central Wyoming. The channel within the middle of the butte is outlined.**

**Figure 11. The Grand Staircase indicating thousands of feet of erosion over the Grand Canyon area (view from the northern Kaibab Plateau north of Grand Canyon)**

**Figure 12. Thick sedimentary rocks in the Wind River water gap through the Owl Creek Mountains.**

sediment were then deposited atop the Great Unconformity. This event can be called the *Great Deposition* and resulted in extensive layering of thousands of feet of sediments deposited on every continent. These deposits have been labeled Paleozoic, Mesozoic, and early Cenozoic in the western United States. The Great Deposition corresponds with Walker's (1994) ascending phase. The lack of strong, turbulent currents during deposition is inferred from the lack of deformation observed in those sediments. At Grand Canyon, 4,000–5,000 ft (1,219–1,524 m) of horizontal sedimentary layers overlie the Great Unconformity. Another 10,000 feet were later eroded, as seen in the Grand Staircase to the north (Figure 11). Rocks preserved in the Grand Staircase were eroded from the Grand Canyon area during the retreating stage of the Flood. This erosion is called the *Great Denudation* by secular scientists (Ranney, 2005), who place it in the mid- to late-Cenozoic.

The Great Deposition also emplaced thick sediments atop the Great Unconformity in Wyoming. Remnants of these rocks are seen along the edges of the Bighorn Basin, including those in Wind River Canyon, a 3,000-ft (914 m) water gap that cuts through the sedimentary rocks of the Owl Creek Mountains (Figure 12). Figure 13 is a schematic summarizing the events during the flooding stage.

## Sedimentary Layers Similar for Long Distances

These thick early Flood sediments were deposited over extensive areas. If we use the bottom two-thirds of the Grand Canyon

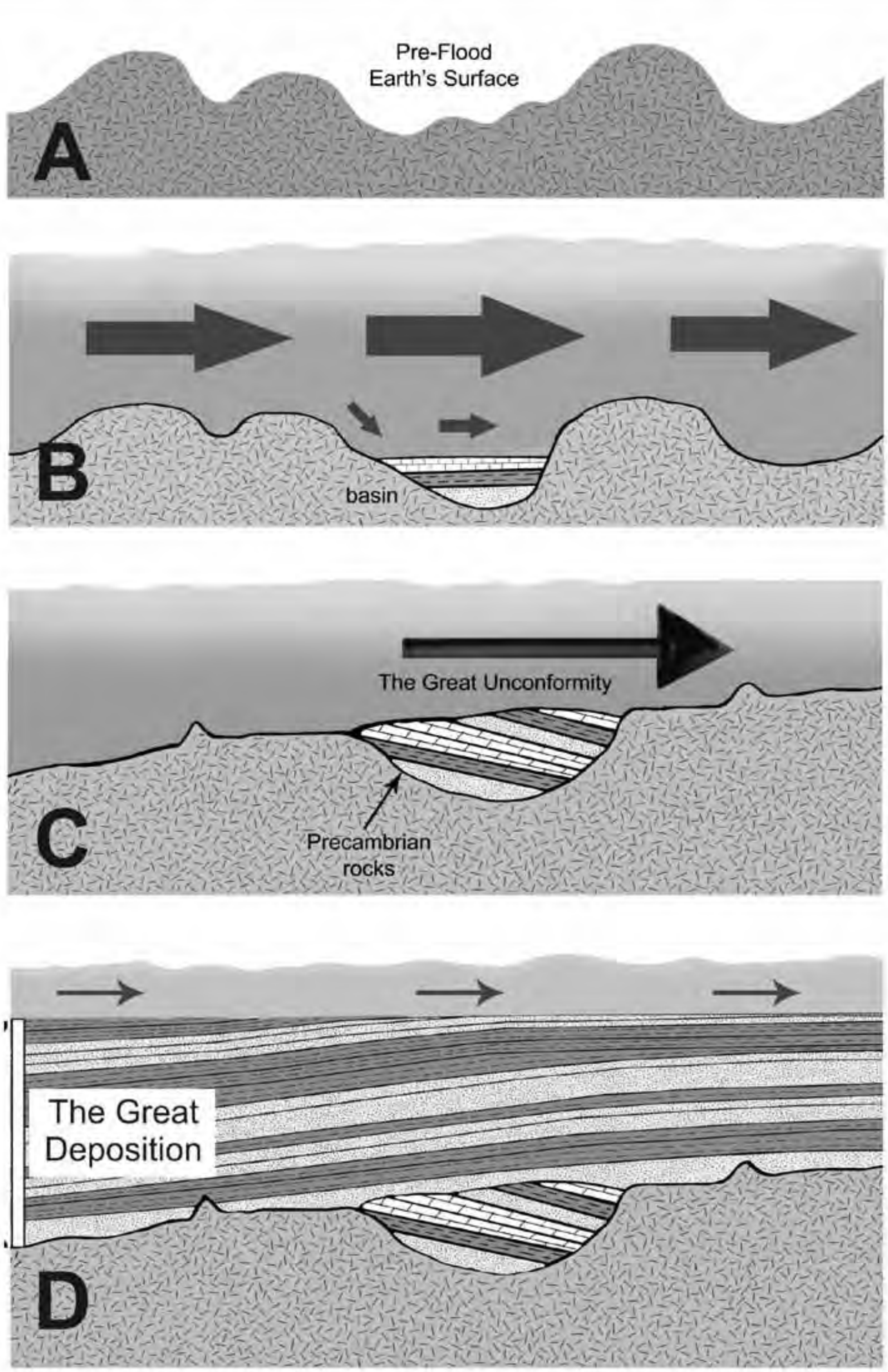



**Figure 13. Schematic of events in the flooding stage (drawn by Mrs. Melanie Richard). A pre-Flood land (a) is flooded with deep basins being filled with sediments (b). Early Flood planing creates the Great Unconformity with deformation causing titled basin sedimentary rocks (c). Hundreds to thousands of meters of sediments are deposited on the Great Unconformity during the Great Deposition (d).**

Paleozoic as a "type section," we observe a similar sequence in Wyoming. The lowest such layer in Grand Canyon is called the Tapeats Sandstone and can be traced over half of North America (Snelling, 2009). In Wyoming and Montana, it is called the Flathead Sandstone and is visible atop the Great Unconformity west of Cody, Wyoming (Figure 8). The different formation names resulted from geologists in different states not knowing they were seeing the same unit. Above the Flathead Sandstone in the Bighorn Basin is a layer of green shale, similar to the Bright Angel Shale in Grand Canyon. Above the shale in Wyoming are carbonates similar to the Muav and Redwall Limestones in Grand Canyon. The Redwall equivalent in Montana, Wyoming, and the Black Hills of South Dakota is called the Madison Limestone. In Wyoming there are a few additional strata in the lower Paleozoic.

## Flat Gaps Between and Within Layers

Field observations indicate continuous sedimentation, but uniformitarian scientists must find large gaps to accommodate their timescale. These breaks are largely flat and thought to account for millions of years. Such breaks are found in sedimentary rocks of Grand Canyon, in Wyoming, and worldwide (Roth, 1998). The most significant is at Grand Canyon, where 160 million years of Cambrian, Ordovician, Silurian, and Lower Devonian rocks are "missing" between the Muav and Redwall Limestones (Figure 14).

A similar gap exists in Montana and Wyoming, with the exception of the Ordovician Bighorn dolomite and the thin Jefferson Formation around the Bighorn Basin (Blackstone, 1986). As in Grand Canyon, the layers are generally conformable, showing little time during deposition. Although this absence of erosion suggested to several geologists that the approximately 2,000 ft (610 m) of sedimentary rocks of the southern Teton Mountains (Figure 15) was deposited in a single, uninterrupted sequence, their uniformitarianism overcame their observations:

> The regularity and parallelism of the layers in well-exposed sections

**Figure 14. The flat gap between the Muav Limestone below and Redwall Limestones above line in the Grand Canyon along the North Kaibab Trail.**


**Figure 15. Sedimentary rocks in southern Teton Mountains from Rendezvous Mountain with Grand Teton in the distance (view north).**

suggest that all these rocks were deposited in a single uninterrupted sequence. However, the fossils and regional distribution of the rock units show that this is not really the case. (Love et al., 2007, p. 42)

Uniformitarian geologists posit millions of years of missing time between the layers (Hill and Davidson, 2016). They point to rare parabolic scours on top of several of the layers in the Grand Canyon as proof of channels that indicate some justification for the missing time, but similar parabolic scours with fish fossils are located on Beartooth Butte (Figure 10). However, the scours lack the V-shaped morphology of channeling. Those scours likely represent current fluctuations during the Flood.

Thick, numerous, widespread sedimentary layers are exactly what we would expect during early Flood deposition. The sediment volume is a function of energy, not time. The flat "gaps" defy uniformitarian explanation, since modern settings show that erosion dissects, rather than planes, surfaces, and sediments are deposited in restricted lens, rather than widespread layers. Sedimentation today often changes its content over short distances, from conglomerate to mud to sand to silt (Figure 16).

## Dinosaur Bones and Tracks

Dinosaur bones and tracks are common in sedimentary rocks at the edge of the Bighorn Basin (mammal fossils are found in the central basin). Several local museums have large displays of dinosaurs such as the one at Thermopolis. A megatracksite is found in the northeast part of the basin (Figures 17 and 18). A megatracksite is a concentration of dinosaur tracks in one area. Tracks are found at widely scattered locations in an area measuring 60 miles (96.6 km) north to south and 15 miles (24 km) east to west.

In one 2.9 mi$^2$ (7.5 km$^2$) area near Shell, researchers estimated 384,000 tracks per mi$^2$ (148,480 tracks per km$^2$) (Kvale et al., 2001). This site has several unusual features difficult to explain by any uniformitarian model (Oard, 2002). First, the tracks are found in two formations supposedly separated by three million years, but all the tracks

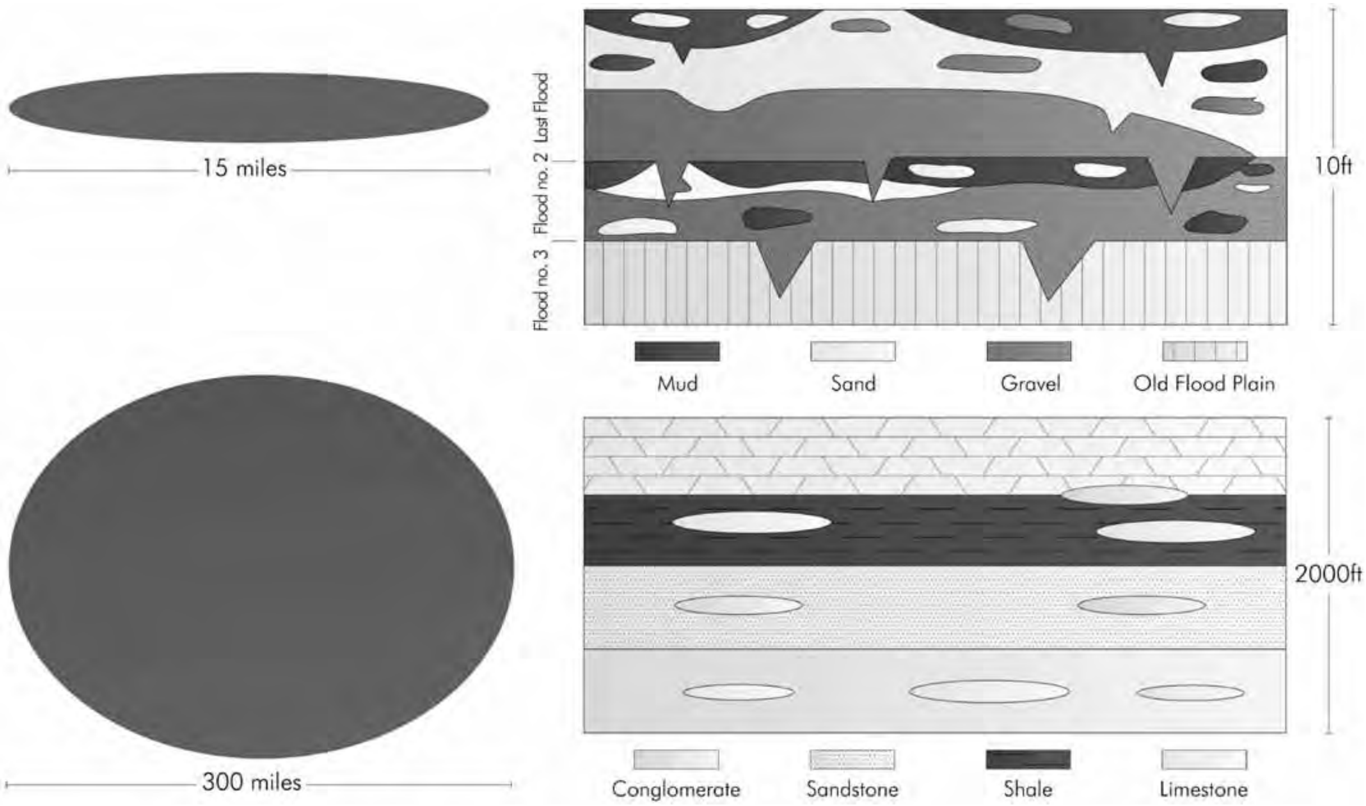



**Figure 16. Contrast between present-day multiple flood sedimentation (top) and sedimentary rock layers (bottom). The left is a plan view while the right is a vertical cross section. Notice much larger scale for sedimentary rock layers than typical flood layers**

were made by small bipedal, three-toed dinosaurs. Second, the two formations that contain the tracks were thought to be marine deposits until the dinosaur tracks were discovered. Suddenly, a "beach" was added. Third, the trackways are generally straight or gently curved, unusual in a natural environment. It appears the dinosaurs may have been fleeing. These features are more easily explained by the Flood. Drops in the elevation of the Flood's water could have allowed tracks to be made in soft sediments. Rapid rises could have covered them with more sediment, preserving the ephemeral tracks. Another drop in water level would have exposed those sediments to capture more tracks. This mechanism is called the BEDS (Briefly Exposed Diluvial Sediments) hypothesis and explains how tracks could have formed between days 40 and 120 of the Flood (Oard, 2011).

## Conclusion

The Bighorn Basin probably exhibits more evidence for Earth's history than any other location. Creation Week igneous and metamorphic rocks were cut by the Great Unconformity early in the Flood. As the energy level of the water dropped, thousands of feet of widespread sedimentary layers were deposited. This period is called the Great Deposition, and corresponds to Walker's ascending phase. In Part II, I will describe the features seen in the Bighorn Basin that correspond to the retreating stage of the Flood and the Ice Age that followed.

## References

Blackstone, D.L. Jr. 1986. Foreland compressional tectonics: southern Bighorn Basin and adjacent areas, Wyoming. *The Geological Survey of Wyoming Report of Investigations No. 34*, Geological Survey of Wyoming, Laramie, WY.

Bown, T.M., K.D. Rose, E.L. Simons, and S.L. Wing. 1994. Distribution and stratigraphic correlation of Upper Paleocene and Lower Eocene fossil mammal and plant localities of the Fort Union, Will-


**Figure 17** ***(left)*****. Straight trackway on limestone about 8 miles (13 km) southwest of Shell, Wyoming.**

**Figure 18** ***(above)*****. Map of the straight to gently curved dinosaur tracks exposed at site about 8 miles (13 km) southwest of Shell, Wyoming.**

wood, and Tatman Formations, southern Bighorn Basin, Wyoming. *USGS Professional Paper 1540*, U.S. Government Printing Office, Washington, D.C.

Clyde, W.C., W. Hamzi, J.A. Finarelli, S.L. Wing, D. Schankler, and A. Chew. 2007. Basin-wide magnetostratigraphic framework for the Bighorn Basin, Wyoming. *GSA Bulletin* 119(7/8): 848–859.

Clyde, W.C., J. Stamatakos, and P.D. Gingerich. 1994. Chronology of the Wasatchian land-mammal age (Early Eocene): magnetostratigraphic results from the McCullough Peaks section, northern Bighorn Basin, Wyoming. *The Journal of Geology* 102:367–377.

Crickmay, C.H. 1974. *The Work of the River: A Critical Study of the Central Aspects of Geomorphology*. American Elsevier Publishing Co., New York, NY.

Froede, C.R. Jr., and M.J. Oard. 2007. Defining the pre-Flood/Flood boundary within the Grand Canyon: were all the pre-Flood sediments scoured down to basement during the Flood? *Creation Matters* 12(4): 3–4, 6.

Gansser, A. 1964. *Geology of the Himalayas*. Interscience Publishers, New York, NY.

Hergenrather, J., T. Vail, M. Oard, and D. Bokovoy. 2012. *Your Guide to Yellowstone and Grand Teton National Parks: A Different Perspective*. Master Books, Green Forest, AR.

Hill, C., and G. Davidson (editors). 2016. *The Grand Canyon: Monument to an Ancient Earth—Can Noah's Flood Explain the Grand Canyon?* Kregel, Grand Rapids, MI.

Kvale, E.P., G.D. Johnson, D.L. Mickelson, K. Kelle, L.C. Furer, and A.W. Archer. 2001. Middle Jurassic (Bajocian and Bathonian) dinosaur megatracksites, Bighorn Basin, Wyoming, USA. *Palaios* 16:233–254.

Love, J.D., J.C. Reed Jr., and K.L. Pierce. 2007. *Creation of the Teton Landscape: A Geological Chronicle of Jackson Hole & the Teton Range*. Grand Teton Association, Moose, WY.

Oard, M.J. 2002. Newly discovered dinosaur megatracksites support Flood model. *Journal of Creation* 16(3): 5–7.

Oard, M.J. 2009. Mt. Everest and the Flood. In Oard, M., and J.K. Reed (editors), *Rock Solid Answers: The Biblical Truth Behind 14 Geological Questions*, pp. 19–27. Master Books, Green Forest, AR.

Oard, M.J. 2011. *Dinosaur Challenges and Mysteries: How the Genesis Flood Makes Sense of Dinosaur Evidence Including Tracks, Nests, Eggs, and Scavenged Bones*. Creation Book Publishers, Powder Springs, GA.

Oard, M.J. 2014. The meaning of the Great Unconformity and Sauk Megasequence. *Journal of Creation* 28(1): 12–15.

Oard, M.J., and C.R. Froede Jr. 2008. Where is the pre-Flood/Flood boundary? *Creation Research Society Quarterly* 45:24–39.

Oard, M.J., and J.K. Reed. 2017. *Understanding Noah's Flood*. Creation Book Publishers, Powder Springs, GA.

Ranney, W. 2005. *Carving Grand Canyon: Evidence, Theories, and Mystery*. Grand Canyon Association, Grand Canyon, AZ.

Roth, A.A. 1998. *Origins: Linking Science and Scripture*. Review and Herald Publishing Association, Hagerstown, MD.

Snelling, A.A. 2009. *Earth's Catastrophic Past: Geology, Creation & the Flood*. Institute for Creation Research, Dallas, TX.

Walker, T. 1994. A biblical geological model. In Walsh, R.E. (editor), *Proceedings of the Third International Conference on Creationism* (technical symposium sessions), pp. 581–592. Creation Science Fellowship, Pittsburgh, PA.

Walton, J.H. 2001. *The NIV Application Commentary: Genesis*. Zondervan, Grand Rapids, MI.

Wei, W. 1995. Chronology of the Wasatchian land-mammal age (Early Eocene): magnetostratigraphic results from the McCullough Peaks section, northern Bighorn Basin, Wyoming: a discussion. *The Journal of Geology* 103:461–463.

Whitcomb, J.C. Jr., and H.M. Morris. 1961. *The Genesis Flood: The Biblical Record and Its Scientific Implications*. Baker Book House, Grand Rapids, MI.

*Creation Research Society Quarterly* 2017. 53:217–224.

eKINDS Project Paper

# Founder Events: Foundational in Rapid Post-Flood Diversification

Jean K. Lightner* and Jon Ahlquist**

## Abstract

A biblical view of natural history begins in Genesis. God created plant and animal life according to their kinds, telling them to reproduce and fill the earth. Another important historical event was the global Flood, where terrestrial and flying animal numbers were severely reduced. Again, the creatures preserved on the ark went on to reproduce and fill the earth. Although creationists reject universal common ancestry on biblical grounds, they still need to adequately account for the diversification and speciation that has occurred within the various kinds of animals since the Flood. Because a biblical model demands the rapid diversification of creatures into forms filling different ecological niches, or adaptive radiation, creationists have the opportunity and responsibility to contribute to our understanding of this important topic and thus show the relevance of the biblical model.

Many biologists recognize three sources of adaptive variation: environmentally based sorting of ancestral alleles, mutation, and hybridization. Conditions following the Flood would have led to an inordinate number of founding events, potentially contributing to environmentally based sorting of alleles. Evolutionists have done considerable work to understand the effect of founding events on subsequent populations. Much of that work is reviewed here. Yet a blind spot remains, as most techniques intended to identify the founder effect assume it is random and that founders do not select the new environment or niche. It is concluded that founder events were foundational in the rapid post-Flood diversification that has taken place in history, setting the stage for other processes that contributed to rapid speciation. There is a tremendous need for creation research to further elucidate key details and promote a biblical understanding of natural history.

* Jean K. Lightner, (Corresponding author), jklightner@gmail.com

** Jon Ahlquist, fifth-day@comcast.net

Accepted for publication May 22, 2017

## Introduction

The Bible presents crucial details of natural history. God created life on earth "according to their kinds" (Gen. 1:11–13, 20–31). He pronounced a blessing on them, directing them to reproduce and fill the earth (v. 22 and perhaps implied in v. 28). Humans, who were created in the image of God rather than according to their kinds, started with just two individuals (Gen. 1:26–28; 2:7–29). We are not given any specific figure for the number of individuals in any of the animal or plant created kinds. However, if it was two for the sexually reproducing animals that Adam was required to name, it would have highlighted to Adam the fact that he did not have a suitable helper prior to God creating Eve (Gen. 2:20).

Another pivotal event in natural history was the Flood (Gen. 6–8). In this event, eight humans and two animals from each created kind among flying and terrestrial creatures were preserved; all other creatures in these groupings died (Gen. 7:20–23). This describes what biologists call a population bottleneck, a sharp reduction in the size of a population due to environmental factors. This historical information makes it clear that within any specific kind of land animal or bird, the diversity we see today can be attributed to the diversity carried by the two individuals[1] on the ark and any diversity that has arisen within the thousands of years since the Flood.

The evolutionary worldview assumes a very different history: the diversity of all life descended naturalistically from a single common ancestor. Unfortunately, the distinction between the worldviews is often muddled since the word "evolution" has several meanings, ranging from the change in allele frequency in a population over time (which creationists recognize) to the idea that all life shares a common ancestor (which contradicts the history in Genesis). The latter would not only involve the formation of novel functional genes but also the placement of these genes into the complex, well-integrated networks that are characteristic of life—all by naturalistic processes.

Despite their differences, both evolutionists and creationists need to account for diversification and speciation in animals. Examples of diversification, such as changes in coat color or adaptation to high altitudes, do not involve the formation of new genes or regulatory networks. Instead, they involve adjustments in what already exists to allow for adaptation (Lightner, 2008; Lightner, 2014). Despite this, these types of examples are often promoted at the popular level as examples of evolution (implying it extends to universal common ancestry); the evolutionists who do so seem to be particularly blind to the fact that these examples *require* preexisting complex, well-integrated networks that were specifically designed to allow for such changes (Lightner, 2016a; Lightner, 2016b).

Ideas about the mechanisms involved in speciation have historically been dominated by theoretical work. This is because the mechanisms are normally inferred, based on observations of what currently exists today. Thus, the mechanisms are controversial, both in how they work and to what extent they contribute to speciation. Natural selection, genetic drift, and founder effect have all been debated for decades, and ideas have shifted as new evidence has come to light (Provine, 1989).

Based on extensive fieldwork, such as Peter and Rosemary Grant's prospective study of finches on the island of Daphne Major in the Galápagos (Grant and Grant, 2014), another mechanism has been demonstrated to affect allele frequencies in a population, and at times speciation—namely, hybridization. Other studies and molecular data appear to support this as well (Mallet, 2005; Berner and Salzburger, 2015; Pease et al., 2016). Currently, some biologists are now identifying three major mechanisms that play a role in rapid diversification and speciation (including adaptive radiations): (1) environmentally based sorting of ancestral alleles, (2) mutation, and (3) hybridization (Hedrick, 2013; Pease et al., 2016).

Regarding the environmentally based sorting of ancestral alleles, many people influenced by evolutionary ideology might think first of Darwin's idea of natural selection. While natural selection is a potential mechanism, it is not the first one that should come to mind in a biblical worldview (Lightner, 2015). The Bible lists two times in history when populations spread out from a localized place: after Creation and again after the Flood. Thus, through migration there may have been an unprecedented amount of environmentally based sorting, more than evolutionists would expect with their model. To understand how founder events affect the diversity we see today, we first need to examine how the concept of founder effect has been developed by the evolutionists.

## Development of the Concept

Though Ernst Mayr first mentions the idea of the founder principle in his 1942 book (Mayr, 1942), the first significant discussion of the concept appeared years later in a book chapter entitled "Change of Genetic Environment and Evolution" (Mayr, 1954). The discussion was an attempt to address a peculiar pattern noted by taxonomists, where there are conspicuous differences in the most peripherally isolated populations that

[1] Seven (or seven pairs) of the clean animals were brought on board (Gen. 7:2–3), but the extra animals were necessary for sacrifice and possibly for food for humans after the Flood (Gen. 8:20; 9:3). Though there may be isolated exceptions where more than two animals contributed to the gene pool, the repetition of "two" in the narrative makes it clear that two was the norm (Gen. 6:19–20, 7:2).

do not appear obviously attributable to natural selection alone.

Mayr pointed to the paradise kingfishers (*Tanysiptera hydrocharis-galeta* complex) as one example. On the New Guinea (now Western New Guinea and Papua New Guinea) mainland, three subspecies were recognized that were all very similar in appearance. Yet when members of this group were found on the surrounding islands, they were different enough to be regarded as separate species. Ironically, the mainland has extremely different environments in different regions, yet morphologically the kingfishers are nearly identical. In contrast, kingfishers on the various islands are morphologically different from those on the nearest coast, which generally has very similar environmental conditions.

Mayr proposed that the islands had been invaded by a small number of breeding individuals. Due to the distance from the mainland, there was essentially no migration between the islands and mainland, and thus no gene flow. This contrasts with the mainland, where gene flow is known to occur between different populations and is ostensibly a major factor in maintaining phenotypic similarities between them (for a different view, see Lande, 1980). Mayr posited that the immigrants to the islands would carry only a fraction of the genetic diversity present in the original population.

Mayr argued that the genetic environment (or genetic background) is changed profoundly by a founder event, since many alleles present in the populations on the mainland were now absent. This would mean the alleles still present may have dramatically different selective values. Combining this with the effects of environmental and biotic factors, he postulated a rapid change in gene frequencies simultaneously at many loci, or in other words, a genetic revolution.

Mayr referenced the work of Sewall Wright, a cofounder of the field of population genetics. Wright introduced the concept of a fitness landscape, which compares fitness to a topographic map (Figure 1). Theoretically, natural selection would favor adaptive alleles and drive the population to an adaptive peak (Wright, 1932). The problem was that if there were a higher peak nearby, natural selection would prevent the population from crossing the intervening valley to reach it.

Wright pointed out that in smaller populations—even in the absence of selection, mutation, or migration—allele frequencies would be expected to drift from previous values. This is because, assuming Mendelian inheritance, offspring carry a random sampling of the alleles of the parents. When the population is small, the random sample can easily differ from the parental population. Thus, alleles could be lost or fixed in a population by this random process, without the necessity of natural selection. This effect becomes negligible in a large population where individuals freely interbreed (Wright, 1931, confirmed by many since including creationists Carter and Powell, 2016).

So, genetic drift (from the random sampling of alleles from the parent population) became the mechanism proposed for knocking a population off a theoretical adaptive peak. If it landed at the base of a different adaptive peak, natural selection would carry it up that peak, which might be higher. Now evolutionists had two naturalistic mechanisms for significantly changing allele frequency in a population (which they commonly call evolution): natural selection and genetic drift. In Wright's shifting balance theory, both play an important role.

It is not uncommon for people to view Mayr's founder principle as a special case of Wright's shifting balance theory. Mayr suggested that a founding event would naturally result in a new population that carried a random sampling of alleles from the parent population, and thus it is an example of genetic drift. Mayr wrote of a shift from one set of coadapted alleles (in the parent population), through a period of instability to another equilibrium of balanced integration. This can be compared to traveling from one adaptive peak through an intervening valley to a second adaptive peak. However, several authors have cautioned that despite superficial similarities, considering Mayr's founder effect as merely a special case of Wright's shifting balance theory is overly simplistic (Provine, 1989; Templeton, 2008).

William L. Brown proposed an alternative that he felt would make a greater

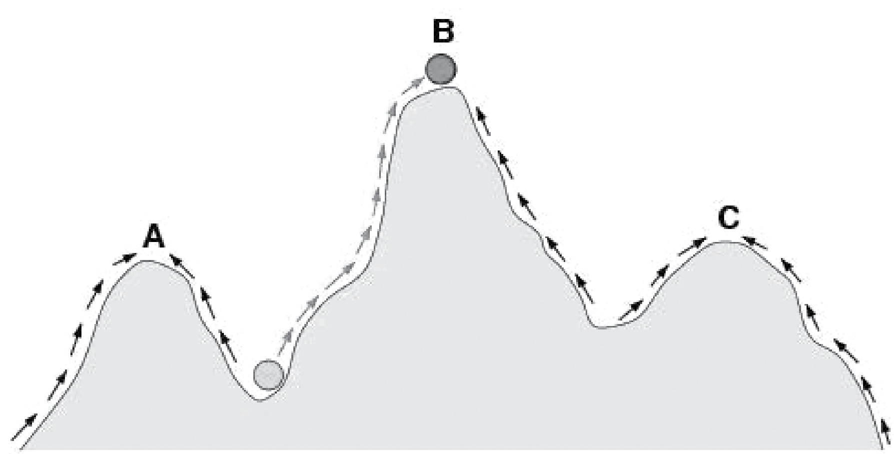



**Figure 1. Simplified diagram of Sewall Wright's "fitness landscape." Original illustration by Claus Wilke used by courtesy of Wikipedia Commons.**

contribution to speciation; he called it centrifugal speciation. He recognized that many populations have been observed to expand their geographical range into less favorable peripheral regions, only to later contract into more favorable refuges. He suggested that during the contraction there may be small breeding populations that remain in restricted pockets or on islands that are favorable enough for survival (Brown, 1957). This is essentially a founder event when they represent a small sample of the larger population, since gene flow is cut off between those remaining in the peripherally isolated pockets and the parental population.

Brown considered his hypothesis stronger than Mayr's because the characters providing the basis for speciation were derived from the more central regions of the population, where variability is naturally expected to be higher (Brown, 1957). In contrast, Mayr had stressed the loss of variability that he believed characterized the founders (Mayr, 1954), causing some to question their ability to further adapt. Both Mayr and Brown cited specific examples in nature where they believed the mechanisms they proposed might be operating.

Hampton L. Carson (1967) further developed the concept by introducing the term "population flush." This is a rare, rapid population growth usually mediated by environmental factors and accompanied by relaxed selection. During this time, an initially variable population could increase available variation dramatically through extensive recombination. Eventually the population would crash, and less favorable combinations of genes would be removed. Similar to Brown's hypothesis, occasional pockets of breeding individuals might remain after the crash and potentially provide the basis of new species.

Both Brown and Carson recognized the cyclic oscillations characteristic of many populations, incorporating it into their models. Both emphasized the importance of initial variability and a role for natural selection. Both recognized that small breeding populations left in the peripherally isolated pockets after the population size contracted could end up being swamped later during the next increase in population size. This, of course, would not lead to speciation. Yet Carson's proposal of relaxed natural selection during the flush theoretically allowed for considerable recombination to break apart previous gene associations that supposedly had been maintained during periods of stronger selection.

Interestingly, Carson discusses an example of a population flush involving inbred laboratory *Drosophila* strains maintained under constant conditions. A dramatic increase in population size was precipitated by the introduction of a single hybrid whose mother was from the population but whose father was from an unrelated laboratory strain. The population size nearly tripled even though the amount of food was kept constant. Carson recognized that this type of hybridization could occur when peripherally isolated pockets of an organism were brought back into contact with the parent population during a subsequent population increase, though he did not consider it as important as other factors (Carson, 1967, pp. 126–127).

Based on Carson's model, Alan R. Templeton developed the concept of "genetic transilience," a rapid shift in a multilocus complex that influences fitness, in response to a sudden perturbation in genetic environment (Templeton, 1980). As with Mayr's proposal, the emphasis was the change in the genetic environment (commonly known as genetic background) leading to altered selection. However, because Templeton postulated the involvement of a smaller number of epistatic genes, he chose to avoid the term "genetic revolution." Based on experimental work, he proposed that loci affecting fundamental development, physiologic, and life history processes were most commonly involved (Templeton, 1980, p. 1013).

Templeton (1980) discusses the various population structures, sampling patterns, and other variables that influence the probability of genetic transilience. As with many after Mayr, he recognized the importance of heterozygosity in the founders to allow for adaptation to the new environment; yet he places importance on inbreeding, which results in homozygosity at some loci. He incorporated both population genetics modeling and laboratory and field observations to develop his model in a way to give it predictive power.

One point of particular note is that Templeton (1980) states that there is no *one* model of founder speciation, a detail that often seems to be ignored in discussions of the topic (p. 1030). Indeed, it is impossible for there to be only one, since there are numerous circumstances, both genetically within the founders and in the environment, which can affect the outcome. These circumstances will vary between different populations. Thus, realistic population genetic modeling would need to be tailored to the specific situation.

There is really no debate that founder events occur. It is well established that a very small number of founders, even a fertilized or pregnant female, can go on to produce a population that can survive and reproduce. In the laboratory, isofemale lines are created by capturing a single wild fertilized female and breeding the offspring together. What has been debated is under what conditions a founder event will lead to speciation (Carson and Templeton, 1984; Lande, 1980; Barton and Charlesworth, 1984; Charlesworth and Smith, 1982; Templeton, 2008).

## Empirical Evidence from Colonizations

There are many known colonizations that have not resulted in speciation.

Mayr (1954) mentions starlings (*Sturnus vulgaris*) and house sparrows (*Passer domesticus*) that were introduced to the United States from Europe. Examples such as these are believed to be generalist or "weedy" species that can colonize new territories but show little change as they do so (Carson and Templeton, 1984, p. 103). Nevertheless, information on colonizations of all types is important to understand how founding events affect the subsequent population. An accumulating number of empirical studies provide some key details in this regard.

In the studies that assess genetic differences, "neutral genetic variation" is generally used. This means short DNA segments that do not code for proteins are sequenced, and from this data, inferences are made. While there are many examples where genetic diversity decreased because of a founding event, there are others where no decrease was detected. Further, even in cases where decreased genetic diversity was identified, it was generally considered moderate (Clegg, 2009; Colautti and Lau, 2015).

Two measures of genetic diversity are often used: allelic diversity (the actual number of alleles at a locus) and heterozygosity (proportion of individuals who are heterozygous at a locus). It is common to find a greater decrease in the first measure than the second. This is because it is relatively easy for rare alleles in the parent population to be lost when a limited number of individuals found a new population. However, loss of rare alleles does little to affect overall heterozygosity. Heterozygosity is considered important in providing a basis for future adaptation of the population (Clegg, 2009).

In addition to the generally mild loss of diversity, there are a surprising number of examples suggesting that rapid adaptation has taken place (Bock et al., 2015; Colautti and Lau, 2015). One particularly interesting example involves the artificial introduction of the brown anole lizard, *Anolis sanrei*, onto seven small Caribbean islands where previous populations had been destroyed when the islands were submerged during a hurricane (Kolbe et al., 2012). This experimental colonization is worth discussing in more detail.

Hind limb length varies adaptively in anole lizards. Those with relatively longer legs can run faster on broad substrates, such as tree branches or trunks. Those with shorter legs in relation to their body size maneuver more deftly on narrower vegetation. The researchers randomly chose seven pairs of lizards from a population adapted to large vegetation and introduced one male and one female to each of the islands with small, scrubby vegetation. Each year they returned to take measurements and tissue samples for genetic analysis.

A clear founder effect was observed, with an average 46% decrease in allelic diversity and 23% in heterozygosity. Each of the new populations increased dramatically during the first two years and fluctuated thereafter. Within three years there was a highly significant decrease in relative hind limb length as the lizards adapted to the smaller vegetation on the islands. Yet despite this rapid adaptation, the genetic and phenotypic traits of the founders were still evident in each population.

One might propose that phenotypic plasticity was involved in this adaptive change, yet that seems unlikely given that the first generation had mean values that completely overlapped those of the founders. By the third generation, the mean relative hind limb length was nearly nonoverlapping. In the end, this study shows that founder effects can play an important role in island divergence, even in cases where adaptation occurs (Kolbe et al., 2012).

Not all introduced species have been observed to undergo such a rapid increase in population size from the outset. In fact, among invasive species it is commonly accepted that a lag phase occurs before a dramatic increase in growth rate (Bock et al., 2015). A variety of reasons have been proposed for this phenomenon. First, it may be that repeated colonization to increase standing variation is a necessary prerequisite in some cases. Second, it is possible that selection can take a while to act on standing variation. Additionally, the lag may be related to the time it takes for a suitable adaptive mutation to occur.

There are also nongenetic factors that may be involved in the lag phase associated with invasive species. These include a sudden change in environmental conditions or dispersal to a more suitable area. However, there may sometimes seem to be a lag phase because no one was really monitoring the population as it grew, and once it is noticed, it is subsequently reported in many new places. While this is an area where more research would be helpful, it is challenging because one cannot generally predict which species will become invasive so they can be monitored from the time they are first introduced (Bock et al., 2015).

## Founder Mutations

The term "founder effect" is often used to refer to the loss of genetic variability in a new population (compared to the parent population) resulting from a founder event. It can also refer to the change in allele frequency resulting from the event, or to unique traits of the founders. In human medicine there is interest in specific mutations carried by the founder(s) (Ankala et al., 2015; Norcliffe-Kaufmann et al., 2016; Ossa and Torres, 2016).

Under most conditions, a new mutation can easily be lost from a population by genetic drift. This is because it starts out so rare, found only in a single individual. The probability of loss is greatest when the population size is large but declining. However, in the case of a founder event where one or more individuals carry a mutation, an increase in population size will result in the mutation becoming quite prevalent even in the absence of selection (Patwa and Wahl, 2008).

The NIH National Cancer Institute dictionary defines a founder mutation as a "genetic alteration observed with high frequency in a group that is or was geographically or culturally isolated, in which one or more of the ancestors was a carrier of the altered gene" (National Cancer Institute, n.d.). Founder mutations are generally recognized as a recurrent mutation seen on the same haplotype background in a specific population (Ankala, et al., 2015). In other words, the mutation shows up repeatedly in the population within the same neighboring DNA sequence.

Founder mutations can be used to trace ancestry, migration, and growth of populations; however, they are primarily of interest in human medicine because they are associated with a high frequency of recessive diseases in some populations (Ankala, et al., 2015). Examples range from mutations in BRCA1 and BRCA2 genes associated with breast cancer to the rare neurologic disorder familial dysautonomia, seen among the Ashkenazi Jews (Ossa and Torres, 2016; Norcliffe-Kaufmann et al., 2016). As genetic studies continue, more examples are continually being identified (Ankala et al., 2015).

## Sorting Out the Variables

In many of the studies involving colonization, the biologists are interested in differentiating between random mechanisms involved in differentiation (i.e., founder effect and genetic drift) and natural selection. Natural selection is generally regarded to be the only mechanism to explain the adaptive differences that are identified. Yet there are other potentially confounding factors that need to be considered. Habitat choice and meiotic drive, for example, may be nonrandom and bias the conclusions.

Generally, evolutionists have assumed that habitat choice that matches adaptive traits to the environment is not involved in colonization. For example, Carson (1967) argued that it is not, perhaps partially because he was attempting to explain the existence of putatively "nonadaptive" characters in certain species. Yet Grant and Grant (2014) clearly documented a colonization where the genetic makeup of the birds that chose to stay and breed on the island was different from those that chose to leave before breeding. This emphasizes the fact that founding events are not necessarily random and that current methods to detect the founder effect are insufficient. The extent to which choice of a suitable environment affects the environmentally based sorting of ancestral alleles remains to be elucidated.

A second potentially confounding factor is meiotic drive. Meiotic drive refers to any of a variety of mechanisms that result in a non-Mendelian inheritance pattern. One example is biased gene conversion, where one allele (version of a gene) is preferentially copied onto the second allele during gene conversion. While evolutionists are aware of this phenomenon, their worldview motivates them to assume it is random with respect to fitness. Yet given the mathematical modeling showing natural selection is not usually very effective at fixing beneficial alleles, meiotic drive may well be a designed mechanism that would normally facilitate the spread of adaptive alleles in the population (reviewed in Lightner, 2015).

There has been discussion of the complexity of adaptive divergence by some in the field. For example, there are several potential sources for the adaptive alleles that natural selection is believed to work on. In addition to the standing variation in the founders, multiple introductions and hybridization can affect the allele distribution. Novel mutations can also be involved, and some authors even discuss the possibility of preadaptation (Bock et al., 2015; Colautti and Lau, 2015). However, currently used statistical methods are not able to identify the founder effect of preadapted organisms; instead, it is attributed to natural selection based on its nonrandom pattern.

## Importance in the Creation Model

Understanding founder events is foundational in reconstructing a plausible natural history using a biblical perspective. After the Flood, there would have been massive global seed germination, since the land was cleared of previous plant life. Scripture mentions that plant regrowth commenced prior to anyone exiting the ark (Gen. 8:11–12). Observational evidence supports the fact that many seeds can germinate after extended exposure to water, even saltwater. In other cases, seeds transported in carcasses (e.g., the crops of dead birds) or sheltered in mats of vegetation would have opportunity to germinate as well (Howe, 1968). Additionally, vegetative propagation could have played a role in plant regrowth (Woodmorrape, 1996).

Not only would the organic matter left after the Flood have provided for vigorous plant growth, but many pollinators are flying creatures (insects, birds) that would have reached these open regions relatively quickly. Thus, by the time land animals migrated out to these regions of the world, there would already be well-established plant communities. Not only would migration and the founding of new populations have been a common occurrence in the years that followed the Flood, but conditions also would naturally be set up for the founder-flush phenomenon proposed by Carson.

As various creatures spread out, founding new populations, there would have been a tremendous amount of sorting of ancestral alleles, the first major component believed to be a part of adaptive radiations. Most of these ancestral alleles would likely have been part of the diversity initially created by God. It is important to note that evolutionary models assume there was no such thing as created heterozygosity, which introduces a bias in their models. This is the reason they make the ill-founded claim that humans must have descended from a group of several thousand individuals (Carter and Powell, 2016; Carter and Lightner, 2016; Hössjer et al., 2016). Yet given the command of God to fill the earth (Gen. 1:22; 8:17) and the importance of heterozygosity in allowing creatures to do so, considerable heterozygosity would logically have been present from the Creation.

There appear to be several factors associated with the environmentally based sorting of ancestral alleles. First, there is commonly some loss of variability when a new population is founded, especially when there are only a few individuals involved. Thus, not all alleles carried through the Flood would become a part of each new population. Much of this loss could be completely by chance, especially when there were many favorable habitats to exploit. At other times, however, the animals could have chosen environments they found most favorable, and thereby carried in alleles that were adaptive in that environment.

Interestingly, in a situation where a few animals carry in adaptive alleles by choosing the environment they find most favorable, it should increase the probability of future speciation. Templeton showed this in his correlated sampling example (Templeton, 1980, pp. 1022–1023). While the initial level of variability is reduced, adaptive alleles are already present. If the population remains isolated, inbreeding would accumulate at a faster rate, increasing chances of changes resulting in speciation. Currently, studies by evolutionists miss this because of the underlying assumption that animals do not choose new environments based on how well they are already adapted to them (e.g., Price, 2008, p. 49).

In summary, while many variables can play a role in diversification and speciation, the multiple founding events that occurred in the years following the Flood would have played a foundational role. In each of the newly founded populations, mutations, genetic drift, natural selection, and meiotic drive would have played variable roles in the process, depending on the specific conditions a particular population encountered. The degree of isolation also likely varied over time, allowing repeated colonization and hybridization to play a role in many cases.

Now it is incumbent on creationists to further develop our models to provide a more detailed, realistic understanding of natural history and how the factors described in the previous paragraph have contributed, under various circumstances, to the pattern of life we see today. This will require an integration of fieldwork, particularly prospective studies that track genetic (and epigenetic) changes through time, DNA analysis, and development of statistical tools and models that more closely reflect the complex reality involved in diversification and speciation.

## Acknowledgements

Support for this work was provided by the Creation Research Society's eKINDS project. The authors thank all the donors of this project for making this research possible.

## References

*CRSQ*: *Creation Research Society Quarterly*

Ahlquist, J., and J.K. Lightner. n.d. Paradise Kingfishers *(Tanysiptera spp.)*, the founder effect, and creation research. *CRSQ* (in press).

Andersen M.J., H.T. Shult, A. Cibois, J-C. Thibault, C.E. Filardi, and R.G. Moyle. 2015. Rapid diversification and secondary sympatry in Australo-Pacific kingfishers (Aves: Alcedinidae: *Todiramphus*). *Royal Society Open Science* 2:140375.

Ankala, A., P.M. Tamhankar, C.A. Valencia, K.K. Rayam, M.M. Kumar, and M.R. Hegde. 2015. Clinical applications and implications of common and founder mutations in Indian subpopulations. *Human Mutation* 36(1): 1–10.

Barton, N.H., and B. Charlesworth. 1984. Genetic revolutions, founder effects, and speciation. *Annual Review of Ecology and Systematics* 15:133–164.

Berner, D., and W. Salzburger. 2015. The genomics of organismal diversification illuminated by adaptive radiations. *Trends in Genetics* 31:491–499.

Bock, D.G., C. Caseys, R.D. Cousens, M.A. Hahn, S.M. Heredia, S. Hübner, K.G. Turner, K.D. Whitney, and L.H. Rieseberg. 2015. What we still don't know about invasion genetics. *Molecular Ecology* 24:2277–2297.

Brown, W.L. 1957. Centrifugal speciation. *The Quarterly Review of Biology* 32(3): 247–277.

Carson, H.L. 1967. The population flush and its genetic consequences. In Lewontin, R.C. (editor), *Proceedings of the International Symposium Sponsored by Syracuse University and the New York State Science and Technology Foundation*, pp.123–137. Syracuse University Press, Syracuse, NY.

Carson, H.L., and A.R. Templeton. 1984. Genetic revolutions in relation to speciation phenomena: the founding of new populations. *Annual Review of Ecology and Systematics* 15:97–132.

Carter, R.W., and J.K. Lightner. 2016. Human genetic data affirms biblical history on many levels and is an excellent resource for creation-based research. *CRSQ* 52:249–255.

Carter, R.W., and M. Powell. 2016. The genetic effects of the population bottleneck associated with the Genesis Flood. *Journal of Creation* 30:102–111.

Charlesworth, B., and D.B. Smith. 1982. A computer model of speciation by founder effects. *Genetical Research* 39:227–236.

Clegg, S. 2009. Evolutionary changes following island colonization in birds. In Losos, J.B., and R.E. Ricklefs (editors), *The*

*Theory of Island Biogeography Revisited*, pp.293–324. Princeton University Press, Princeton, NJ.

Colautti, R.I., and J.A. Lau. 2015. Contemporary evolution during invasion: evidence for differentiation, natural selection, and local adaptation. *Molecular Ecology* 24:1999–2017.

Grant, P.R., and B.R. Grant. 2014. *40 Years of Evolution: Darwin's Finches on Daphne Major Island*. Princeton University Press, Princeton, NJ.

Hedrick, P.W. 2013. Adaptive introgression in animals: examples and comparison to new mutation and standing variation as sources of adaptive variation. *Molecular Ecology* 22:4606–4618.

Hössjer, O., A. Gauger, and C. Reeves. 2016. Genetic modeling of human history, part 1: comparison of common descent and unique origin approaches. BIO-complexity. http://bio-complexity.org/ojs/index.php/main/article/view/BIO-C.2016.3 (accessed November 12, 2016).

Howe, G.F. 1968. Seed germination, seawater, and plant survival in the great Flood. *CRSQ* 5:105–112.

Kolbe, J.J., M. Leal, T.W. Schoener, D.A. Spiller, and J.B. Losos. 2012. Founder effects persist despite adaptive differentiation: a field experiment with lizards. *Science* 335:1086–1089.

Lande, R. 1980. Genetic variation and phenotypic evolution during allopatric speciation. *The American Naturalist* 116:463–479.

Lightner, J.K. 2008. Genetics of coat color I: the melanocortin 1 receptor (MC1R). *Answers Research Journal* 1:109–116.

Lightner, J.K. 2014. Adaptation of endotherms to high altitudes. *CRSQ* 50:132–140.

Lightner, J.K. 2015. Natural selection: assessing the role it plays in our world. *Answers Research Journal* 8:111–119.

Lightner, J. 2016a. Review of *The Making of the Fittest: Evolving Switches, Evolving Bodies* (video). *CRSQ* 52:325–326.

Lightner, J. 2016b. Review of *The Making of the Fittest: Natural Selection and Adaptation* (video). *CRSQ* 52:326–327.

Mallet, J. 2005. Hybridization as an invasion of the genome. *Trends in Ecology & Evolution*. 20:229–237.

Mayr, E., 1942 *Systematics and the Origin of Species*. Columbia University Press, New York, NY.

Mayr, E. 1954. Changes in genetic environment and evolution. In Huxley, J., A.C. Hardy, and E.B. Ford (editors), *Evolution as a Process*, pp. 157–180. Allen and Unwin, London, UK.

National Cancer Institute. n.d. *NCI Dictionary of Genetics Terms*. https://www.cancer.gov/publications/dictionaries/genetics-dictionary?cdrid=570712 (accessed November 16, 2016).

Norcliffe-Kaufmann, L., S.A. Slaugenhaupt, and H. Kaufmann. 2016. Familial dysautonomia: history, genotype, phenotype and translational research. *Progress in Neurobiology* DOI: 10.1016/j.pneurobio.2016.06.003

Ossa, C.A., and D. Torres. 2016. Founder and recurrent mutations in BRCA1 and BRCA2 genes in Latin American countries: state of the art and literature. *Oncologist* 21:832–839.

Patwa, Z., and L.M. Wahl. 2008. The fixation probability of beneficial mutations. *Journal of the Royal Society, Interface* 5(28): 1279–1289.

Pease, J.B., D.C. Haak, M.W. Hahn, and L.C. Moyle. 2016. Phylogenomics reveals three sources of adaptive variation. *PLoS Biology* 14:e1002379. http://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.1002379

Price, T. 2008. *Speciation in Birds*. Roberts and Company Publishers, Greenwood Village, CO.

Provine, W.B. 1989. Founder effects and genetic revolutions in microevolution and speciation: an historical perspective. In Giddings, L.V., K.Y. Kaneshiro, and W.W. Anderson (editors), *Genetics, speciation and the founder principle*, pp. 43–76. Oxford University Press, New York, NY.

Templeton, A.R, 1980. The theory of speciation *via* the founder principle. *Genetics* 94:1011–1038.

Templeton, A.R. 2008. The reality and importance of founder speciation in evolution. *Bioessays* 30:470–479.

Woodmorrape, J. 1996. *Noah's Ark: A Feasibility Study*. Institute for Creation Research, Santee, CA.

Wright, S. 1931. Evolution in Mendelian populations. *Genetics* 16:97–159.

Wright, S. 1932. The roles of mutation, inbreeding, crossbreeding and selection in evolution. In Jones, D.F. (editor), *Proceedings of the Sixth International Congress of Genetics*, pp. 356–366. Brooklyn Botanic Gardens, Brooklyn NY.

# Minutes of the 2016 Creation Research Society Board of Directors Meeting

The Creation Research Society (CRS) Board of Directors fifty-third annual meeting was held 2–4 June 2016 at the Drury Inn in Birmingham, Alabama.

President Don DeYoung called the first session of the general board meeting to order at 19:00 on Thursday, 2 June 2016. The following board members were present: Rob Carter, Gene Chaffin, Don DeYoung, Robert Hill, Jean Lightner, Gary Locklair, Michael Oard, John Reed, Ron Samec, and Glen Wolfrom. VACRC director Kevin Anderson and professional staff member Diane Anderson were also present. Board members Danny Faulkner and Russ Humphreys were not present. Don outlined the agenda for our meetings. The first part of the general board meeting would be Thursday evening. Friday would be dedicated to committee meetings. Friday evening would be at Faith Presbyterian Church. The second half of the general board meeting would be on Saturday.

President DeYoung thanked John and Diana Reed for hosting and coordinating the meeting. He reviewed the duties of board members and shared some thoughts about creation and the current state of the Society. In 1998 we spent a day considering long-range plans, and we considered how well we have accomplished our goals. As a Society we must grow and improve. We need to communicate our mission and purpose to scientists.

Don asked each board member to provide a brief update on his or her life and work. He shared a number of letters from friends and supporters. Our iDino research project continues to generate interest and support. The annual disclosure statement was read and signed by all board members

Recording secretary Gary Locklair asked for corrections or additions to the 2015 meeting minutes as published in the winter 2016 *CRSQ* (Vol. 52, No. 3). The minutes stood approved as printed. Gary reported the results of the 2016 board elections. With 182 ballots received, the following were elected to a three-year term: Don DeYoung, Russ Humphreys, Gary Locklair, and Ron Samec The board now stands at 13 members. A list of future candidates suggested by the membership was presented.

A discussion regarding the late publication schedule for the *CRSQ* ensued. This is an issue that needs to be monitored and corrected.

Financial secretary Bob Hill reported that our income should be $230,000 for this fiscal year, which is a slight increase from the previous fiscal year. He noted that 69% of Society income is from donations, 20% from membership fees, and 10% from book sales. Bob reminded the board that scientists don't usually consider money, but "with no bucks, there's no Buck Rogers." The future of the Society depends upon our recruitment rate, our retention rate, and our return on investment. Bob provided instructions regarding the budget for Friday committee meetings. He encouraged the board to be cautious regarding proposed expenditures.

Earlier in the day, the lab committee met. Our laboratory facilities, now 20 years old, are in good shape. The iDino principal investigator, Kevin Anderson, reported a book has been produced and a video is in production. The iDino project received more than $50,000 this past fiscal year. Now that almost everyone accepts there really is soft dinosaur tissue, the evolution community is working on preservation mechanisms. iDino demonstrates there is no need for a rescue mechanism if the tissue is only thousands of years old (and not millions). The lab budget increased due mainly to a 233% increase in health insurance premiums.

The upcoming CRS conference will be held on the campus of Concordia University, Ann Arbor, Michigan. So far, 60 are registered, and we are expecting 100 attendees. There was some discussion whether our conference should be held every year or every other year. The

CRS conference is designed for scientists to share their research into the creation model of origins.

For the past year, several board members have been in discussion with the administration of Concordia University, Ann Arbor, about locating the Society's research center on campus. The administration is very supportive of this. At the same time, there are issues relating to space that would need to be addressed. This conversation will continue.

Possible locations for the fifty-fourth annual board meeting were discussed. The board will be meeting on the campus of Concordia University in Mequon, Wisconsin next June. Gary and Karen Locklair will host the meeting. It is likely the board will meet at the Society's research facilities in 2018.

The CRS constitution specifies that the board must be composed of between 12 and 18 members. Bob Hill nominated Tim Clarey for the board. There will be five names on the upcoming ballot for the board of directors: Rob Carter, Tim Clarey, Danny Faulkner, Bob Hill, and Mike Oard.

The first session of the full board meeting adjourned at 20:45.

Friday, 3 June 2016, was devoted to committee meetings. The constitution, finance, Internet, membership, periodicals, publication, and research committees all met and conducted business. (The lab committee met previously on Thursday afternoon.)

These individuals chaired the standing committees of the CRS: Don DeYoung, the lab committee; Gary Locklair, the Internet committee; Gene Chaffin, the periodicals committee; Mike Oard, the publication committee; Glen Wolfrom, the membership committee; Gary Locklair, the constitution committee; Gene Chaffin, the research committee; and Bob Hill the finance committee.

Financial secretary Bob Hill led a full board discussion on the future of the Society.

Friday evening several board members spoke at Faith Presbyterian Church in Birmingham.

The second part of the general board meeting was called to order at 08:30 on 6 June 2015 by Vice President Gene Chaffin. The following board members were present: Jerry Bergman, Rob Carter, Gene Chaffin, Robert Hill, Jean Lightner, Gary Locklair, Michael Oard, Ron Samec, and Glen Wolfrom. VACRC director Kevin Anderson and professional staff member Diane Anderson were also present.

Ron Samec led a devotion on the sun for the board. Ron referenced the Sun-in-Time project. While the evolution model supposed it would be easy to find analogs to our sun in the galaxy, it turns out that the sun is special. Of the two million stars cataloged by the Tycho project, only two are somewhat similar to the sun. The sun is an oddity in the universe. Evolution models cannot explain the main problems of a "young sun" billions of years ago. It is more reasonable that the sun was created with a special purpose. The sun was designed to sustain and nurture life on earth. The Creator, who made the sun on Day 4, is worthy of praise.

Internet committee chairman Gary Locklair reported on matters relating to the CRS website, CRSnet, and the CRS Facebook page. The excellent work of volunteer webmaster Fred Williams was noted. The committee proposed we contract with a website developer to revamp, redesign, update, and expand our website. As part of the update, all of our current content needs to be preserved. Our rich heritage of research needs to be accessible online. The committee proposed the Society expend \$10,000 to contract for a website update and redesign. There was discussion regarding our next steps (e.g., a content management system, etc.). These issues will be for Phase 2 after the new website is running. The committee moved an expense budget of \$12,000. The motion was approved.

Gene Chaffin, periodicals committee chairman, indicated the winter Quarterly (*CRSQ*) is currently at the printers. The spring issue will be out in the next fiscal year. The spring issue will be a special on genetics. There has been an increase in articles. There was discussion regarding special (themed) issues. The production timeline was shared, and Gene stated it takes 6 weeks for our

graphic designer, Cindy, to lay out an issue. The board discussed managing and assistant managing editor positions and responsibilities. Five issues of the *CRSQ* will be produced in the upcoming fiscal year, resulting in an increased budget. *Creation Matters* editor Glen Wolfrom stated that article submissions have increased, and he would like to have some new authors. Glen commended Jean, John, and Don for their on-going columns (a new regular column by John Reed has commenced). The committee moved an expense budget of $45,000. The motion was approved.

Publication committee chairman Mike Oard shared that the Society has published both eBook and print-on-demand titles and has plans for additional eBooks and print-on-demand titles. He thanked Glen for his work on setting this up. The board discussed better ways to advertise and promote our publications. Mike suggested that someone should be identified to coordinate our marketing efforts. An advantage of print-on-demand is we can offer technical publications without having to maintain a large stock on hand. Mike suggested the Society consider reviving technical monographs. Postage rates have increased for mailing publications. The committee moved an expense budget of $12,000. The motion was approved.

Glen Wolfrom, membership committee chairman, reported that membership activities have been fully transferred to Diane. Total membership stands at 1587, a slight increase from last year. Due to our future-leaders program, student memberships have increased to 67. The Society currently has 644 voting members. The board thanked Glen for his useful graphical presentation of membership data. The committee moved an expense budget of $3,000. The motion was approved.

Research committee chairman Gene Chaffin shared that no new research projects were approved this year. The board discussed ways to encourage student research with the Society. The committee moved to permit student research as follows: A student member of the CRS may apply for research grant with a mentor's support. The mentor must be a voting member of the CRS. This motion was approved. A form will be developed that can be used to apply for student research funding. The current research projects were shared with the board. The committee moved an expense budget of $10,000. The motion was approved.

Gary Locklair, constitution committee chairman, reported on several issues related to the bylaws, ideas for long-range planning, and Society incorporation. Since our inception, we have been incorporated in the state of Michigan. Our attorney suggested we consider incorporating in the state of Arizona. The committee moved that the Society expend up to $3,000 to incorporate in the state of Arizona with Kevin Anderson, working with our attorney, investigating the process. The committee moved an expense budget of $4,000. Both motions were approved.

Diane Anderson reported for treasurer Danny Faulkner. Our checking account has a good balance for day-to-day expenditures. While we have had cash flow issues historically, now we are financially healthy. No draw was made from our endowment fund this year. We estimate income of $231,000 for the fiscal year. Planned expenditures are estimated at $250,000 for the Society.

Financial secretary Bob Hill reported on the Society's financial holdings. He presented a history of our endowments from 2000 to the present. Our investments have been nearly flat for the past 18 months. Bob will investigate changing our very conservative invest-

ment strategy to one with a little more risk in the hopes of generating more income. Bob reviewed the proposed committee budgets for 2016–2017. The following committee budget requests were approved: VACRC (lab)–$181,700; Executive/Treasurer–$14,000; Membership–$3,000; Publication–$12,000; Periodicals–$45,000; Research–$10,000; Internet–$12,000; Constitution–$4,000; Finance–$0.

An expense budget of $281,700 was approved for fiscal 2016–2017. This budget represents a $24,000 increase over last year's expense budget. A motion was approved to authorize Diane to withdraw up to $20,000 without executive committee permission to cover Society expenses. Diane will notify the board if a draw is required.

The board submitted the names of Rob Carter, Tim Clarey, Danny Faulkner, Bob Hill, and Mike Oard as candidates for the 2017 board of directors election.

Election of board officers was held. Don DeYoung was elected president, Gene Chaffin was elected vice-president, and Gary Locklair was elected recording secretary. The following were elected for the second year of a three-year term: Glen Wolfrom as membership secretary, Bob Hill as financial secretary, and Danny Faulkner as treasurer.

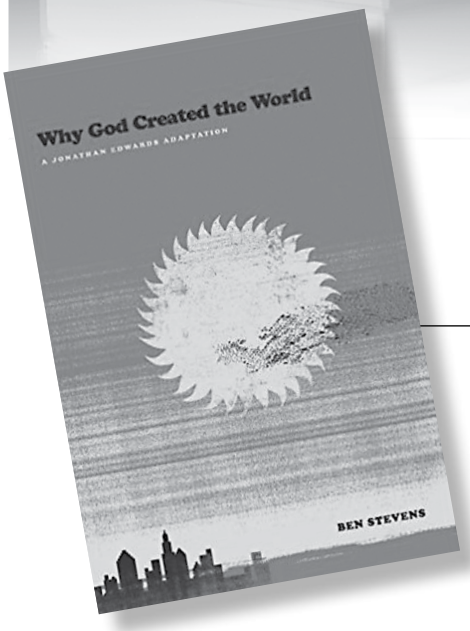
Jerry Bergman presented the findings of his personal survey of active creationists. He indicated it is important to get feedback from our membership regarding issues they identify as important. According to the survey, most respondents feel it is important both to respond to evolutionary claims and to present positive creationary evidences.

The board discussed the CRS logo, as there seem to be several different logos in use. It was decided that all entities should use the official CRS logo, available in digital form from Glen.

It should be noted that much discussion is taking place in-between meetings, informally, as should be expected in any healthy group.

The meeting was adjourned at 11:30.

**Respectfully submitted,**
**Gary Locklair**
**CRS Recording Secretary**


## *Why God Created the World: A Jonathan Edwards Adaptation*

**by Ben Stevens**

Tyndale House Publishers,
Carol Stream, IL, 2014,
155 pages, $14.00

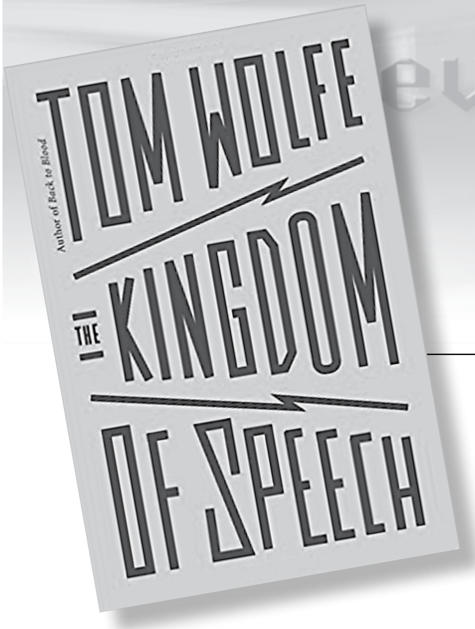
Many people, especially creation scientists, spend a lot of time thinking and discussing *how* God created the world. This question is certainly an important one, and the young-earth perspective has much to offer regarding the answer. A more foundational question, and one that should be a subject of reflection for all Christians, is *why* God created. Stevens suggests that the answer to this question provides the backdrop for how we ought to view God, ourselves, and, in fact, the entire universe and its history, which includes origins and Creation research. This book, adapted into modern English from an original work by Jonathan Edwards entitled "A Dissertation Concerning the End for Which God Created the World" (1765, Posthumous), invites us to consider God's perspective on why He created.

We might imagine many possible reasons for God to create: perhaps because of His love for us, or because He wanted to have a relationship with us. These reasons, while important from our perspective, cannot be the primary reason God created because (1) we did not exist prior to creation, and (2) God did not create out of a need that He had. The real reason, found at the end of chapter 2, forms the central thesis of the book. God creates, not primarily to have a relationship with us or because of us; instead, "Creation must have resulted from the way God saw the value of expanding Himself: His goodness, truth, beauty, and all the things which are a part of Him" (p. 16). This way of thinking, which begins with God instead of with us, promises to change our whole understanding of who we are, why we are here, and why God created the world.

The book is organized into two parts: "logical" arguments and "scriptural" arguments. Stevens and Edwards begin by using analogies from art and family life to show us that Creation accomplishes something that God values and that expands His own glory and goodness. They then take us on a grand tour of Scripture to show us how the entire Bible sheds light on the subject. Although there are few places in Scripture that directly touch on the subject, many verses give us hints and glimpses into God's original motives for Creation. In addition to the main work, there are several appendices covering miscellaneous topics: Use of the book for small-group study, a brief biography of Jonathan Edwards's life, and a description of how Stevens adapted the original work by Edwards.

For those who have already studied the works of Jonathan Edwards, this adaption will be a refreshingly clear, concise work that retains the essential themes of the original while using some reorganization and updated language to make the work easier. For those new to Edwards, this is a great introduction to his work, and the topic is relevant to all believers. Young-earth creationists should view the work as a refreshing and edifying reminder of why we do what we do and a means to keep our work in the broader perspective of God's eternal plan for glorifying Himself. As creation scientists, we have a unique ability to convey the revelation of God's beauty, truth, and goodness in the natural world to others, and in doing so we directly fulfill God's purpose in creating.

**Jeremy Maurer**
**Maurer.jeremy@gmail.com**




## *The Kingdom of Speech*

**by Tom Wolfe**

Little, Brown and Company, New York, 2016, 185 pages, $26.00

Tom Wolfe, the iconic author of *Bonfire of the Vanities* and *The Right Stuff*, has donned his journalistic hat and invaded the sacred halls of evolutionary linguistics. This book is a very readable, interesting, and revealing examination of the problem of the origin of language and the apparent dead end that modern linguistics has reached. I found the book particularly interesting as one of my early forays into this area was Mortimer Adler's *The Difference of Man and the Difference It Makes* (1967).

Where Adler spent long paragraphs detailing exacting philosophical differences between "differences in degree" and "differences in kind" (complete with diagrams), Wolfe prefers to address the characters of the story. The first part of the book explores the relationship between Charles Darwin and Alfred Wallace, with Charles Lyell, Thomas Huxley, and Joseph Dalton Hooker playing nefarious supporting roles. Wolfe emphasizes the role that the social stratification of Victorian England played in Darwin and his "old pal" gentlemen hijacking Wallace's theory of natural selection and later turning him into a fawning acolyte. Wolfe recounts that Wallace was a plebian "flycatcher," collecting tropical samples in harsh jungle conditions for those who did not want to sully their hands with such work. Upon returning to England, he discovered that his idea had evolved into Darwin's. He could fight a losing battle or play along and accept the small slice of reflected glory graciously dispensed by the luminaries that were his betters.

Though Darwin thought he had, in *Origin of Species*, successfully hidden his agenda of grouping humans and animals by a common evolutionary descent, it was transparent almost immediately, long before *The Descent of Man*. But one of the irritating splinters under Darwin's skin was German linguist Max Müller, who stated in 1861, "Language is our Rubicon, and no brute will dare cross it" (p. 54). The origin of language continued to bedevil Darwin for the rest of his life; Müller evidently proved adept at publicly ridiculing a sensitive Darwin's attempts to explain it. Wolfe takes great delight in following in Müller's shoes, comparing Darwin's labored attempts to Kipling's *Just So* stories.

Wolfe jumps forward to the middle of the twentieth century, to Noam Chomsky (b. 1928), noting that the period between Darwin and Chomsky was a "Dark Age" for linguistics. In the 1950s and 60s, Chomsky developed explanations for language that fit well with evolutionary anthropology, and he dominates the discipline to this day. Wolfe draws a fascinating parallel between Darwin and Wallace, and Chomsky and Dan Everett, the linguist famous for living among the primitive Pirahã tribe in the Amazon for many years, learning their conceptually simplistic but phonetically difficult language and using his findings to challenge Chomsky's core theories.

Wolfe parallels the influence of the social structure in both periods, highlighting the animosity of the academic elites against a "field" man, who had dabbled in Christianity, to boot! Yet the result has been the admission by Chomsky and other leaders in their field, in a 2014 article, "How Could Language Have Evolved?" that "the evolution of the faculty of language largely remains an enigma" (p. 150). Wolfe is amazed:

> *Language – what is it? What is it?* Chomsky's own words at age eighty-five after a lifetime of studying language! The previous 150 years had proved to be the greatest era ever in solving the riddles of *Homo sapiens*—but not in the case of *Homo loquax*, man speaking. A parade of certified geniuses had spent lifetimes trying to figure it out—and failed. (p. 151)

Wolfe is no friend of Christianity, but he understands that evolution is a barrier in linguistics, rather than an aid to explanation.

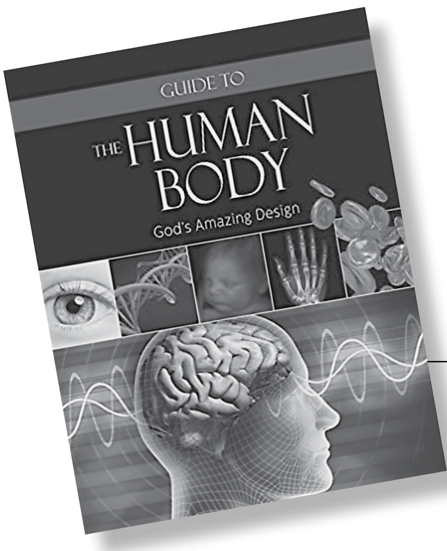
Whether it was Darwin alone at his desk in 1870 thinking, between bouts of vomiting, of ways to get around Alfred Wallace's objections that he couldn't account for speech … or Chomsky plus the truth squad with Berwick at the keyboard chundering out fantastical arrays of calculus sigma blades … or any of the scores of hypotheses in the 150 years in between … all were based on the same "uncontroversial" assumption. That was Chomsky's and his MIT colleagues' very word in their August 2014 article in *PLoS Biology* entitled "How Could Language Have Evolved?" That it had evolved was a given. Rare was the linguist, the psychologist, the anthropologist who could entertain the notion that something as fundamental to human life as language might be an artifact. (p. 159)

*The Kingdom of Speech* is as entertaining as one would expect from Tom Wolfe, but it is also a clear, contrarian critique of evolutionary linguistics. It also provides interesting insights into the character and motivation of Darwin, Lyell, and their fellow secular revolutionaries. It is short enough and requires only a pleasant few hours. It is certainly worth the time.

**John K. Reed**
**reed4004@gmail.com**

## Reference

Adler, M.J. 1967. *The Difference of Man and the Difference It Makes*. Holt, Rinehart, and Winston, New York, NY.




# *Guide to the Human Body*

**edited by Jayme Durant**

Institute for Creation Research, Dallas, TX, 2015, 116 pages, $20.00

This is the fourth entry in the *Guide* series with earlier volumes titled *Creation Basics*, *Animals*, and *Dinosaurs*. These 9 x11-inch hardbacks have outstanding pictures in full color, especially of people. The books are a delight to page through.

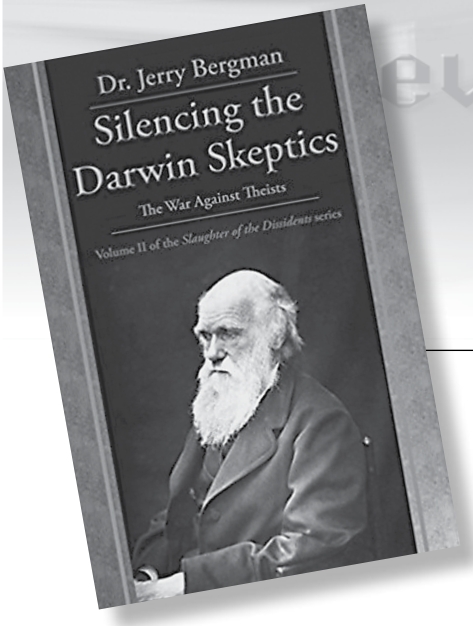
The human body is described in terms of eleven interrelated systems: integumentary (skin), respiratory, circulatory, digestive, skeletal, endocrine, reproductive, urinary, muscular, nervous, and immune. The solid case is established that each of these systems is related in irreducible complexity.

Some interesting tidbits follow: An adult body consists of 30 trillion cells. Of the 206 total bones in our body, 22 are in the skull, and about 50 in the feet (pp. 11, 18). *Gray's Anatomy* of the human body has gone through at least 30 revisions since its start in 1858. The many additional topics include athletic success (p. 90), bioethics (p. 104), cancer (p. 80), CPR (p. 84), comparison with animals (p. 102), gigantism (p. 95), dimples and freckles (pp. 16, 17), living in space (p. 98), organ transplants (p. 86), and so-called vestigial organs (p. 88).

Research shows that our bodies are accumulating harmful mutations at a nontrivial rate. The timescale for this deterioration conflicts with evolutionary deep time and fits with young earth creation: "This degradation, called *genetic entropy*, fits perfectly with a recent creation of six or so thousand years ago" (p. 78). I would suggest that the word "perfectly" is a bit strong in view of the uncertainties of mutation frequency and exact earth age.

The book has a helpful index and mention of the eight contributing authors. Well-done compliments to the ICR for this helpful volume.

**Don DeYoung**
**DBDeYoung@Grace.edu**




# *Silencing the Darwin Skeptics*

**by Jerry Bergman**

Southworth, WA: Leafcutter Press, Southworth, WA, 2016, 396 pages, $25.00

"Death to those who oppose Darwinism! Death to the Christers (exact quote)" reads the blog volokh.com about the freedom to teach anti-Darwinism (p. 56). This is seemingly the lowest that Darwinists in secular academia and the media would stoop in their attempt to silence those who dare to oppose Darwinian ideology in America. Author Bergman rightly notes that if the government is allowed to suppress the freedom of one group, it opens the door to suppress the freedom of other groups. Thus, we must understand the situation in secular academia so as to be able to properly respond to it. The situation in academia is only one step toward complete intolerance against creationists, a parallel with what happened to Jewish people in Nazi Germany, as covered in chapter 10. It is imperative that this intolerable situation is more widely known to help facilitate dealing with it. Tributes to Bergman, who was able to stomach the mocking and slanderous comments that he summarized after reading through the atheistic blogs and university discrimination cases.

Bergman is a prolific creationist writer with nine degrees, including two PhDs. He has written over 800 articles and 40 books and has taught at several universities. This book has an index, an appendix by Ohio Supreme Court Judge Pfeifer, and is documented by 1,186 references. The book presents thorough research on the situation creationists face in secular academia and public schools. The book is an easy read and is intensely gripping as it opens the reader up to the hitherto little-known problem of secular oppression against Christians. The book is a must-read if one wants to understand this issue.

As some 100 million Americans do not accept Darwinism, and 45 percent of the populace believe in creation (p. 273), one could argue that their views should be fairly represented in secular academia. Ironically, creation science and intelligent design have next to a zero chance of being fairly expressed there. Even theistic evolutionists, in spite of their compromised theology, are not safe. Nor are even some evolutionists, such as University of Vermont professor John Davison, who proposed the semi-meiosis mechanism to explain evolution (p. 125). Creation scientists, even those who have sterling academic credentials, are legally not allowed to bring up scientific evidence that refutes evolution. Charges include religious bias, interference with science, and "proselytizing" students. This is despite the fact that the main argument the ACLU (which defends the rights of Nazis, pedophiles, anarchists, terrorists, and Ku Klux Klan members [p. 87]) argued during the 1925 Scopes trial was that both creation and evolution should be taught in science classrooms. Furthermore, there have always been many Christians involved in science, such as Gregor Mendel, the father of genetics and Augustinian monk who preceded Darwin by 50 years.

Approximately 10,000 American scientists are strict creationists (a mere 0.15 percent of all American scientists [p. 51]; Witham, 1997), yet evolutionary ideologues claim that creation science and intelligent design advocates want to bring about a theocratic police state (p. 254). The methods the "secularocracy" employs bespeaks of Middle Age inquisition techniques, when inquisitors were dispatched to inquire about the presence of heretics in certain communities. The phenomenon of expelling creationist teachers from their classrooms is also similar to the 1662 Act of Uniformity, when Puritan preachers were ejected from their pulpits because they didn't agree with the Church of England rites and worship (Beeke and Pederson, 2006). Examples Bergman cites include the National Education Association (NEA) sending out questionnaires to state organizations "asking teachers to identify those who believe in creationism." The NEA also obstructs Christian speakers from presenting on campuses, opposing Christians' right to free speech, and opposes Christians' use of public school facilities on Sunday (p. 100). The situation is also somewhat similar to what happened during the Communist era, when the state actively infiltrated the church in order to control it.

Darwin skeptics suffer from lower salaries, suspension of teaching certain classes, termination, denial of tenure and rightfully earned degrees, and sometimes even jail, loss of health, or in extreme cases physical assault and murder (pp. 111–112, 215, 265). Yale University openly advised, "Students with strong religious convictions should go elsewhere" (p. 81). The court system is also very biased against creationists who bring lawsuits against their former employers to rectify unlawful termination cases. Their chance of prevailing is almost zero in these cases, despite solid evidence that discrimination had occurred. A spokesperson for the ACLU rather hypocritically stated that "the Constitution guarantees only the freedom to practice one's religion, not protection from being fired because of it" (p. 89). Secularists in academia and the courts often refer to the separation-of-church-and-state principle despite the fact that the founding fathers intended this country to be a Christian nation. In their terms, that meant that while prohibiting an established denomination (Kayser, 2015), Christianity was never meant to be disestablished, but rather supported. The Bible was taught in public schools for over 200 years without opposition. The great irony is that the Declaration of Independence, the founding document of this nation, declared that men have inalienable rights endowed to them by their Creator.

As described by Bergman, shortly after the fall of communism in 1990, Eastern European countries such as Russia and Romania invited scientist Dr. Charles Thaxton (coauthor of the book *The Mystery of Life's Origins*) to present his intelligent design views to the leading scientists and educators. Hundreds of people attended his lectures and read his books. As a member of a Hungarian creationist ministry around 2005, I can corroborate the fact that creationism and ID are more openly accepted in Eastern Europe than in the US. As part of our ministry activities, we offered creationist books for sale, one of which was Thaxton's book, at Budapest Technical University. Two university staff walked by, resulting in conversation something like this: "You know, this author supposedly proved that chemical evolution has never happened." "Really?" said his colleague with a tone of interest. They then bought a copy of the book. My atheist supervisor knew that I was a creationist while I did my PhD work in Szeged, Hungary, and never during my eight years there did I suffer any career setbacks. The Hungarian television station, MTV2, also hosted a creation/evolution discussion between a creationist professor and an evolutionist professor.

One of the most sordid cases described in the book is the case of John Freshwater, a high school science teacher in Mount Vernon, Ohio. As thoroughly documented in the book, Freshwater was harassed, discriminated against, and ultimately terminated for such harmless activities as having a Bible on his desk (when copies of the Bible were in the school library), having Bible verses on his classroom's wall (as did other teachers, and despite the fact that displaying the state motto, "With God all things are possible" in schools is mandatory), praying at a Fellowship of Christian Athletes meeting, having a poster of Colin Powell in his room that was given to him by the school, and allegedly teaching the weak points of evolutionary theory. On this point, the Supreme Court ruled in 1987 in *Edwards v. Aguilard* that teaching creation science is legal if certain criteria are met (p. 341). All this despite the fact that Mr. Freshwater was a beloved teacher and had a nearly 20-year stellar teaching record.

In summary, the situation in academia now looks bleak and is getting worse. Speaking from my own experience as a victim of religious harassment at a former workplace, secularists behave as if academia is their exclusive playground, off-limits to anyone who questions Darwinism. Such oppression would not be tolerated if it was leveled against feminists, gays, blacks, or Muslims. The situation has gotten so bad that creationists have even been expelled from academic institutions that call themselves Christian, such as the dissolution of the Polanyi Center at Baptist Baylor University (p. 289). I suggest (and this is also a conclusion made by the book) that instead of trying to fight an uphill battle of acceptance in secular academia, the time has come for Christian creationists to withdraw from secular academia and build their own colleges.

Many PhD-level creationist researchers in secular academia, including myself, feel similar to Martin Luther when he asked himself if he should remain in the Roman Catholic Church. If Christians work toward building institutions explicitly for creation research, pioneering new fields of creation science, and establishing more creation science journals, we would then be unhindered to present scientific results to spread the gospel and build a Christian school of thought with which to reform the nation.

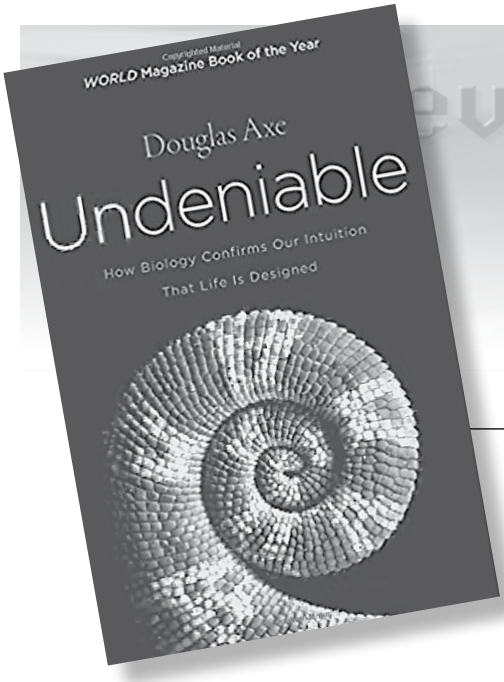
**Jean O'Micks**
**csmatyi1@gmail.com**

## References

Beeke, J.R., and R.G. Pederson. 2006. *Meet the Puritans*. Reformation Heritage Books, Grand Rapids, MI.

Kayser, P. 2015. Christian Nation? Biblical Blueprints Series, biblicalblueprints.org.

Witham, L. 1997. Many scientists see God's hand in evolution. *Reports of the National Center for Science Education* 17(6): 33.




# *Undeniable: How Biology Confirms Our Intuition that Life Is Designed*

**by Douglas Axe**

Harper Collins, New York, 2016, 298 pages, $26.00

Author Douglas Axe did his graduate study in molecular biology at Caltech and the University of Cambridge. He is a rising star in intelligent design (ID) and currently directs the Discovery Institute in Seattle. It is refreshing that Axe tells the full biblical worldview in his ID discussion, including many references to the Creator of the universe.

Axe is an experimental scientist with cutting-edge research credentials and many published papers on protein structure and function. His work shows that unguided processes cannot produce successful proteins even if unlimited time is available. This conclusion is backed up in the text with illustrations of complex amino-acid appendages that form protein structures.

The book gives refreshing credit to readers who may lack background in science training. Axe describes a universal design intuition, or common sense, which he declares as a valid evaluator of major science ideas. Thus, even a child knows by sight and experiences that things as simple as bricks or shoes require a designer. And even the most sophisticated man-made technological successes fall far short of what we see in nature every day. One comparison is between the underwater vehicle *Tavros* 2 and a dolphin (p. 164). The vehicle is completely outclassed by the frolicking dolphin.

Discussion is given to the mechanism and limits of natural selection. Axe limits the entire process to a "fiddling" with genetics on a micro level, and that is often retro or harmful in nature. His research on guided mutations of genes repeatedly led to their irreversible deactivation (p. 109). There is included the popular phrase, "Natural selection may explain the survival of the fittest, but it cannot explain the arrival of the fittest" (p. 220). Axe attributes this memorable quote to Hugo De Vries in a 1904 publication.

A fascinating analogy is presented regarding the popular assumption that complex fossils originated by chance. Suppose that civilization suffered total amnesia that erased all knowledge of computers, including all documentation. Researchers then begin to examine the mysterious electron devices they find lying about. The majority school of thought is that the devices formed by accident. Computers are dissected, their binary code is read, and the electronics are placed in the order of their assumed evolution. However, the group never figures out what a computer actually is. Continuing the analogy, a contrasting school of thought believes that the solid-state devices demonstrate intelligent design. They see purpose and planning in the treasure of discovered instruments (p. 268). And so it is today with contrasting schools of thought regarding the wonder of life upon the earth.

The book concludes with thoughts on how science would progress and prosper if the Creator of the universe were acknowledged in research laboratories across the land. Among several helpful ideas, one is an entirely new approach to science inquiry, the uncovering of endless secrets embedded in nature. These discoveries offer new products, medicines, and solutions to technical problems, placed there for our well-being.

**Don DeYoung**
**DBDeYoung@Grace.edu**

# Instructions to Authors

## Submission

Electronic submissions of all manuscripts and graphics are preferred and should be sent to the editor of the *Creation Research Society Quarterly* in Word, WordPerfect, or Star-Office/Open Office (see the inside front cover for address). Printed copies also are accepted. If submitting a printed copy, an original plus two copies of each manuscript should be sent to the editor. The manuscript and copies will not be returned to authors unless a stamped, self-addressed envelope accompanies submission. If submitting a manuscript electronically, a printed copy is not necessary unless specifically requested by the *Quarterly* editor. Manuscripts containing more than 35 pages (double-spaced and including references, tables, and figure legends) are discouraged. An author who determines that the topic cannot be adequately covered within this number of pages is encouraged to submit separate papers that can be serialized.

All submitted manuscripts will be reviewed by two or more technical referees. However, each section editor of the *Quarterly* has final authority regarding the acceptance of a manuscript for publication. While some manuscripts may be accepted with little or no modification, typically editors will seek specific revisions of the manuscript before acceptance. Authors will then be asked to submit revisions based upon comments made by the referees. In these instances, authors are encouraged to submit a detailed letter explaining changes made in the revision, and, if necessary, give reasons for not incorporating specific changes suggested by the editor or reviewer. If an author believes the rejection of a manuscript was not justified, an appeal may be made to the *Quarterly* editor (details of appeal process at the Society's web site, www.creationresearch.org).

Authors who are unsure of proper English usage should have their manuscripts checked by someone proficient in the English language. Also, authors should endeavor to make certain the manuscript (particularly the references) conforms to the style and format of the *Quarterly*. Manuscripts may be rejected on the basis of poor English or lack of conformity to the proper format.

The *Quarterly* is a journal of original writings, and only under unusual circumstances will previously published material be reprinted. Questions regarding this should be submitted to the Editor (CRSQeditor@creationresearch.org) prior to submitting any previously published material. In addition, manuscripts submitted to the *Quarterly* should not be concurrently submitted to another journal. Violation of this will result in immediate rejection of the submitted manuscript. Also, if an author uses copyrighted photographs or other material, a release from the copyright holder should be submitted.

## Appearance

Manuscripts shall be computer-printed or neatly typed. Lines should be double-spaced, including figure legends, table footnotes, and references. All pages should be sequentially numbered. Upon acceptance of the manuscript for publication, an electronic version is requested (Word, WordPerfect, or Star-Office/Open Office), with the graphics in separate electronic files. However, if submission of an electronic final version is not possible for the author, then a cleanly printed or typed copy is acceptable.

Submitted manuscripts should have the following organizational format:

**1. Title page.** This page should contain the title of the manuscript, the author's name, and all relevant contact information (including mailing address, telephone number, fax number, and e-mail address). If the manuscript is submitted by multiple authors, one author should serve as the corresponding author, and this should be noted on the title page.

**2. Abstract page.** This is page 1 of the manuscript, and should contain the article title at the top, followed by the abstract for the article. Abstracts should be between 100 and 250 words in length and present an overview of the material discussed in the article, including all major conclusions. Use of abbreviations and references in the abstract should be avoided. This page should also contain at least five key words appropriate for identifying this article via a computer search.

**3. Introduction.** The introduction should provide sufficient background information to allow the reader to understand the relevance and significance of the article for creation science.

**4. Body of the text.** Two types of headings are typically used by the *CRSQ*. A major heading consists of a large font bold print that is centered in column, and is used for each major change of focus or topic. A minor heading consists of a regular font bold print that is flush to the left margin, and is used following a major heading and helps to organize points within each major topic. Do not split words with hyphens, or use all capital letters for any words. Also, do not use bold type, except for headings (italics can be occasionally used to draw distinction to specific words). Italics should not be used for foreign words in common usage, e.g., "et al.", "ibid.", "ca." and "ad infinitum." Previously published literature should be cited using the author's last name(s) and the year of publication (ex. Smith, 2003; Smith and Jones, 2003). If the citation has more than two authors, only the first author's name should appear (ex. Smith et al., 2003). Contributing authors should examine this issue of the *CRSQ* or consult the Society's web site for specific examples as well as a more detailed explanation of manuscript preparation. Frequently-used terms can be abbreviated by placing abbreviations in parentheses following the first usage of the term in the text, for example, polyacrylamide gel electrophoresis (PAGE) or catastrophic plate tectonics (CPT). Only the abbreviation need be used afterward. If numerous abbreviations are used, authors should consider providing a list of abbreviations. Also, because of the variable usage of the terms "microevolution" and "macroevolution," authors should clearly define how they are specifically using these terms. Use of the term "creationism" should be avoided. All figures and tables should be cited in the body of the text, and be numbered in the sequential order that they appear in the text (figures and tables are numbered separately with Arabic and Roman numerals, respectively).

**5. Summary.** A summary paragraph(s) is often useful for readers. The summary should provide the reader an overview of the material just presented, and often helps the reader to summarize the salient points and conclusions the author has made throughout the text.

**6. References.** Authors should take extra measures to be certain that all references cited within the text are documented in the reference section. These references should be formatted in the current *CRSQ* style. (When the *Quarterly* appears in the references multiple times, then an abbreviation to *CRSQ* is acceptable.) The examples below cover the most common types of references:

Robinson, D.A., and D.P. Cavanaugh. 1998. A quantitative approach to baraminology with examples from the catarrhine primates. *CRSQ* 34:196–208.

Lipman, E.A., B. Schuler, O. Bakajin, and W.A. Eaton. 2003. Single-molecule measurement of protein folding kinetics. *Science* 301:1233–1235.

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

Margulis, L. 1971b. *Origin of Eukaryotic Cells*. Yale University Press, New Haven, CT.

Hitchcock, A.S. 1971. *Manual of Grasses of the United States*. Dover Publications, New York, NY.

Walker, T.B. 1994. A biblical geologic model. In Walsh, R.E. (editor), *Proceedings of the Third International Conference on Creationism* (technical symposium sessions), pp. 581–592. Creation Science Fellowship, Pittsburgh, PA.

**7. Tables.** All tables cited in the text should be individually placed in numerical order following the reference section, and not embedded in the text. Each table should have a header statement that serves as a title for that table (see a current issue of the *Quarterly* for specific examples). Use tabs, rather than multiple spaces, in aligning columns within a table. Tables should be composed with *14-point type* to insure proper appearance in the columns of the *CRSQ*.

**8. Figures.** All figures cited in the text should be individually placed in numerical order, and placed after the tables. Do not embed figures in the text. Each figure should contain a legend that provides sufficient description to enable the reader to understand the basic concepts of the figure without needing to refer to the text. Legends should be on a separate page from the figure. All figures and drawings should be of high quality (hand-drawn illustrations and lettering should be professionally done). Images are to be a minimum resolution of 300 dpi at 100% size. Patterns, not shading, should be used to distinguish areas within graphs or other figures. Unacceptable illustrations will result in rejection of the manuscript. Authors are also strongly encouraged to submit an electronic version (.cdr, .cpt, .gif, .jpg, and .tif formats) of all figures in individual files that are separate from the electronic file containing the text and tables.

## Special Sections

### Letters to the Editor:

Submission of letters regarding topics relevant to the Society or creation science is encouraged. Submission of letters commenting upon articles published in the *Quarterly* will be published two issues after the article's original publication date. Authors will be given an opportunity for a concurrent response. No further letters referring to a specific *Quarterly* article will be published. Following this period, individuals who desire to write additional responses/comments (particularly critical comments) regarding a specific *Quarterly* article are encouraged to submit their own articles to the *Quarterly* for review and publication.

### Editor's Forum:

Occasionally, the editor will invite individuals to submit differing opinions on specific topics relevant to the *Quarterly*. Each author will have opportunity to present a position paper (2000 words), and one response (1000 words) to the differing position paper. In all matters, the editor will have final and complete editorial control. Topics for these forums will be solely at the editor's discretion, but suggestions of topics are welcome.

### Book Reviews:

All book reviews should be submitted to the book review editor, who will determine the acceptability of each submitted review. Book reviews should be limited to 1000 words. Following the style of reviews printed in this issue, all book reviews should contain the following information: book title, author, publisher, publication date, number of pages, and retail cost. Reviews should endeavor to present the salient points of the book that are relevant to the issues of creation/evolution. Typically, such points are accompanied by the reviewer's analysis of the book's content, clarity, and relevance to the creation issue.

# Creation Research Society Membership/Subscription Application and Renewal Form

The membership/subscription categories are defined below:

1. **Voting Member** .............. Those having at least an earned master's degree in a recognized area of science.
2. **Sustaining Member** ....... Those without an advanced degree in science, but who are interested in and support the work of the Society.
3. **Student Member** ............ Those who are enrolled full time in high schools, undergraduate colleges, or postgraduate science programs (e.g., MS, PhD, MD, and DVM). Those holding post-doctoral positions are not eligible. A graduate student with a MS degree may request voting member status while enrolled as a student member.
4. **Senior Member** .............. Voting or sustaining members who are age 65 or older.
5. **Life Member** .................. A special category for voting and sustaining members, entitling them to a lifetime membership in the Society.
6. **Subscriber** ....................... Libraries, churches, schools, etc., and individuals who do not subscribe to the Statement of Belief.

All members (categories 1–5 above) must subscribe to the Statement of Belief as defined on the next page.

Please complete the lower portion of this form and mail it with payment to CRS Membership Secretary, 6801 N. Highway 89, Chino Valley, AZ 86323, or fax for credit card payment to (928) 636-1153. Applications may also be completed online at creationresearch.org.

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

This is a ❑ new ❑ renewal application for the subscription year beginning Summer ❑ 2016 ❑ __________. *(Please type or print legibly.)*

Name ______________________ Address ______________________

City ______________________ State __________ Postal/Zip code ______________ Country ______________

Phone (optional) ______________________ Email ______________________

Degree ______________________ Field ______________________

Year granted ______________ Institution ______________________

Presently associated with ______________________

*I have read and subscribe to the CRS Statement of Belief.* Signature ______________________

For foreign orders, including Canadian, payment must be made in U.S. dollars by a check drawn on a U.S. bank, international money order, or credit card. *Please do not send cash.*

| *Indicate applicable category* | *Indicate payment* | | | |
|---|---|---|---|---|
| | Paper** | | | |
| ❑ Voting ❑ Sustaining | USA | Canada Mexico | Other countries | Paper-less‡ |
| ❑ Regular [per year] | ❑ $38 | ❑ $58 | ❑ $75 | ❑ $31 |
| ❑ Senior [per year] | ❑ $33 | ❑ $53 | ❑ $70 | ❑ $26 |
| ❑ Life member | ❑ $500 | ❑ $500 | ❑ $500 | ❑ $500 |
| ❑ Student* [per year] | ❑ $33 | ❑ $53 | ❑ $70 | ❑ $26 |
| ❑ Subscriber [per year] | ❑ $41 | ❑ $61 | ❑ $78 | ❑ $34 |

* Student members are required to complete the bottom portion of this form.
**NOTE:** Student members may qualify for the *Future Leaders Sponsorship* program. See the CRS website at www.creationresearch.org for details.
** Rates for the paper option include postage for First Class Mail International

‡ **PAPERLESS option:** You may opt out of receiving paper copies of the CRS periodicals (*CRS Quarterly* and *Creation Matters*). By choosing this option you may register for access to the Premium Area of the website, where you may view or download electronic (PDF) versions of these publications. Of course, regular members and subscribers may also have access to the Premium Area. Only members, however, will have access to the Members Exclusive Area of the website.

| | |
|---|---|
| Member/Subscriber | $______ per year |
| | x ______ years |
| SUBTOTAL | $__________ |
| Optional contribution | + $__________ |
| Life membership | + $__________ |
| TOTAL | $__________ |

❑ Visa ❑ MasterCard ❑ Discover
❑ American Express ❑ Check/money order
Card number ______________________
Expiration date (mo/yr) ______________________
Phone number (_______) ______________________
Signature ______________________

***Student Members* are required to complete the following:**

School or institution now attending ______________________
______________________

Your current student status: ❑ high school; ❑ undergraduate; graduate program ❑ MS ❑ PhD; ❑ other ______________

Year you expect to graduate or complete your degree ______________

Major, if college or graduate student ______________________

Signature ______________________

# Order Blank for Past Issues

Cost of complete volumes (per volume): .......members (all categories) – $18.00 + S/H
nonmembers and subscribers (libraries, schools, churches, etc.) – $25.00 + S/H

Cost of single issues (per issue):......................members (all categories) – $5.00 + S/H
nonmembers and subscribers (libraries, schools, churches, etc.) – $7.00 + S/H

| Volume | Number 1 | 2 | 3 | 4 | Volume | Number 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|---|---|---|
| 22 | ☐ | ☐ | ☐ | ☐ | 38 | ☐ | ☐ | ☐ | ☐ |
| 23 | ☐ | ☐ | ☐ | ☐ | 39 | ☐ | ☐ | ☐ | ☐ |
| 24 | ☐ | ☐ | ☐ | ☐ | 40 | ☐ | ☐ | ☐ | ☐ |
| 25 | ☐ | ☐ | ☐ | ☐ | 41 | ☐ | ☐ | ☐ | ☐ |
| 26 | ☐ | ☐ | ☐ | ☐ | 42 | ☐ | ☐ | ☐ | ☐ |
| 27 | ☐ | ☐ | ☐ | ☐ | 43 | ☐ | ☐ | ☐ | ☐ |
| 28 | ☐ | ☐ | ☐ | ☐ | 44 | ☐ | ☐ | ☐ | ☐ |
| 29 | ☐ | ☐ | ☐ | ☐ | 45 | ☐ | ☐ | ☐ | ☐ |
| 30 | ☐ | ☐ | ☐ | ☐ | 46 | ☐ | ☐ | ☐ | ☐ |
| 31 | ☐ | ☐ | ☐ | ☐ | 47 | ☐ | ☐ | ☐ | ☐ |
| 32 | ☐ | ☐ | ☐ | ☐ | 48 | ☐ | ☐ | ☐ | ☐ |
| 33 | ☐ | ☐ | ☐ | ☐ | 49 | ☐ | ☐ | ☐ | ☐ |
| 34 | ☐ | ☐ | ☐ | ☐ | 50 | ☐ | ☐ | ☐ | ☐ |
| 35 | ☐ | ☐ | ☐ | ☐ | 51 | ☐ | ☐ | ☐ | ☐ |
| 36 | ☐ | ☐ | ☐ | ☐ | 52 | ☐ | ☐ | ☐ | ☐ |
| 37 | ☐ | ☐ | ☐ | ☐ | 53 | ☐ | ☐ | ☐ | |



Add 20% for postage (**for U.S. orders:** min. $6, max. $18; **for Canadian orders:** min. $10, no max.; **for other foreign orders:** min. $15, no max.) **Total enclosed: $**_______________

Make check or money order payable to Creation Research Society. Please do not send cash. For foreign orders, including Canadian, please use a check in U.S. funds drawn on a U.S. bank, an international money order, or a credit card.

*(Please type or print legibly)*

Name ___________________________ Address ________________________________________

City ________________________ State ________ Zip ______________ Country________________

❏ Visa ❏ MasterCard ❏ Discover ❏ American Express Card number ___________________________

Expiration date (mo/yr) ______________ Signature________________________________________

**Mail to: Creation Research Society, 6801 N. Highway 89, Chino Valley, AZ 86323, USA**

## *Creation Research Society*

**History**—The Creation Research Society was organized in 1963, with Dr. Walter E. Lammerts as first president and editor of a quarterly publication. Initially started as an informal committee of 10 scientists, it has grown rapidly, evidently filling a need for an association devoted to research and publication in the field of scientific creation, with a current membership of over 600 voting members (graduate degrees in science) and about 1000 non-voting members. The *Creation Research Society Quarterly* is a peer-reviewed technical journal. It has been gradually enlarged and modified, and is currently recognized as one of the outstanding publications in the field. In 1996 the *CRSQ* was joined by the newsletter *Creation Matters* as a source of information of interest to creationists.

**Activities**—The Society is a research and publication society, and also engages in various meetings and promotional activities. There is no affiliation with any other scientific or religious organizations. Its members conduct research on problems related to its purposes, and a research fund and research center are 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.

**Membership**—Voting membership is limited to scientists who have at least an earned graduate degree in a natural or applied science and subscribe to the Statement of Belief. Sustaining membership is available for those who do not meet the academic criterion for voting membership, but do subscribe to the Statement of Belief.

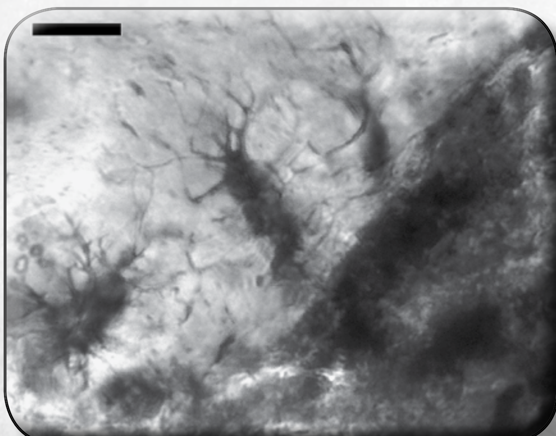
**Statement of Belief**—Members of the Creation Research Society, which include research scientists representing various fields of scientific inquiry, are committed to full belief in the biblical record of creation and early history, and thus to a concept of dynamic special creation (as opposed to evolution)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

1. The Bible is the written Word of God, and because it is inspired throughout, all its assertions are historically and scientifically true in all the original autographs. To the student of nature this means that the account of origins in Genesis is a factual presentation of simple historical truths.
2. All basic types of living things, including humans, were made by direct creative acts of God during the Creation Week described in Genesis. Whatever biological changes have occurred since Creation Week have accomplished only changes within the original created kinds.
3. The Great Flood described in Genesis, commonly referred to as the Noachian Flood, was a historical event worldwide in its extent and effect.
4. We are an organization of Christian men and women of science who accept Jesus Christ as our Lord and 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.

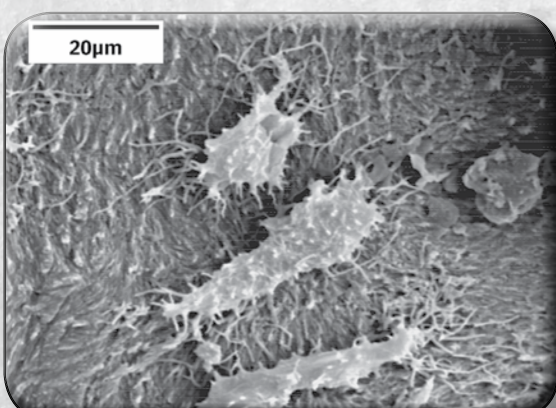
# iDINO II

## Investigation of Dinosaur Intact Natural Osteo-tissue

**A fragment of the *Triceratops* brow horn. Fragments, such as this one, still contain tissue and cells.**



**Microscopic examination of tissue extracted from a *Triceratops* horn reveals bone cells still present.**




**Electron microscope picture of intact bone cells still in tissue extracted from a *Triceratops* horn.**

### How can pliable, stretchable tissue survive inside dinosaur fossils for over 65 million years?

### How can this tissue still contain intact cells and even dinosaur proteins?

### How can this fragile biological material survive for so long?

The answer to these questions directly challenges the current, evolutionary-biased, geologic timescale.

The Creation Research Society began its iDINO research initiative for the purpose of studying soft tissue in dinosaur fossils. The first phase of the project detected pliable, unfossilized tissue in a brow horn of a *Triceratops*. Within this tissue were intact osteocytes (bone cells). Some results from the iDINO project have been published in a technical microscopy journal and presented at an international microscopy conference. The Spring 2015 issue of the *Creation Research Society Quarterly* also features a special report of the iDINO project. Plus, to further spread the important information about soft tissue, the Society is developing a video (Echoes of the Jurassic).

The **second phase** of the project (iDINO II) will look more extensively at the process of tissue preservation. Evolutionists have offered various theories of how this tissue could survive for millions of years. iDINO II will methodically investigate these preservation claims, assessing their plausibility.

The iDINO results have already provided a strong challenge to the evolutionary worldview. More extensive and detailed examination may provide even stronger evidence that the age of dinosaur fossils is far less than 65 million years. To this end, the Society continues to seek those willing to fund this project with either one-time gifts or monthly donations.

*For more information contact us at (928) 636-1153 or crsvarc@crsvarc.com.*

*Also visit http://tinyurl.com/nphm2c4 for project updates and details.*