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Haec Credimus

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

The Chaotic Chronology of Catastrophic Plate Tectonics

John K. Reed and Carl R. Froede, Jr.*

Abstract

Developed from computer models, Catastrophic Plate Tectonics was introduced in 1994 as a global tectonic model of the Genesis Flood. Advocates of the model claimed that evidence for Plate Tectonic theory also supported its catastrophic daughter. Examination of the literature identified several inconsistencies in the timing of events between the parent

Plate Tectonic theory and its creationist offspring. Various events within catastrophic plate tectonics also appear to be in conflict in their relative timing and potentially in disagreement with the biblical record. Caution should be exercised in applying catastrophic plate tectonic concepts to field situations until these problems are addressed and resolved.

Introduction

Catastrophic Plate Tectonics (CPT) was introduced at the 1994 *International Conference on Creationism* by a multi-disciplinary consortium of creationists as a comprehensive geological and geophysical model of the Genesis Flood (Austin et al., 1994). The concept is based on and derived from uniformitarian Plate Tectonic (PT) theory. Support for CPT was based on extensive computer modeling performed by Baumgardner (1986; 1990; 1994). Following its introduction, only one article was published by a member of the CPT group (Snelling, 1995) until Baumgardner (2002a; 2002b; 2002c) participated in a plate tectonics forum sponsored by the Answers in Genesis journal, *TJ*. We are unaware of any other publications either discussing or applying CPT to specific field data.

Shortly after the introduction of CPT in the 1994 publication, Reed et al. (1996) published an assessment of both uniformitarian and catastrophic plate tectonics. Later, the Creation Research Society published the book, *Plate Tectonics: A Different View* (Reed, 2000). The publication provided areas of greater detail about many shortcomings of PT and its creationist derivative, CPT. We believe that skepticism toward PT is a minority position in the uniformitarian Earth sciences and perhaps even within creationism, but we do not equate majority support with truth.

Our interest in CPT led us to carefully read the material presented in the *TJ* forum and research the pertinent portions of PT theory. In doing so, we became aware of a number of serious problems facing the CPT model—that of its inconsistent sequencing of events: (1) internally (Table I); (2) potentially with respect to the biblical account; and (3)

with uniformitarian plate tectonics (Table II)¹. Our analysis was enabled by the simple step of inferring timelines for both PT and CPT from the literature.

We believe that logical inconsistencies contrasting the incompatibility of events between PT and CPT are serious, carrying greater evidential weight than empirical data (Reed, 2002). In order to accurately capture and convey the seriousness of each issue, we quote extensively where a statement regarding CPT has been put forward. We have tried to maintain context in our citations and have searched for disclaimers or new information in more recent publications correcting information in the earlier publications.

Internal Conflicts within Catastrophic Plate Tectonics

Most of the inconsistent sequencing of events that will be discussed in this paper are related to the difficulty that supporters of CPT have with the “Paleozoic” section of the geologic column. This issue can be summarized as follows:

- As the *most* compelling evidence for their theory, CPT proponents present the “Mesozoic” and later age of the sea floors as compared to the continental sedimentary record,
- CPT proponents equate the onset of the Genesis Flood with the initiation of a “runaway subduction event” that led to the destruction of the antediluvian ocean floors and the recrystallization of the present floors; and
- CPT advocates propose the onset of the Flood corresponds (roughly) with the Precambrian/Paleozoic boundary.

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¹We are aware that CPT advocates reject the 4.5 billion year absolute timescale; however, the problems are with the *relative* sequence of events.

Table I. Apparent internal inconsistencies within catastrophic plate tectonics.

CPT	Apparent Inconsistencies
The Pangean supercontinent break-up was initiated at onset of Flood.	The uniformitarian Pangean supercontinent did not break-up until the early Jurassic—well after the end of the Paleozoic. The entire Paleozoic and Triassic stratigraphic sections would have been deposited on the continents <i>before</i> the pre-Flood oceanic crust would have been subducted.
The break-up of the Pangean supercontinent is marked stratigraphically where metazoans occur in the fossil record.	Metazoans are believed to document the explosion of life near the Precambrian/Cambrian boundary (see Appendix). Pangea broke up at the beginning of the Jurassic Period—approximately 420 million years later—with a completely different set of flora and fauna. Why is the boundary not “marked” by the early Jurassic fossils but rather by metazoans? From a creation standpoint, all life was already created and living on Earth, so why are metazoans the <i>only</i> fossils that should be used as pre-Flood/Flood boundary markers?
Termination of runaway subduction during the Flood	Which day during the Flood marks the end of runaway subduction: 40 or 150?
Pre-Flood “Paleozoic” oceanic crust was completely subducted during the Flood.	If this is true, then the Paleozoic and Triassic stratigraphic sections already existed on the continents <i>before</i> the Flood (pre-Flood death on a very large scale—similar to the concept of the Creation/Curse/Catastrophe model [Gentet, 2000a; 2000b]). Flood geology would then begin one-third of the way into the Mesozoic Era. When were the Paleozoic and Triassic strata deposited on the continents?
Triassic Flood Basalts	The Triassic strata (including all of the areas covered by massive flood basalts) were deposited after the Paleozoic, but before the break-up of Pangea in the early Jurassic. It is unclear whether these basalts are then pre-Flood or Flood.
Downwarping continents after marine Paleozoic section	If the RSE is Mesozoic, then thick marine Paleozoic continental sediments are pre-Flood, and should have been eroded by cavitation.

However, these three propositions cannot all be true at the same time. If the Paleozoic is to be included in the Flood and the runaway subduction event began during the Mesozoic, then the timing of the runaway subduction event should be placed at mid-Flood. Otherwise, the Mesozoic age of the seafloors is not correct and is not useful as evidence for CPT (Figure 1), or the Paleozoic stratigraphic record for the continents was not deposited as a part of the Flood. This stratigraphic problem is at the heart of many of the internal conflicts within CPT (Table I).

When Did the Runaway Subduction Episode Occur?

The internal coherence of CPT is further constrained by its presentation as a singular event initiated by a runaway subduction episode (RSE), resulting in a cascading set of consequences purported to provide a physical explanation of the Genesis Flood. We believe that the possibility of

multiple runaway subduction episodes appears unlikely, especially in light of biblical statements about the singularity of the Flood. Thus, statements in the available references (Austin et al., 1994; Baumgardner 1986; 1990; 1994; 2002a; 2002b; 2002c) which suggest the RSE occurred at the onset of the Genesis Flood appear to contradict other statements that affirm the inclusion of the Paleozoic in the Flood.

Within CPT, was the RSE the initiating event of the Genesis Flood? The answer appears to be affirmative.

The Flood was initiated as slabs of oceanic floor broke loose and subducted along thousands of kilometers of pre-Flood continental margins. (Austin et al., 1994, p. 609)

In addition to this unambiguous statement, the initial 40 days of rain (Genesis 7:12) is said to have resulted from atmospheric fallout of water placed there by supersonic steam geysers originating from the newly opened mid-ocean ridges formed by continental dislocation that was caused by runaway subduction.

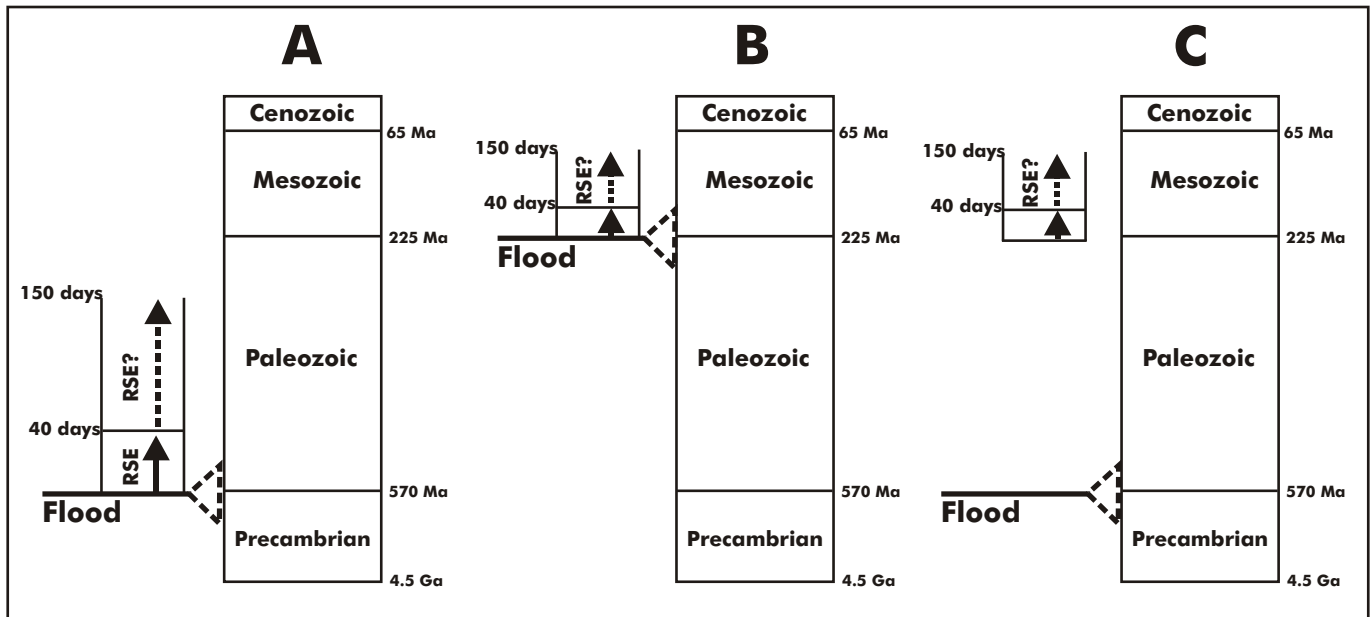


Figure 1. The dilemma of the timing of the catastrophic plate tectonic runaway subduction episode (RSE) is demonstrated by the three possibilities that are implied in the existing literature. In the first (A), both the Flood onset and the RSE (whether 40 or 150 days) are defined near the Precambrian/Cambrian boundary. However, this does not explain the “Mesozoic” age of the seafloor. In the second (B), both the Flood onset and RSE are placed at the beginning of the Mesozoic, implying that the Paleozoic is pre-Flood. In the third (C), The Flood onset is identified near the Precambrian/Cambrian boundary and the RSE at the beginning of the Mesozoic. However, this requires the RSE to be a mid-Flood event.

The jets also provide a potent source of water for the 40 days and nights of rain described in Genesis 7. (Baumgardner, 2002a, p. 61)

These geysers are also equated with the “windows of heaven,” the biblical origin of the rain.

It is this geyser-produced rain which we believe is primarily responsible for the rain from ‘the windows of heaven’... which remained a source of water for up to 150 days of the Flood... (Austin et al., 1994, pp. 612–613)

Likewise, the RSE is tied to the beginning of the Flood by the equating of the geysers with the “fountains of the great deep” which Genesis 7 states were a proximal cause of the Flood.

This geyser activity, which would have jettisoned gases well into the atmosphere, is, we believe, what Scripture refers to as the “fountains of the great deep”... (Austin et al., 1994, p. 612)

These statements appear to place the onset of catastrophic plate tectonics and its runaway subduction episode at the beginning of the Genesis Flood.

Termination at Day 40 or Day 150?

While it appears that there is a clear link between the onset of the Flood and the initiation of runaway subduction, the

same cannot be said when identifying RSE termination. One CPT advocate states that the RSE event lasted for 40 days.

...it seems likely the runaway episode coincides with the 40 days of intense rain. (Baumgardner 2002b, p. 71)

In an earlier article, CPT advocates stated that the cessation of both the geysers and tectonic activity should be placed at the 150th day of the Flood:

When virtually all the pre-Flood oceanic floor had been replaced with new, less-dense, less-subductable rock, rapid plate motion ceased. The lack of new, hot, mantle material terminated spreading-center-associated geyser activity, so the global rain ceased. This is very possibly the 150-day point in the Genesis chronology... (Austin et al., 1994, p. 614)

It cannot be both; the termination of the event was abrupt.

When the rock comprising these plates subducts and sinks to the bottom of the mantle and the hot rock at the core-mantle boundary rises to near the Earth’s surface, this energy is all converted to other forms and is no longer available to drive the process. The rapid motions in the mantle and in the plates at the surface come to a rather abrupt halt. When this occurs, the steam jets shut down and the high stresses associated with the rapid motions relax. (Baumgardner, 2002a, p. 62)

Therefore, although it seems to be clear that the RSE began at the onset of the Genesis Flood, it is unclear whether it ended abruptly on the 40th day or on the 150th day, and clarification of that aspect of the model by its developers would be helpful.

We attempted to constrain the timing of the termination of the tectonic episode by determining the length of time required for the continents to drift to their present positions at the stated model speed of “meters per second” (Austin et al., 1994, p. 612). If “meters per second” means at least two meters per second and the motion is bilateral then over 40 days, the lateral plate displacement would have been nearly 14,000 kilometers, and over 150 days the displacement would have been over 50,000 kilometers. Unfortunately, given the present minimum width of the Atlantic Ocean (3,000 kilometers), the model assumes lateral motion far beyond what is required or even possible in either scenario, and thus does not predict the present configuration of continents and oceans. Neither does it clearly account for the discrepancy between the estimated and actual distances with either proposed termination day. Thus, the proponents of CPT need to (1) clarify both the beginning and the end of the RSE relative to the Genesis Flood, and (2) reevaluate the lateral velocities of the crust during the subduction event.

The “Mesozoic” Dilemma

It is not just the termination of the RSE that is unclear. In spite of the previous statements that appear to clearly tie the RSE with the beginning of the Flood, Baumgardner (2002a) equates its age with the Mesozoic, since uniformitarian geology dates the ocean crust as all younger than early Mesozoic.

...none of today's ocean floor basement anywhere on Earth is older than Mesozoic relative to the microfossil record... (Baumgardner, 2002a, p. 59)

This age-date is presented as being crucial, since the evidence of the oceanic lithosphere being younger than the continental record is a key pointer to the historicity of CPT.

...the issue on which the ultimate validity of the plate tectonics paradigm rests is the age of the ocean floor... relative to the sediment record of the continents. (Baumgardner, 2002b, p. 69)

This creates a great tension for the hypothesis. The relationship between runaway subduction, the beginning of the Flood, and the Paleozoic record on the continents requires one of two possibilities, either (1) the Paleozoic was pre-Flood (Figure 1B), or (2) the RSE started during the mid-Flood (Figure 1C). Baumgardner appears to go in one direction when he states:

The igneous ocean crust and sediments overlying it today postdate the entire continental Paleozoic sedimentary record. (Baumgardner, 2002b, p. 69)

However, in the same forum, he goes the other direction by saying:

First, I am convinced the Biblical text requires the beginning of the metazoan fossil record to coincide with the beginning of the Genesis Flood... (Baumgardner, 2002a, p. 59)

If he equates the Paleozoic with the Genesis Flood, it is hard to escape the conclusion that he is correlating the RSE with a mid-Flood time. He implies that when he states:

I consider... the present ocean basement to be no older than the Mesozoic portion of the continental fossil record. This requires... the entire pre-Flood ocean floor, *as well as any generated when the Paleozoic fossils were being deposited*, to have vanished from the Earth's surface. (Baumgardner, 2002a, p. 59) [emphasis added]

This suggests that the Flood had already begun when the RSE took place, and that it had proceeded to the point where the Paleozoic record had already been deposited. But this contradicts the statements above, which unambiguously places the RSE at the onset of the Genesis Flood. This idea seems to be carried further when he states:

If one also includes the compelling evidence the present ocean floor was formed progressively and simultaneously with the deposition of Mesozoic and Cenozoic fossils... (Baumgardner, 2002a, p. 59)

This implies that the Flood subduction event and subsequent resurfacing of the ocean floor occurred during the Mesozoic and Cenozoic. However, not only would this force the Paleozoic to be pre-Flood, but it also implies that the Mesozoic and Cenozoic represent the first 150 days of the Flood, and that the remaining Flood events are not represented in the rock record at all! But then he retraces his path and states that:

This mechanism accounts for... the ubiquitous evidence in the continental Paleozoic and Mesozoic record for rapid, high-energy, globally-correlated sedimentary processes... (Baumgardner, 2002a, p. 63)

How can the RSE account for the continental Paleozoic stratigraphic section if it did not begin until the Mesozoic?

Related Problems

Two related problems arise from the confusion over the Paleozoic record. The first involves the mechanism of CPT that allows thick sediments to be deposited on the continents, but not in the oceans. The model posits the

downwarping of the continents caused by downwelling in the mantle caused by subduction of cold oceanic plates underneath the continents.

Downwelling flow associated with the rapidly sinking lithospheric slabs, mostly below regions of continents, tends to pull the surface down. (Baumgardner, 2002a, p. 62).

The lowering of the continents and the simultaneous raising of the ocean floors supposedly resulted in the continents becoming large sedimentary basins. But how were thick marine Paleozoic sequences deposited on continents, if the RSE and the subsequent downwarping did not take place until the Mesozoic?

The second problem comes from the assertion that continental transgression involved cyclonic currents (Baumgardner and Barnette, 1994) and cavitation erosion of the continental interiors. If that happened in conjunction with the early Mesozoic runaway subduction, then why were the continental interiors not eroded down to basement and the sediment redeposited as Mesozoic section?

Catastrophic Plate Tectonics and the Bible

If the RSE began after deposition of the Paleozoic sequence and the Flood encompasses the Paleozoic section, then catastrophic plate tectonics, as it has been presented, is potentially at odds with the biblical record. That is because it relates the RSE to the onset of the Genesis Flood and the resulting steam geysers to the “fountains” and “windows” of Genesis 7 (Table II). Yet at the same time, the episode can be construed as being a mid-Flood event, based on the relationship between the Paleozoic and Mesozoic sections.

In the recent *TJ* forum, this dilemma is apparently recognized in favor of a mid-Flood timing of the runaway event.

In terms of the Flood cataclysm, the very oldest basement rocks in today's oceans formed when dinosaurs were first being buried in significant numbers as the floodwaters began encompassing their continental habitats. The extremely important implication is that all of today's ocean plates have formed via seafloor spreading processes at mid-ocean ridges since sometime in the middle of the Flood cataclysm. (Baumgardner, 2002b, p. 69)

However, it is unclear how this squares with the biblical account of the Flood. For example, how can the proposed steam geysers be the “fountains of the great deep” or the “windows of heaven” if they did not start until mid-Flood time? There seems to be a suggestion of some undefined process that preceded the RSE, but no explanation or evidence is offered:

Table II. Connections between the biblical account of the Flood and the events of catastrophic plate tectonics strongly suggest that the runaway subduction event must have occurred at the onset of the Flood. If proponents now advocate a mid-Flood timing of the runaway subduction episode, then they must resolve these connections with Genesis.

<u>Biblical Description of Flood Onset</u>	<u>CPT Connection to Flood Onset</u>
Rainfall (Genesis 7:11,12)	Steam Geysers
Breakup of Fountains (Genesis 7:11)	Runaway Subduction Episode
Marine Transgression (Genesis 7:19)	Lowering of Landmasses

In regard to pre-Mesozoic plate motions, the lack of pre-Mesozoic seafloor to tell us what these motions may have been leaves everyone, uniformitarian and creationist alike, with precious little to work with beyond a few clues in the continental record and one's own imagination. (Baumgardner, 2002b, p. 71)

But if the runaway subduction was a single unique event, then how could there have been any pre-Mesozoic plate motions?

This line of thought continues:

The calculation obviously does not capture the earliest portion of the cataclysm that corresponds roughly with the Paleozoic part of the rock record. Explicit modelling of this earlier portion of the catastrophe will be difficult to achieve because the ocean floor from this period is no longer available and clues from the continental rocks are few. (Baumgardner, 2002c, p. 80)

If the “catastrophe” that he is referencing is the Genesis Flood, then runaway subduction during the mid-Flood would not allow the steam geysers to be equated to the “fountains” or the “windows” of Genesis 7, and previous published assertions require modification. Furthermore, advocates of CPT must now explain how the presence of these steam geysers during the late Flood stages correspond to the biblical teaching that the rain had ceased and the fountains of the great deep had been closed.

Finally, we must emphatically disagree with the final assertion in this quote. The “clues” from the continental record for the Paleozoic are much more abundant and clear than any comparative information that we have from the Mesozoic and younger ocean floor. They include millions of wells, miles of seismic lines, outcrops, and many decades of intensive study that have resulted in millions of

pages of description and interpretation of the continental Paleozoic record.

Incompatibility of Uniformitarian and Catastrophic Plate Tectonics

We believe that a major impetus in the development of CPT was the perception by some that the case for uniformitarian plate tectonics was compelling enough to force a biblical version:

Let me begin by affirming without apology that indeed I am persuaded the basic mechanical reality of plate tectonics has been established beyond any reasonable doubt. (Baumgardner, 2002c, p. 78)

Putting aside the validity of that statement, is it possible for the uniformitarian parent to be successfully morphed into a catastrophist child? We believe that uniformitarian and catastrophic plate tectonics are fundamentally incompatible in (1) the relative timing of their events, and (2) their assumption of how events operate over time (Table III). This second difference between catastrophic plate tectonics and its uniformitarian parent is the philosophical difference between history being composed of discrete events or of ongoing processes. Uniformitarian plate tectonics is an ongoing process integral to the functioning of the Earth. Catastrophic plate tectonics is a one-time event contrary to the regular functioning of the earth. This distinction is true of any comparison between uniformitarian and catastrophist Earth history (Reed, 2001). So, at this very fundamental level, the two versions of plate tectonics are quite different. How do the proposed sequences of their events compare?

The Dance of the Continents

Advocates of the CPT model have proposed that a pre-Flood supercontinent similar to “Pangea” (Figure 2) broke apart during the Flood (Baumgardner, 2002a). Evidence in support of this proposal is believed to come from paleontological (i.e., the rise of the metazoans) and crustal (i.e., the absence of any Paleozoic oceanic crust) uniformitarian evidence (Austin, 1994; Austin et al., 1994; Baumgardner, 2002a; 2002b). A different dataset supports the uniformitarian breakup of the Pangean supercontinent

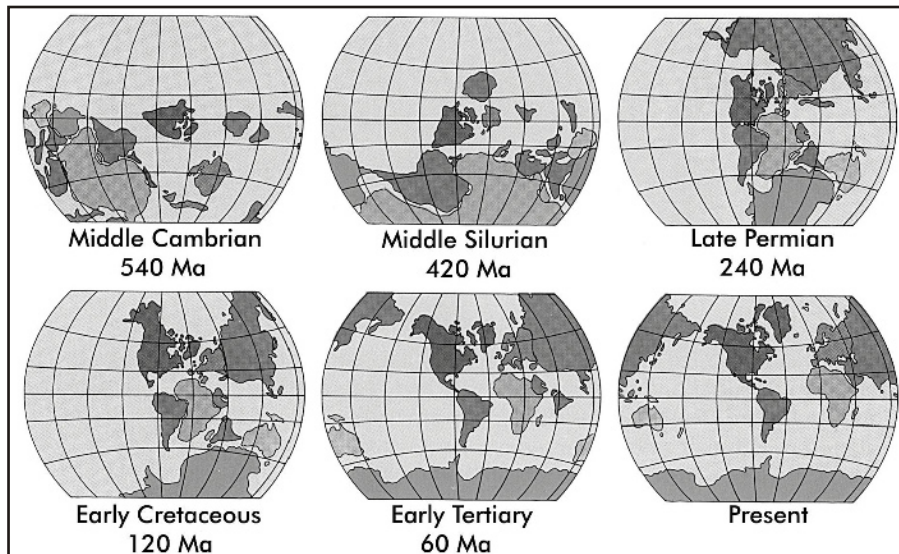


Figure 2. Generalized paleogeographic map showing the convergence of the continents during different uniformitarian periods to form the Pangean supercontinent during the Permian (at the end of the Paleozoic), and its subsequent breakup in the early Jurassic. Advocates of Catastrophic Plate Tectonics begin the Flood with the break-up of the Pangean supercontinent (based on PT), but this would mean that all of the Paleozoic Era and Triassic Period would have been deposited *before* the Flood began. Modified from Carlson (1993).

during the early Jurassic Period approximately 180 million years ago (Osborne and Tarling, 1996, p. 98).

Unlike CPT, uniformitarians have proposed multiple episodes of the formation and breakup of supercontinents long before their Pangean supercontinent ever came into existence (Figure 3). If uniformitarian PT theory is so compelling, the one-time event associated with the Genesis Flood does not account for much uniformitarian evidence. The advocates of CPT should explain how parts of the uniformitarian data are compelling and yet the remainder is so easily discarded.

In addition to the post-Mesozoic plate motions mimicked by CPT, uniformitarian Earth history is replete with openings and closings of various oceans, including some no longer in existence. Structural and lithological parts of the continental basement are believed a result of Precambrian subduction and collision (e.g., Anderson, 1990; Hoffman, 1989). Thus, a severe problem for CPT is the appearance of arbitrary data selection.

“Slow” or “Fast” Breakup of the Pre-Flood Supercontinent

Incorporating PT data (e.g., seafloor ages), Baumgardner (2002a) has proposed that the pre-Flood Pangean supercontinent broke apart with the onset of the Flood. But unlike the slow multi-million year drift of the continents

Table III. A list of inconsistencies between Plate Tectonics and Catastrophic Plate Tectonics.

Concept	Plate Tectonics	Catastrophic Plate Tectonics
Timing of Plate Motion	Plates have been moving since the formation of a semi-molten crust—4.5 billion years ago (Ga).	Plate motion initiated with the onset of the Flood beginning with the break-up of the Pangean supercontinent.
Duration of Plate Motion	Landmasses have been moving since the first crust was formed, and motion continues today.	Plate motion was first initiated at the Flood onset and it terminated during the Flood. No large-scale plate motions are believed to be occurring today.
Dating Plate Motion	Plates have been moving across the planet since the beginning of Earth history—4.5 Ga.	CPT began with metazoan life—equal to the uniformitarian Precambrian/Cambrian boundary approximately 570 million years ago.
Supercontinents	Multiple supercontinents have formed and broken apart on Earth since its origin. Pangea was only the most recent.	Only one “Pangean” supercontinent has existed on Earth. It was broken up at the onset of the Flood.
Mountain Building Periods (i.e., Orogenies)	Episodes of orogenesis have occurred since the formation of the first semi-solid crust and extend into the present.	Mountain building occurred at two distinct times during the Flood. Only very limited orogenic activity has occurred since.
Ice Ages	Multiple events have occurred throughout Earth history.	Only one has occurred(?) and it was post-Flood. The ice age events before the “metazoans” remain unaddressed.
Flood Basalts	Episodes of flood basalt outpourings span the uniformitarian timescale. The Triassic was a period that witnessed multiple flood basalt events globally.	Flood basalts on top of basement rock could be associated with the Creation Week. However, it is unclear how the other periods of flood basalt outpourings coincide with the Biblical record. Additionally, it is not clear if the Paleozoic and “Triassic” flood basalts were deposited before the Flood.

proposed by uniformitarians, runaway separation was measured in meters per second (Austin et al., 1994; Baumgardner, 1994; 2002a). However, the complete PT dataset does not support this catastrophic interpretation.

Continental drift was originally deduced from matching geomorphology, geology, and fauna on opposing continents. But the faunal “matches” have led advocates of uniformitarian plate tectonics advocates to propose a Pangean breakup lasting almost one hundred million years (Osborne and Tarling, 1996, pp. 98–99). The differences in “age” (derived from the conceptual global stratigraphic column) between the fauna are then believed to accurately reflect the time when the continents separated. Although we are aware that CPT advocates do not accept the absolute timescale, they should explain how the uniformitarian paleontological evidence that supports a “slow” breakup also supports a “fast” CPT breakup.

Advocates of CPT have stated that they view the breakup of the pre-Flood supercontinent as having started with the beginning of the metazoan fossil record (Austin, 1994; Austin et al., 1994; Baumgardner, 2002a). If this is true, and if faunal distribution assumptions are consistently followed, then the formerly joined continents should not “match” paleontologically from the beginning of the Flood, which supposedly corresponds to the beginning of the metazoan fossil record (see Appendix). This is not the case. Uniformitarian plate tectonics cite “matching” fauna well before the Pangean breakup in the early Jurassic (Osborne and Tarling, 1996)! According to CPT, most of the separation between the continents should already have occurred by this time in Earth history, unless the RSE is a mid-Flood event or the Flood did not start until the Jurassic. Once again the appearance of a selective use of data requires explanation.

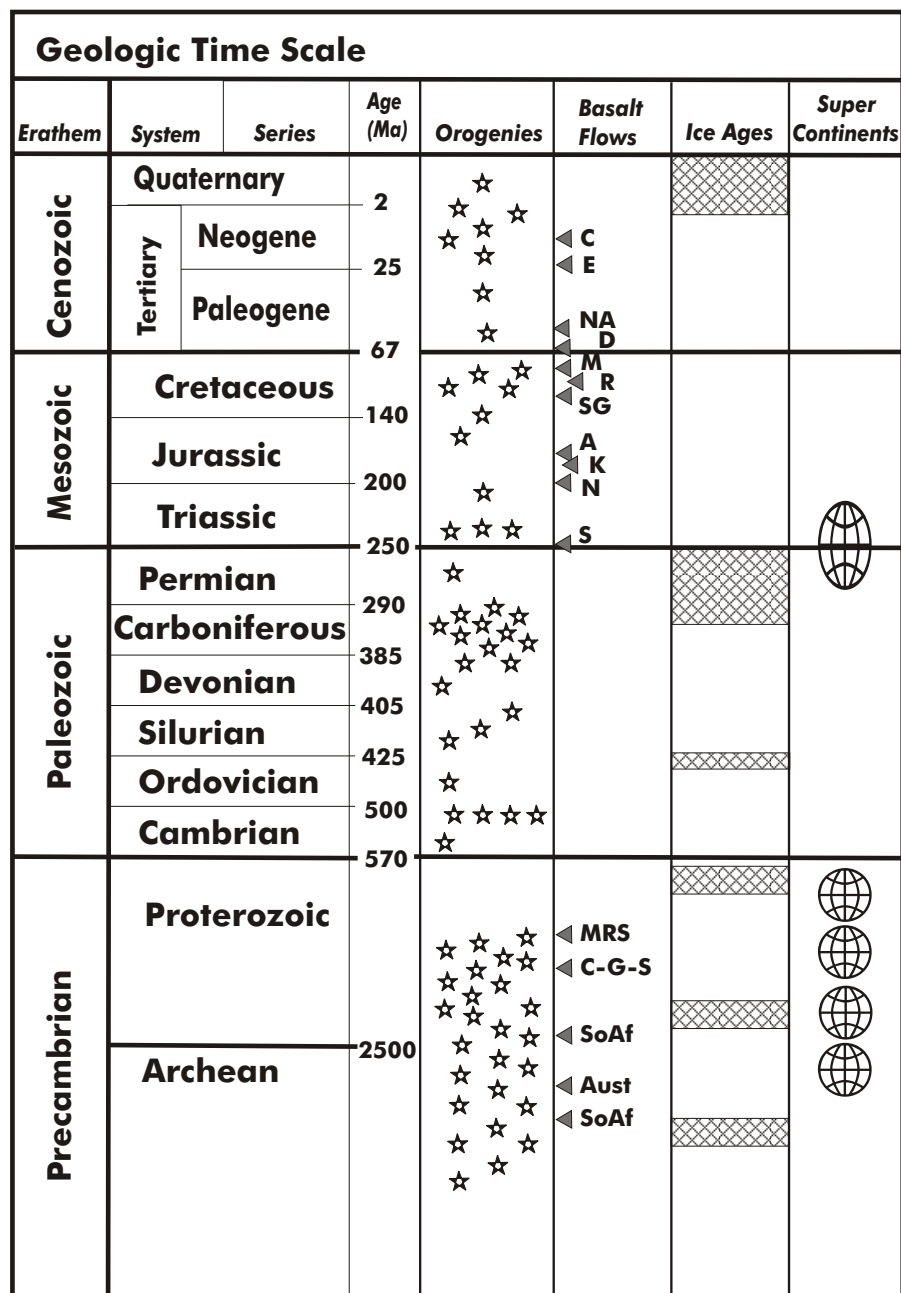


Figure 3. Catastrophic plate tectonics would predict discrete stratigraphic horizons that would capture intense geologic activity: (1) at the onset of the runaway subduction episode, and (2) at the point of continental rebound. However, the timing of orogenies, basalt flows, ice ages, and the formation and breakup of various supercontinents within the uniformitarian column do not demonstrate these discrete events. C = Columbia River Basalt Group, E = Ethiopia, NA = North Atlantic, D = Deccan, M = Madagascar, R = Rajmahal, SG = Serra Geral (Parana), A = Antarctica, K = Karoo, N = Newark, S = Siberian, SoAf = South Africa, Aust = Australia, C-G-S = Canada-Greenland-Scandinavia. Data from Haq and Van Eysinga (1987), and Windley (1995). Various internet sites were also accessed for information: http://www.museum.state.il.us/exhibits/ice_ages/when_ice_ages.html, http://volcano.und.nodak.edu/vwdocs/volc_images/europe_west_asia/india/deccan.html, <http://www.geolsoc.org.uk/template.cfm?name=fbasalts>

Precambrian Ice Ages

Uniformitarians have informed us that Earth has experienced multiple ice ages throughout its 4.5 Ga history (Figure 3). Geologic materials from several of these supposed events have been used as evidence that currently separated continents were once joined. Multiple ice ages are believed to have occurred on Earth during the Precambrian (before the metazoans). If this evidence is compelling for plate tectonics, then it should be accommodated or explained by CPT, and yet this has been ignored. This also gives the appearance of arbitrary use of uniformitarian data. At this point we must state that we support Oard's theory that these data reflect Flood forces and deposits and not glacial episodes (Oard, 1990; 1997). With that aside, we are somewhat surprised that these Precambrian deposits are not recognized as Flood deposits within CPT.

Once again, adherence to the uniformitarian column appears to place CPT advocates in a corner. CPT must either adjust its boundaries or propose significant pre-Flood catastrophes (e.g., Gentet, 2000a, 2000b), or include significant and multiple pre-Flood ice ages.

Orogenies

CPT implies that continental mountain building would occur at specific times during the Flood. The first would have been associated with the RSE, which would have resulted in island arc/volcanic chain mountain building and mid-oceanic ridge formation. The second orogenic episode would have been initiated at the termination of the RSE, caused by the isostatic rebound of the continents. However, the uniformitarian sequence of mountain building does not offer much support for two distinct phases of mountain building. Instead, uniformitarians note numerous orogenies extending throughout the

geologic column (Figure 3). Other features of the rock record, such as the formation of Large Igneous Provinces by basalt flows present similar difficulties to the proponents of catastrophic plate tectonics (Figure 3).

We believe that a fruitful line of research for CPT advocates would be to review the PT datasets related to the various orogenies and provide their perspective on how creationists can use this same information to derive interpretations completely in defense of Flood geology.

Discussion

The available literature about CPT allows significant confusion over the sequence and timing of its events. There are internal conflicts, possible conflicts with the biblical record, and conflicts with the uniformitarian parent supposedly providing much support for it (Tables I, II, and III). It is not enough to only identify these issues. Their causes and solutions must also be investigated; the burden of that effort falling, of course, predominantly on the model's proponents. However, we would like to share some simple observations that may help those researchers repair these problems.

What are the presuppositions that force these issues? The most basic is certainly the acceptance of the faulty assumption of the validity of the uniformitarian stratigraphic column. If the definition of Paleozoic and Mesozoic rocks is valid on a global scale (the relative ages defined by the uniformitarian geologic column), then catastrophic plate tectonics is caught between its assertions that (1) the Flood encompasses Paleozoic rocks and (2) the timing of the runaway subduction event must correspond to the Mesozoic age of the seafloor. The theory cannot let go of the Mesozoic solution without erasing its own, self-proclaimed most-basic-line-of-evidence. It cannot decouple from the Paleozoic without creating logical inconsistencies within the model and between the model and the Bible. And yet, both cannot be true.

We encourage the supporters of CPT to explore the possibility that the column is not a valid representation of the rock record. In doing so, they would be free of uniformitarian constraints and could explore a new relationship among rock units. It is true that they would also lose a valuable piece of their supposed evidence—the relative age inequity between the oceanic and continental crusts. However, we suggest that they strongly consider the distinctions between empirical and nonempirical stratigraphy discussed by Klevberg (2000).

However, we believe that logical and biblical consistency is more important to the model than some “key” piece of empirical evidence, and we firmly believe that the shifting of presuppositional baselines can illuminate empirical data in new ways and lead to fruitful reinterpretations.

In a similar manner, we would discourage reliance on radiometric ages or fossil assemblages to provide relative dates. We are convinced that radiometric dating is too flawed to be useful (Woodmorappe, 1999), and that conditions found inferred from the Genesis Flood invalidate the assumptions of the stratigraphic significance of the fossils in the uniformitarian sense. It is clear that in any creationist model of Earth history, part of the difficulty will be the differentiation between real data and uniformitarian interpretation.

We encourage the development of various models to explain Earth's brief and catastrophic history. However, creationists must also subject themselves to the critical process in order to ensure that models correspond to biblical propositions and sound science. We believe that researchers developing models should consider the distinctions between evidence and uniformitarian interpretation. This distinction is not always clear in the uniformitarian literature. Those who propose models should be ready to engage in vigorous debate about their ideas in order to advance creation science and natural history.

There are major discrepancies between the parent plate tectonics theory and its derivative. Catastrophic plate tectonics cannot claim unequivocal support from uniformitarian data and still remain consistent with the biblical record. As we have demonstrated, claiming support from select pieces, but failing to accommodate all the uniformitarian data results in confusion, especially when advocates of CPT have not explained which specific plate tectonic data are germane to their theory and why. How much uniformitarian Earth history may young-Earth creationists accept? The concept is philosophically bankrupt (Reed, 2001), and outside of the excellent descriptive datasets (Reed and Froede, 1997); creationists should beware its use in forensic speculation.

Reed (2002) set up a hierarchy of evidence to use when evaluating creationist models of Earth history. As opposed to the philosophical positivism of naturalists, Christians should recognize the primacy of Scripture and accept its primacy in Earth history research. While this approach is not meant to eliminate the scientific contribution to natural history, it is meant to eliminate its undeserved, monopolistic primacy. The dearth of data in the Bible does not detract from the force of its truth. In addition to consistency with the Bible and its derivative worldview, creationist models must meet logical demands of formal consistency. Finally, empirical evidence plays its role in fleshing out such models. The problems described above touch on both the model's consistency with the Bible and its logical consistency. Thus, to strengthen their hypothesis, proponents of CPT must first ensure that the sequence and timing of tectonic events intersects the biblical record without distortion to the latter. Secondly, they must derive

a self-consistent timeline for their model that will remove all questions regarding logical consistency. Finally, they must reevaluate their selective dependence on empirical data from uniformitarian plate tectonics.

We believe that the cause of many of the sequential issues within CPT are directly related to overconfidence in uniformitarian constructs, chiefly the geologic column (Reed and Froede, in press) and equivocal evidence for plate tectonics (Reed, 2000; Oard 2002a; 2002b; 2002c). We encourage the proponents of catastrophic plate tectonics to reevaluate their model absent these bounding conditions and formulate a more consistent approach.

Conclusion

We cannot think of a better summary of mission statement for creationists than that provided by Dr. Baumgardner in the recent forum:

To make progress in reconstructing truthfully the Earth's past... we simply cannot afford... to be careless in how we approach this task. We cannot indulge in building straw man illusions. We cannot pick and choose what data we address and what data we ignore. Rather, we must do our best to bring all the data to bear on any candidate model we construct. (Baumgardner, 2002b, p. 72)

We encourage all advocates of CPT to reexamine their assumptions and resolve these issues. If they can successfully do so and maintain their essential framework, then their model will have passed important tests of consistency.

Appendix: The Metazoan Fossil Record

The "first appearance" of metazoan fossils within the evolutionary uniformitarian model is presently under question. Their place within the young-Earth creationist framework also remains unresolved (Froede, 1999a), but because this relates to the CPT model, a brief review is warranted. Baumgardner (2002, p. 59) has stated that metazoans mark the pre-Flood/Flood boundary:

First, I am convinced the Biblical text requires the beginning of the metazoan fossil record to coincide with the beginning of the Genesis Flood, and most of the subsequent fossil record to be a product of that year-long event.

The danger of hanging the pre-Flood/Flood boundary on uniformitarian paleontology is the confusion it creates when no fossils are found at various locales, or their possible ambiguity as they relate to the strata (e.g., Austin, 2000; Froede, 2000). We will not dwell on this point further, but direct the interested reader to previous discussions related to this concept (Froede, 1997; 1998; 1999a; 1999b).

Within the uniformitarian model, metazoans are found in rocks believed to be around one billion years old. However, they are most often accepted by uniformitarians as occurring in late Precambrian to early Cambrian rocks (i.e., 620 to 550 Ma). One can immediately note the wide range of time available to define the "beginnings" of life (based on fossils!) and the pre-Flood/Flood boundary. We believe that the use of such "markers" is both arbitrary and capricious. For example, how does one "date" the rocks where no fossils are found or great unconformities exist based on corresponding fossils? To mark the onset of CPT using the "first" evidence of metazoans in the rock record is not a tenable idea.

Secondarily, metazoans do not mark the boundary of the breakup of the uniformitarian Pangean supercontinent. Rather, they mark the convergence of several of the continents into the Pangean supercontinent (Figure 3). Baumgardner cannot invoke "metazoans" as biostratigraphic markers for continental separation and remain consistent with the PT dataset. Advocates of CPT have not explained at what time the Pangean supercontinent formed within the biblical framework (i.e., at creation, during the antediluvian period, etc.).

Consistency between the early Jurassic breakup of Pangea and the onset of metazoans in the rock record does not equate in the uniformitarian framework, and some explanation should be made by CPT advocates to help allow an understanding of these differences.

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La Brea Tar Pits: A Critique of Animal Entrapment Theories

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Abstract

New evidence acquired from an ongoing excavation project at Rancho La Brea has led to a major re-evaluation of how the fossils were deposited. The traditional idea that animals were trapped in continuously active, open pools of tar has been discarded, and new theories of entrapment and deposition emerged. Although more realistic in some

ways than the old theory, the alternatives suffer from the same inability to provide a defensible, gradualistic explanation. This critique represents a preparatory stage in the development of a theory that discards the principle of animal entrapments and advances the concept of a diluvial process in the formation of the tar pit fossil beds.

Introduction

Dr. John C. Merriam, a vertebrate paleontologist at the University of Berkeley, first heard of the fossils of Rancho La Brea in 1905 from Union Oil geologist William W. Orcutt. After viewing the fossils and visiting the source beds, Merriam wrote an article in 1906 about a pool of tar that deceived, trapped, and swallowed up its victims. Two years later, he wrote an expanded treatment of the subject for a popular magazine. The editor's introduction to the article had the following words:

This sticky pool of water and tar has been a Death Trap of the Ages. Here, for centuries, evidently, the enormous ground-sloth and other clumsily moving creatures of his kind came for water, only to be held relentlessly; herds of bison and horses were entombed, extinct forms with whose bones mingle those of the mammoth and the camel. To this helpless prey, snared for them in this bird-lime bed, came the lords of the era, the huge sabre-tooth tiger and monster wolf, the largest of the dog family. Trapped in their turn, they, too, fed the black maw of the asphalt pool and the death trap baited itself anew (Merriam, 1908).

Although the above description paints a vivid picture of the struggle for survival among the tar pits, it is unfortu-

nately marred by the use of misleading evidence. The "death trap" pictured in the article was actually a water-filled quarry dug out by a defunct asphalt mining enterprise (Figure 1).

About two hundred yards northwest of the quarry was a real tar pit excavated in 1906 by the University of Califor-

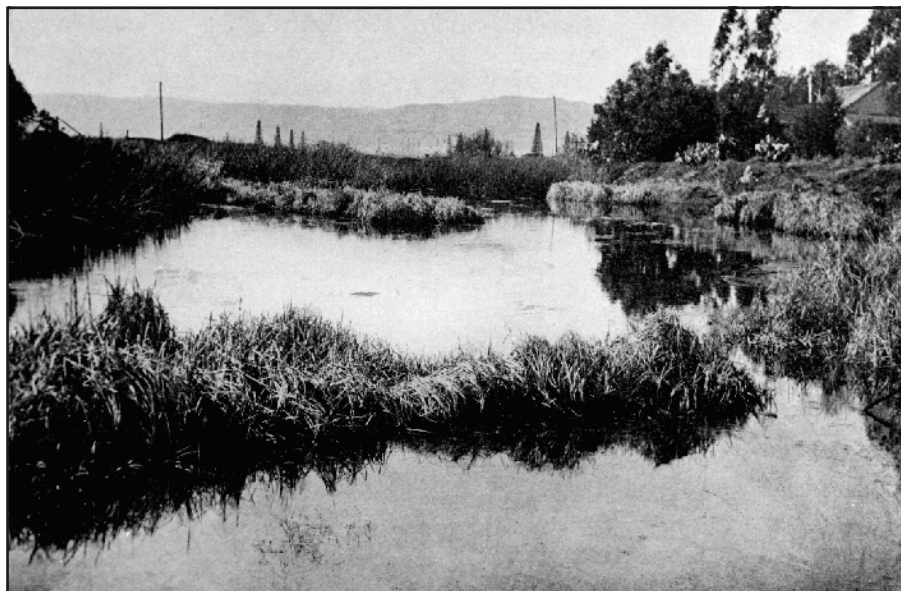


Figure 1. Asphalt quarry now filled in with water. It was misidentified as the "death trap of the ages" (Merriam, 1908).

nia. Six years later, three more pits were excavated in the same vicinity (Stoner, 1913). In 1913, the County of Los Angeles began a two-year, trial-and-error search for more fossil pits. They dug 96 test holes, of which more than half turned out to be unproductive. (The test holes were called "pits," which makes discussion of the subject confusing. A "pit" in the sense of a test hole may, or may not, be synonymous with an actual fossil pit.) Only 16 test holes turned

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up pits with large quantities of bones. With the exception of Pit 91, these pits were emptied of their contents, packed in wooden crates, and transported to the Museum of History, Science, and Art. The main part of the bone mass of Pit 91 was left intact as a showcase for future public display.

The Re-opening of Pit 91

After a fifty-four year hiatus, excavation work at Pit 91 was re-activated on June 13, 1969. It continues on a seasonal basis to the present day. More methodical than the early excavations of 1906 through 1915, the renewed excavation is a painstaking centimeter-by-centimeter search for fossils of all kinds, from large bones to microscopic-sized organisms such as pollen and diatoms. Identification, position, and orientation of all items found are meticulously noted and illustrated with diagrams and sketches.

The wealth of information thus acquired was by no means a confirmation of old ideas. On the contrary, some discoveries did not fit within the rubric of continuously active, deep tar pools. At a little over six feet below the surface of the ground, excavators found an ancient streambed that ran from an east-to-west direction, curving towards the south wall. They also found levels of sedimentation, which pointed toward the fluid dynamics of water as a formative factor in Pit 91.

The fossil remains were frequently admixed with gravel lenses, cobbles, and pebble clasts of fluvial origin. Freshwater limestone lenses, mollusks, and hardened asphaltum deposits were interbedded with bone-bearing sediment in several of the pits. . . . Both the molluscan faunas and the limestone strata indicate intervals during which separate tar seeps were submerged, possibly by ephemeral lakes or ponds, or meandering stream channels (Woodard and Marcus, 1973, p. 56).

The geological history of the fossil deposits, as revealed by the renewed excavation, appeared to be more complex than previously imagined, and the tar pool entrapment theory was clearly in trouble. Weaknesses that had previously been overlooked were now coming under close scrutiny. One flaw in particular was the small size of some of the pits. Woodard and Marcus (1973, p. 63) acknowledged that "many bone pockets, although containing numerous disarticulated skeletal remains, were too small to have served as asphaltic traps."

Pit 36, for example, was four feet long by two feet wide by eleven feet deep. Considering the preponderance of carnivores in Rancho La Brea censuses, Pit 36 unquestionably lacked the space for entrapment episodes requiring as many as six carnivores pouncing on a single herbivore. Another undersize hole was Pit 16. Only four feet wide, this

pit was a near circular hole that went down 24 feet before it contracted three more feet into a small tar vent. Compare these pit sizes to a typical victim such as the saber-tooth cat with a head and body length of five and a half feet, or the mastodon, which had a length of twelve feet. Pit 37 was merely a "narrow chimney" only eight feet deep. Inside were the bones of badger, deer, coyote, and a large number of birds, over 90% of which were the predacious types such as vultures, hawks, and owls (Howard, 1962). While the average size of a tar pit was 15 feet in diameter at the surface (the largest one having a semi-commodious measurement of 25 x 15 feet at the surface), the smaller pits with diameters of five feet or less present a serious challenge to animal entrapment scenario writers.

By the early 1970's, paleontologists had reached a consensus that the animal entrapment theory had to be either modified or discarded. Consequently, two alternative theories were formulated. One was the tar puddle entrapment theory, and the other was the fluvial transport theory.

The Tar Puddle Entrapment Theory

The fossil pits of Rancho La Brea are located at Hancock Park. Within the park, visitors can see tar seeps forming puddles about two to four feet in diameter. If on a slope, the seep can spread farther, perhaps as much as 15 feet or more. When tar seeps reach an advanced stage of development, they look like volcanoes about three to four inches high with a circumference equivalent to an automotive tire (Figures 2 and 3). Bubbling from the center of these mounds are flows of tar that move at a sluggish, almost imperceptible rate. These larger seeps are called tar springs, and some of them can be fairly extensive in the puddles they generate. One geologist observed a puddle with a diameter of 30 feet (Merriam, 1911).

For small creatures such as birds, rabbits, snakes, and insects, tar puddles are dangerous traps (Figure 4). Even large animals, such as cows and horses, have reportedly been stuck in puddles only two or three inches deep. These modern episodes have led some scientists to formulate the tar puddle entrapment theory. According to Akersten, Shaw, and Jefferson (1983),

. . . very shallow puddles of asphalt, more nearly analogous to flypaper than to quicksand, were often concealed by floating leaves and dust. Occasionally, an incautious herbivore became entrapped and, in turn, lured a number of carnivores to their fates. The carcasses decayed; individual bones rotted free, became saturated with asphalt, and settled at least part-way into the mire.

During the warmer months of the year, tar seeped up through the permeable sands of dry streambeds, creating puddles that were highly viscous and hazardous to unwary



Figure 2. Tar spring seeping into asphalt quarry now filled with water. Photograph taken by the author in May 2002.

creatures. With the onset of winter, the tar seeps became dormant and the puddles started to solidify. During rainstorms, water filled the streambeds and spread a thin layer of sand over the inactive seeps. With the return of warm weather, the streams dried up and the tar seeps once again began to flow, creating new traps. The fact that bones were found in pit-like formations is due to the tar vents saturating and preserving the bones within their reach, while the remaining bones beyond the margin disappeared through the attritional effects of weather and decay. Over time the annual buildup of tar seeps and bone material grew simultaneously higher along with the surrounding level of the alluvial terrain. A good summary of the key ideas of this theory is provided by Harris and Jefferson (1985, p. 10):

Animals and plants were captured in shallow surface sheets of viscous asphalt rather than in large pools or "pits," but over time such asphalt layers built up into large conical bodies through continued deposition. The preservation of the bones and plant



Figure 4. A tar puddle in which two birds had been caught. The smaller bird to the right is a meadowlark. The bird in the center is unidentified (Merriam, 1911).



Figure 3. Close up of same tar spring near asphalt quarry. Dark cavity in the center of spring shows where a bubble had burst. Photograph taken by the author in May 2002.

materials was aided by their subsequent burial in sediments of the alluvial plain.

Although generally accepted by the scientific establishment, there are no observational or experimental data that show that tar puddles have the viscosity to capture large animals, including such megafauna as elephants and bison. Even local anecdotes about horses and cows standing trapped in tar puddles, whether true or not, cannot properly be called scientific proof if they lack such routine items of information as time, place, and names of witnesses. Considering the lack of solid evidence, the tar puddle theory does not merit further discussion.

The Fluvial Transport Theory

The fluvial transport theory is a modification of the deep tar pool entrapment concept. As formulated by Woodard and Marcus (1973, p. 63), the fluvial transport theory postulates "localized fluvial concentrations of bones in stream channels or ponds."

Some of the larger fossil concentrations probably represent actual sites of animal entrapment and burial. Many bone deposits appear to represent concentration under fluvial conditions after the bones had lain on the surface for some time. This is supported from the character of the enclosing sediments, size of the fossil pockets, and the abraded and weathered nature of the bones (Woodard and Marcus, 1973, p. 68).

To support their theory, the two authors drew upon the core sample data collected during a search for undiscovered fossil pits in 1945. A total of 87 test holes were drilled all around Hancock Park. The test holes revealed four distinct sedimentary layers. The uppermost layer consisted of

6.5 to greater than 17 feet of flood-plain deposits of sand, clay, gravel, and asphalt. Rounded gravel and cobble sized clasts were an indication of “fluvatile disintegration” (Woodard and Marcus, 1973, p. 60) of granitic rocks.

The second layer consisted of asphaltic sand varying in thickness from less than 3.5 and up to 7.6 feet. The authors believed that the second layer represented a period when bones were possibly being deposited by animal entrapments.

The third layer was 4.3 to 8 feet of clay that was frequently sandy towards the base. Like the first layer, the third layer was the result of “fluvatile deposition, probably in a flood-plain environment.”

The fourth layer consisted of bituminous sand that went down to a depth of 66 feet. Unlike the second layer of tar and sand mentioned above, the fourth layer does not represent a period of animal entrapment activity. According to mainstream scientific thinking, the fourth layer is a transitional phase in the geology of Southern California. Ocean water receded from the continent, and the basin of Los Angeles became a dry land environment with bodies of freshwater. It was towards the end of this period that land animals began migrating into the area.

According to Woodard and Marcus, the four sedimentary levels described above were observed inside the tar pits as well. To prove their point, they refer to the field notes for the excavations of Pits 3, 4, 13, and 81. Since their stratigraphical analyses of these four pits are basically similar, we shall focus on Pit 3 to illustrate their argument.

The Excavation of Pit 3

Pit 3 began on July 16, 1913 as an exploratory trench from the bank of a man-made pond. The excavators proceeded toward a spot where a fresh puddle of tar was spreading from a tar vent. When they had reached the puddle, they broke away six inches of asphalt outcropping and found a quantity of mainly coyote bones as well as many from birds and rodents. Most of these bones were so decayed that they had to be thrown away. The excavators widened the hole and saw that the fossil pit had a diameter of about 15 feet. They found an abundance of wolf and saber-tooth cat skulls, as well as a small number of herbivore skulls such as sloth and bison. The disproportionate number of carnivores was typical throughout the pit. As they proceeded downward, they found that the pit had a conical shape. The above comments apply to the pit as a whole. The following is a summary of what was found at various levels.

At a depth of four-and-a-half feet below the surface of the ground, excavators found the trunk of a cypress tree about ten inches in diameter. The wood was so fresh, that it appeared that the tree had been buried alive. The top of the trunk was missing, either having been burned or rotted



Figure 5. Cypress tree taken from Pit 3. When found, it was heavily saturated with water and tar (Wyman, 1926).

off. As they dug down, they found that the trunk had a large branch that projected horizontally across the pit (Figure 5). Around the branch and trunk was a mass of bones so tightly packed and interlocked that it was difficult to squeeze fingers into the narrow cavities to remove them.

At the seven-and-a-half-foot level, the matrix of tar and sand was described as “the very best preservative sort, as many of the bones coming out now are in a high state of preservation.”

At the nine-foot level, the matrix was described as “mostly of a rather coarse sand well tar-soaked, in places with some small gravel and twigs, apparently drift material.” Saber-tooth cat bones were far exceeding the wolf bones. There were occasional herbivores such as sloths and mastodons. Along the south wall was a deposit of tarry sand that was virtually barren of bones. The surface contact between the barren sand and the mixture of sand and fossils was sharply defined.

At the ten-foot level, excavators were finding more small gravel, twigs, and leaves. Again these were recognized as “drift material,” which meant that floods had transported them from somewhere else and buried them in the pit. The leaves and twigs were saturated with water. It was soon discovered that water-soaked plant material had a spoiling effect on the quality of fossil preservation. Any bones close to wood were mushy, crumbly, and badly decayed.

At the twelve-foot level, the matrix changed from bituminous sand to a mixture of clay and a substance that looked like asphalt with a reddish-brown color. Here excavators found the cypress tree rooted in stiff clay. Many of the larger roots penetrated almost horizontally into the wall of clay. It appeared that the tree had either grown on the bank of a buried gully, or the edge of the bone deposit had been completely covered by a heavy deposit of clay. The total height of the tree trunk was about eight feet. It had two large branches, one eight feet long and the other eleven feet long. These branches had been broken off at

the ends. [Some of these details were not in the field notes but were provided by (Davidson, 1914)]. In order to remove the trunk, excavators had to cut off numerous roots. Lifting the tree out of the pit was a difficult operation requiring a team of twelve men, for it was heavily saturated with water and tar (Figure 5).

At the thirteen-foot level, the slanting-in of the west wall was decreasing the amount of available space for the digging crew to work in. This was the beginning of the contraction of the pit, which at deeper levels would taper down to a small hole.

At the fifteen-foot level, the matrix changed more into clay with numerous pockets of tarry sand. Excavators found a log four feet long standing upright upon the crotch of an inverted tree stump. Underneath the tree trunk, excavators found great quantities of bones. The matrix here was gravel impregnated with tar.

At the eighteen-foot level, the matrix became asphalt with fewer bones than in the softer tar-soaked sand.

At the twenty-foot level, the whole pit was clogged with areas of asphalt, which made digging very hard.

At the twenty-one-foot level, fewer bones were found. The whole floor of the pit was contracting at an ever-increasing rate as the excavators dug deeper. More than half the floor was oxidized asphaltum, or semi-hardened tar, which was very hard to dig through.

At the twenty-three-foot level, the floor of the pit was only four feet across. Bones at this depth were still being removed.

At the twenty-five-foot level, a sloth pelvis completely filled the small hole. Underneath the pelvis was a bison skull – the last bone to be removed from the pit.

At the twenty-seven-foot level, the pit had tapered down to a narrow chimney several inches wide and continued downward to a petroleum deposit one to three thousand feet below the surface of the earth. At this level, the excavation for Pit 3 was terminated on August 18, 1913.

Stratigraphical Analysis of Pit 3

Woodard and Marcus (1973, p. 64) identified six phases in Pit 3. These phases are listed below in the order in which they appear stratigraphically from the uppermost layer to the lowermost:

- Phase VI: This phase is the last and most recent of the layers to have been deposited. It consists of “sediments of probable flood-plain origin” from the surface level of the ground to a depth of 2.4 meters (8 feet).
- Phase V: At the 2.4-meter level, excavators encountered “richly fossiliferous asphaltic sand.”
- Phase IV: At the 3.6-meter level (12 feet), the strata changed to stiff clay. Separating the second layer from the third layer was a boundary layer consisting of hard

asphaltum, oxidized a dark reddish-brown color. According to the authors, this layer represents a period when tar vents were inactive.

- Phase III: At the 4.5-meter level (15 feet), excavators encountered another boundary of hardened reddish-brown asphaltum, below which was a layer of grey clay enclosing pockets of fossils in bituminous sand.
- Phase II: At the 5.4-meter level (18 feet), a layer of asphaltic grey clay with pockets of gravel and limestone was found. At this interval the fossil-bearing bituminous sand was being replaced by barren clay.
- Phase I: This phase is the earliest of the layers to be deposited at the site of Pit 3. It consisted of “asphaltic sand” that began at the 6.3-meter level (21 feet). This sediment continued unchanged to the point where the excavation ended at 8.1 meters (27 feet).

These stratigraphical phases can be related to the four-level core sample data of 1945, if one combines Phases II, III, and IV into a single level. As described by Woodard and Marcus, these phases appear to indicate that the deposition of the contents of Pit 3 corresponded to the deposition of equivalent sedimentary layers of the surrounding terrain.

To fix the time spans for both animal entrapment and fluvial deposition, the authors rely on carbon-14 dating of various bone specimens. Table I shows the results for samples from Pit 3. Assuming that the carbon-14 dates are accurate, the recent period of fluvatile deposition is almost 13,000 years long; the period of animal entrapments was less than 2,000 years long; and the older period of fluvatile deposition was 7,000 years long. (Woodard and Marcus explain the anomalous specimen at twenty-six feet as being the result of either contamination of the sample or the shifting of bones inside the pit.)

To support their argument that at least two layers in Pit 3 were deposited by fluvatile conditions, the authors refer to a significant discovery from the renewed excavation of Pit 91. What excavators were amazed to find was that the onset of tar seeps came *after* the bones were deposited. A saturation zone emanating from a tar vent permeated into the bone mass. The saturation gradually decreased the fur-

Table I. Sample results from Pit 3.

Specimen Depth (ft.)	Sample Number	Carbon-14 Age	Deposition Activity
7	UCLA-1292B	12,700 BP*	Fluvatile
11	UCLA-1292E	14,400 BP	Entrapping
12	UCLA-1292C	14,500 BP	Entrapping
22	UCLA-1292J	20,500 BP	Fluvatile
22	UCLA-1292A	21,400 BP	Fluvatile
26	UCLA-1292K	19,300 BP	Fluvatile

*BP = before the present

ther it spread, so that bones at the periphery of the zone were only partially, if at all, permeated by the tar.

This information is strong evidence for a theory that combines animal entrapments and fluvial conditions in the making of the fossil beds. Yet as the reader of my article will soon see, this same information can also be used for a theory that eliminates animal entrapments altogether.

Water-Saturated Wood

Another detail supporting the fluvial transport theory is the water-saturated wood debris found inside Pit 3. The upright cypress tree trunk (Figure 5) was so heavy with water that removing it was a difficult operation. Twigs and leaves were also drenched. These details do not represent a minor anomaly. Stumps, branches, twigs, and leaves within other pits were similarly soaked with water. In the field notes, this woody material was described as the result of "drift" or being "washed in." The abraded surfaces of the wood indicated water-driven movement over rough terrain.

Yet if the fluvial transport theory were true, we should expect to find pieces of timber lying more or less horizontally within the sediments that brought them into the pits. Some wood specimens were in horizontal positions and others were positioned vertically, crossing sedimentary boundaries. The aforementioned cypress tree trunk crossed two layers representing fluvial transport and animal entrapments. If thousands of years of deposition are represented in these two layers, it is doubtful the tree would have maintained the freshness and integrity its wood displayed. In addition to these polystrate pieces of timber, the tangled and interlocked mingling of bones and wood debris seem to point toward a single violent event rather than a gradual layering of sediments over an indefinite period of time. The strange juxtaposition of the four-foot log standing upright upon the crotch of an inverted tree stump bears witness to a flooding episode several orders of magnitude more powerful than the winter overflows of streambed channels called for by the fluvial transport theory.

Bone Concentrations in Flood-Plain Environments

After nearly thirty years, the article produced by Woodard and Marcus still stands as a landmark in the literature of the La Brea Tar Pits. Yet much of their material has lost its value in the light of recent studies of modern flood-plain environments.

One such study was conducted at a dry lake basin within the Amboseli National Park in southern Kenya. A

limited number of spring-fed channels periodically flood the basin, moving and burying the scattered remains of deceased animals. The study focused on a stable population of 1000 wildebeests. Every year this herd contributes 250 carcasses to the basin floor with about a 100 of these being infants or juveniles. The smaller carcasses are normally devoured by predators and scavengers, which leaves about 150 carcasses remaining. About two-thirds of these carcasses are destroyed by weathering before they can be transported by flooding to suitable places for burial. Finally, for each carcass, only eight out of the original 152 skeletal parts are actually buried. While these numbers cannot be expected to apply to all situations, they do provide a case study for illustrative purposes. The predicted yearly input of buried bones from ten of the major herbivores at Amboseli, averaged over the whole basin area of 600 km², would be 0.01 bone per 1000 m². Since a fossiliferous deposit is assumed in these studies to be one bone per 1000 m², it will take one hundred years for the dry lakebed to become incrementally more fossiliferous, even if all the buried bones are preserved over time. These figures are compatible with studies made in other flood-plain environments around the world. Assumed accumulation totals cannot be much higher, without pushing animal mortality rates into the catastrophic range (Behrensmeyer, 1982).

Now let us compare the above figures with the conditions of the La Brea Tar Pits. Pit 3 had nearly 50,000 skeletal parts and fragments. Since the pit had a rough conical shape of about 15 feet at the surface and a depth of about 27 feet, that works out to be approximately 1600 cubic feet, or 850 bones per cubic yard. This numerical density is comparable to bone concentrations in other pits. For example, a large quantity of bones, including 17 complete skulls of the saber-tooth cat and 40 complete skulls of the dire wolf, were contained in two cubic yards of bone material at UC Locality 2050 (Merriam, 1908). If the first fluvial phase was 13,000 years and the second fluvial phase was 7,000 years, the number of bones in each pit is too high when compared to bone assemblage surveys in modern flood-plain environments. Uniformitarian rates of fluvial deposition are therefore unworkable when applied to the La Brea Tar Pits.

Pits and Sedimentary Layers

The fluvial transport theory combines two processes of nature that are essentially contradictory.

1. The process of bone deposition in concentrated masses requires the existence of holes or ground surface depressions that are stable and continuously open.
2. The process of sedimentation does not create holes; instead it fills them.

If the analysis of Woodard and Marcus is correct, then both these processes had simultaneously occurred in the pits. It is worth noting here that this theory replaces an old idea that was conceived by Luther E. Wyman, the supervisor of the county excavations of 1913 through 1915. Here is what he said about the origin of the tar pits in 1926.

During the two years' work of the Museum, however, many phenomena were encountered which seem explainable only on the theory that pits were formed by heavy "blow-outs" of gas from the oil deposit below, forming surface craters, most of which were roughly funnel-shaped, and followed by an inflow of oil which with sand filled the craters to the surrounding level. The gas pressure relieved, the craters would become quiescent, possibly crusting over, . . . (Wyman, 1926, p. 9)

There are features about Pit 3 as well as other pits that confirm Wyman's conclusion. These features include the funnel shape of the pits and the sharply defined contour against the surrounding terrain. On the other hand, we cannot easily dismiss the theory of Woodard and Marcus, for they have used the latest studies of the strata of Hancock Park and surrounding areas. They also rely on the data of Pit 91, which is far more thorough and meticulous in the recovery and analysis of fossil material than the old excavations ever were.

It should be pointed out here that the sedimentation *outside* the pits is not under dispute. The core sample studies of 1945 are compatible with both views. The issue in question is the perceived stratification *within* the pits. Wyman relied on his observations of phenomena in the vicinity of the tar pits to formulate the gas blowout theory. Woodard and Marcus relied on the field notes of 1913 through 1915 and the recent observations and field notes of Pit 91 to formulate the fluvial transport theory.

It is relevant to point out that the author of the early field notes was Wyman himself. Although he was a trained and observant scientist, carefully noting significant details, he was not always clear about what he was actually seeing. For example, the first time that Wyman makes a comment about the matrix of Pit 3 was on August 12, when excavators were down to the seven-and-a-half-foot level. He said, "Matrix is apparently of the very best preservative sort," meaning it was a mixture of tar and sand. When he made this comment, he said nothing about the thickness of this matrix. Did he mean that this type of matrix was first encountered at the seven-and-a-half-foot level, or was he applying his comment to the whole pit as dug out to that point? Even Woodard and Marcus admit that the field notes are not detailed geological records and can only be used to provide general information. Thus to ascribe distinct and precisely measured strata within the pits based on random comments within Wyman's field notes may be placing too fine an interpretation on them.

In my own survey of the field notes, I found a great many references to "tarry sand" or "good matrix of tar-soaked sand" and correspondingly very few references to "tarry clay." In fact wherever the word "clay" was joined with an adjective, it was most often the word "barren," meaning absolutely no bone material was found in it. These details lead me to believe that the predominant matrix was a mixture of tar and sand and that it was generally well distributed throughout the pits from top to bottom.

Let us now turn to the evidence of Pit 91. It is true, of course, that this ongoing excavation has been uncovering stratification levels within the bone mass. Yet this evidence cannot be regarded as wholly trustworthy. It is an unfortunate fact that Pit 91 is not an undisturbed pit. During the late 1800's, the ground had been turned over by workmen seeking commercial grade asphalt. According to Wyman's field notes of June 13, 1915, "about 2 ft. of earth that had been moved at some time (probably in the search for asphaltum long ago)." On June 28, Wyman wrote, "Soft vegetation that appears like hay show in spots down to 8-ft., evidently marking the bottom of old asphalt diggings. As traced on the wall of the pit, the floor of these old diggings was extremely irregular. This mixed earth and asphaltum moved so long ago is almost as hard as any original earth."

After the excavation of Pit 91 ended in August 1915, the hole was filled in over the course of the next several decades. This provided another complicating factor, as the following extract from the field notes of the renewed excavation shows:

Sept 3, 1969: Today several geologists came to study the excavation trying to determine which sediments were reworked & which undisturbed.

[List of names of four geologists provided here]

The consensus of the above group and myself [George J. Miller] was that Unit 1 was definitely fill, that Unit 2 was probably fill, (I feel that this material could have been the result of work done in the 1800's to recover asphaltum) and that Unit 3 (including darker asphaltic sandy materials) was undisturbed. The area in which the bone showing a tool mark (not made in present excavation) was difficult to interpret. We all felt it could possibly represent reworked material, but might just as well be in place. It seems possible to me that the mark could have been made in the late 1800's work; when bone was struck, the workers moved to another area because of the hindrance. The presence of much bone was probably a nuisance to them.

Although the renewed excavation of Pit 91 has provided much valuable data, the vacillations apparent in the field notes stand as a warning not to accept Pit 91 data without due caution.

Since the competing ideas of the gas blowout theory and the fluvial transport theory both have merit, a work-

able solution might be to meld both ideas into a unified theory and to discard the animal entrapment idea entirely. The following is a suggested sequence of events.

1. Through the force of moving water, alternating sediments of sand and clay were spread over the basin of Los Angeles.
2. As a result of earth tremors, cracks in the ground developed, allowing gas to escape upward and create funnel-shaped blowouts through the sediments of sand and clay.
3. The bones of uncounted animals which died during this period as well as numerous uprooted trees and branches were swept up by the force of water. Some of these transported bones and vegetation were concentrated into the funnel-shaped holes that had previously released natural gas. Other bones came to rest upon the surface of the ground surrounding the holes.
4. Petroleum followed the gas, filling the boniferous holes and spilling over the bone-strewn ground. A large asphalt lake spread approximately over a square mile. This lake eventually dried into a hard crust that capped and preserved the contents inside the pits.

In my next article, I will discuss the dynamics of the water itself in the destruction of animal life in Southern California and in the concentration of the bone material into the La Brea Tar Pits.

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Book Review

Moral Darwinism: How We Became Hedonists by Benjamin Wiker
InterVarsity Press, Downers Grove, IL. 2002, 327 pages, \$20

Dr. Benjamin Wiker is a Lecturer in the philosophy and history of science at Franciscan University, a Senior Fellow of the Discovery Institute, and a free-lance writer. Most people think that Darwinism began with Charles Darwin in the mid-19th century. In *Moral Darwinism*, however, Wiker traces its roots to a much earlier genesis – the Greek philosopher Epicurus.

Epicurus' philosophy was that the greatest pleasure is the absence of pain. We often think of Epicurus as a hedonist (one devoted to physical pleasure), but in fact he was an ascetic. His simple lifestyle was, for him, the best way to avoid painful experiences.

The science of Epicurus was materialistic in nature. He believed in "the simple, eternal atom" (p. 40) as

the base of the physical world. Epicurus thought the universe was infinite and had no beginning. To him "the gods were a part of nature, made of atoms just like everything else in the universe" (p. 43). Epicurus' theology was based on "the subordination of the gods to nature so that they could not interfere with human affairs" (p. 45). Epicurus' theology led to a materialistic morality; he believed that no moral actions were intrinsically evil.

Epicureanism was effectively dead by about 400 A.D., having been supplanted by Christianity. The Christianization of Europe assured that the intelligent design view of the universe would prevail in Western thought for the next thousand years.

Epicurean materialism re-emerged in Europe during the Renaissance and Enlightenment. What made it popular again was the scientific revolution of the 17th and 18th centuries. Major influences in the early part of this revolution were Galileo Galilei and Isaac Newton, who spearheaded the successful application of mathematics to nature. Scientists like Galileo and Newton did not intend, of course, that explaining nature through mathematics would lock the divine out of the picture. Nevertheless, the scientific revolution did eventually have this effect.

Wiker points to three major points of transformation of Epicureanism in the post-Renaissance period. First, Epicureanism became Machiavellian in strategy. Machiavelli's name is "synonymous with duplicity and the ruthless use of force" (p. 146). Second, Epicurean materialism shifted from an emphasis on asceticism to hedonism. Here the goal was "the progressive removal of these natural limits [to moral behavior] through technology" (p. 144). A focus here is Francis Bacon. Third, materialism became a political movement rather than apolitical, as it had been originally. Notable personalities here were Thomas Hobbes, John Locke, and Jean-Jacques Rousseau.

In this entire process, Christianity was "transformed from being doctrinally true to being merely a morally edifying story for the masses" (p. 200). *Deism* became the religion of the new view of nature. Such basic biblical tenets as miracles and the divinity of Christ had to be rejected in this new religion. God was reduced to a first cause who could not (or would not) interact in any meaningful way with His creation.

This, in essence, became the God of Charles Darwin. To Darwin the human soul was "an idle concept and had no place in his system" (p. 239). With Darwinian evolution, moral behavior lost its God-based foundation. Morality became "just one more effect of natural selection working on the raw material of variations in the individual" (p. 244).

In his chapter on Darwin's theory, Wiker makes it clear that Darwin knew his evolutionary hypothesis was questionable. That is, evolution was not based on firm evidence, rather "it was rooted in his *faith* that his theory would be vindicated in the future" (p. 222). Darwin's faith in natural selection "was an extrapolation from [micro-evolutionary] changes actually affected by breeders in artificial selection" (p. 222). Darwin knew that the fossil record did not show the transition forms his theory would predict, and he also knew that the complexity of such organs as the vertebrate eye would provide trouble for evolutionary theory. But still Darwin had faith that evolution would eventually be accepted.

Wiker views Charles Darwin as "the first social Darwinist and also the father of the modern eugenics movement" (p. 243). As evidence, Wiker profiles three of Darwin's disciples who later advanced the moral Darwin-

ist approach. One was Ernst Haeckel, the German zoologist who advocated suicide and euthanasia. Another was Margaret Sanger, the founder of Planned Parenthood and an ardent proponent of sexual liberation, birth control, and abortion. The third was Alfred Kinsey, who embraced homosexuality, voyeurism, and other deviant sexual practices.

Moral Darwinism concludes with a discussion of the emerging modern debate between Darwinian evolution (based in materialism) and intelligent design. Wiker points out that the theoretical framework of materialism is collapsing as a result of modern scientific discoveries. First, "big bang" cosmology asserts that the universe had a beginning. This idea is consistent with biblical religion but contradicts the Epicurean view that the universe has always existed. Second, the model of the simple "indivisible" atom has been shown to be false. Instead, the atom can be sub-divided into a dizzying array of smaller particles whose features continue to amaze the scientific world. Third, biologists have "discovered that biological complexity is far more intricate than ever Epicurus or Darwin dreamed" (p. 293). Darwinian mechanisms simply cannot explain the information content and specified complexity of living systems.

Yet despite these recent developments, the "habits of materialistic thinking" (p. 290) continue. That is, the *faith* of the materialist remains even as the framework collapses. Materialistic science "cannot rule out the possibility of an intelligent design approach to science, but must compete with it" (p. 291). In the end "there are only two extremes, moral Darwinism and Christianity. All attempts at compromise by those in between are only temporary, and one extreme – one view of the universe, our place in it, and the human good – will win out" (p. 301).

Moral Darwinism lays out, in compelling form, the steps that have led to our current cultural war. If materialism is correct, then hedonism is an appropriate (if distasteful) response. If theism is correct, then we must realign our moral conscience with the will of the Creator. Wiker sees the intelligent design movement as "a most needed attempt to restore the human intellect to its rightful place as that which can know and take delight in the created order" (p. 321).

Materialistic science has censored intelligent design from its legitimate role as a competing theory to Darwinian evolution. This censorship is not based on any scientific evidence; it is based on the *assumption* that materialistic (atheistic) philosophy is true. Wiker concludes that "all evidence must be examined and none censored. The truth shall be revealed" (p. 321).

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Darwin's Cousin Sir Francis Galton (1822–1911) and the Eugenics Movement

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Abstract

A central plank in Nazism, communism, and other totalitarianism movements was eugenics. Eugenics, the science of improving the human race by scientific control of breeding, was viewed by a large percentage of all life scientists, professors, and social reformers for over a century as an important, if not a major means toward producing

paradise on Earth. The founder of this new science was Sir Francis Galton, a cousin and close associate of Charles Darwin. Galton's work was crucial in providing the foundation for a movement that culminated in the loss of many millions of lives, and untold suffering for hundreds of millions of people.

Introduction

The now-infamous eugenics movement grew from the core concepts of biological evolution—primarily those ideas expounded by Charles Darwin (Gould, 1996; Himmelfarb, 1959; Shannon, 1920; Haller, 1971; Barzum, 1958). Eugenics took a firm hold in most western European nations and the United States, where it was translated into social policy and still exists in a form often called sociobiology (Sahlins, 1977). It has been well documented that “Eugenics was the legitimate offspring of Darwinian evolution, a natural and doubtless inevitable outgrowth of currents of thought that developed from the publication in 1859 of Charles Darwin's *The Origin of Species*” (Haller, 1984, p. 3). An example of the racism that Darwin produced is illustrated in the following quote from a widely used zoology text in the 1920s:

The gulf between the most highly civilized and capable races of Europeans and the degraded brute-like African pygmies is so vast that some authorities are impelled to conclude that they belong to distinct species, or at least to subspecies (Newman, 1925, p. 403).

This tragic application, which some would say is a misapplication, eventually contributed to the Nazi Holocaust and many other destructive social movements (Proctor, 1988). The first step that resulted in Galton's life long eu-

genic crusade was his acceptance of macroevolution. Larson points out that Galton accepted Darwinism for several reasons, not the least of which he expressed in a letter to Darwin saying that it:

“drove away the constraint of my old superstition” and allowed the acceptance of a purely secular faith in progress. Traditional spiritual beliefs in a fallen creation and human redemption through divine grace gave way to a materialistic view of humanity rising through evolutionary development (Larson, 1995, pp. 18–19).

Pearson claimed that Galton was loyal to Darwin “with a loyalty far rarer” than today (1914, p. vii).

Galton was the nephew of Erasmus Darwin, and thus the younger cousin to Charles Darwin. Galton was independently wealthy and held no scientific or teaching post. Best known for his work as the founder of eugenics, he argued that it was largely genetics (“nature”) that determined our intellect. Thus, our destiny was fixed at conception and, in the belief that certain people were superior, he strongly advocated controlled breeding to maintain the finest ruling classes (Taylor, 2001).

Understanding why the eugenics movement grew so rapidly and to be so large requires a knowledge of how evolution was viewed in America and Europe during the late 1800s and early 1900s. Many scientists had applied Darwinian analysis to various human “racial” groups, and had concluded that some “races” had evolved further than others. They then reasoned that the presence of certain racial groups in the United States and Europe constituted a

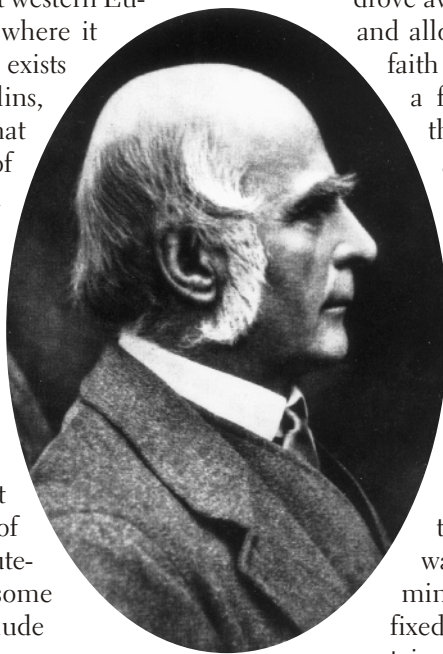


Figure 1. Sir Francis Galton (1822–1911) at age 66

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threat to “the long-run biological quality of the nation.” Consequently, it was concluded that “selective breeding was a necessary step in solving many major social problems” (Haller, 1984, p. x). We today are keenly aware of the tragic results of this belief. Most people are horrified by such statements when voiced by modern-day white supremacists and racist groups such as the Arian Nation or Ku Klux Klan. Many of the extremist groups today often quote from, and also reprint and distribute extensively, the scientific and eugenic literature of this time.

Although the eugenics movement dates back to the original work of Darwin, several discoveries around 1880 caused it to become somewhat scientifically respectable. After a basic understanding of the mechanism of heredity, and the rediscovery of Mendelian genetics which occurred soon after the turn of the twentieth century, more scientists than ever before became convinced that they had unlocked the secret of heredity, and thus the key to evolution (Cravens, 1978, pp. 39–47). These discoveries opened up a whole new understanding about humankind’s place in nature, and the key to a method that many felt offered major potential for societal improvement. Just as the variations in animal species made them more or less fit for evolutionary survival, so too it was argued that the variations within certain human racial groups made them more or less fit, depending on the environment (Haller, 1984, pp. x–xi).

The Founder of Eugenics, Darwin’s Cousin Francis Galton

In the late 1850s when Francis Galton was in his late 30’s, he began his lifelong quest to quantify human traits which he grouped into “races,” so that he could develop ways of genetically improving the human race. Strongly influenced by his older second cousin Charles Darwin, Galton concluded that the key to human progress was the direct application of Darwinism to society, reinforced by law and national programs (Gallagher, 1999). So important was the eugenic doctrine that within six years of the publication of *The Origin of Species* “Galton had arrived at the doctrine that he was to preach for the remainder of his life ... this became for him a new ethic and a new religion” (Haller, 1984, p. 10). Once he got his “new religion” he set out to find convincing evidence for it:

The wealth that he inherited from his father at the age of twenty-two allowed him to broaden his familiarity with various racial types through extensive world travels that included explorations of parts of Africa unknown to Europeans, and then to settle into the life of a Victorian gentleman scientist in London. Galton brought back from his travels a firm conviction that there was a natural hierarchy of the human

racess that placed Anglo-Saxons above all others. His cousin’s masterpiece *On the Origin of Species*... stimulated Galton to investigate how the human species had developed through variation, selection, and inheritance, which were the driving forces of Darwinian evolution (Larson, 1995, p. 18).

In 1865, Galton first published his eugenic ideas in a two-part series of articles for *Macmillan’s Magazine*, which he eventually expanded into a book titled *Hereditary Genius* (1865). His article focused on the source of natural abilities such as intellect, personality disposition, and even moral qualities, especially those that enabled one to become an effective leader. He also researched the skills needed to achieve in the arts, sciences, literature and in positive human endeavors in general. Galton openly stated that his goal was

to produce a highly gifted race of men by judicious marriages during several consecutive generations. Consequently ... to obtain by careful selection a permanent breed of dogs or horses gifted with peculiar powers of running, or of doing anything else, so it would be quite practicable to produce a highly-gifted race of men by judicious marriages during several consecutive generations (Galton, 1869, p. 1).

He proposed in his 1865 *Macmillan’s* article that the state sponsor competitive “examinations” to find the “best” humans, and that the male winners marry the female winners.

Galton later even went so far as to suggest that the state rank people according to evolutionary superiority, and then use monetary rewards to encourage those who ranked high to have more children. Those ranked toward the bottom would be segregated into monasteries and convents in order to prevent them from propagating more of their kind (Kevles, 1985, p. 4). Galton knew that for his goals to be successful, he needed to avoid what the common people would regard as extreme statements. One reason Galton was conservative in his comments was because he realized, as did Darwin, that radical claims would insure that their eugenic cause would fail:

Shaw’s later proselytizing of the eugenic cause was not to be looked upon by Galton with much favour: he was too extreme and deliberately provocative, while Galton was preaching caution to elicit public acceptance (Forrest, 1974, p. 258).

For his book, Galton relied on a methodology to study genius that has been used by many others since (see Goertzel and Goertzel, 1962). The source of his sample population, which spanned two centuries, was the bibliographical encyclopedia, *Dictionary of Men of Time* published in 1865. Not unexpectedly, he found that many of those included in this massive reference work, presumably the most distinguished statesmen, scientists, painters, and jurists of his day, were blood relatives. Galton con-

cluded that families that had eminent members were far more likely than others to produce offspring of ability. Later researchers, such as Karl Pearson, concluded that fully 90% of one's intelligence was inherited (Hofstadter, 1955). The most commonly cited estimate today is 70%, meaning that a good environment could raise the I.Q. of a child from average (I.Q. 100) to as much as 130, which would qualify the child for gifted programs in most cities.

Galton's goal was to produce a super race to control tomorrow's world, a dream about which he not only wrote, but actively promoted for his entire life. To describe his use of evolution to improve humans, Galton coined the word *eugenics* (from two Greek words meaning *well born*). He also introduced the terms *nature* and *nurture* into scientific discussions, fueling the nature/nurture debate that still rages today. The term *eugenics* was important because

By giving a popular name to theories that he had already begun developing from the evolutionary concepts of his cousin Charles Darwin, Galton founded a movement that swept throughout Europe and North America during the ensuing half century (Larson, 1995, p. 18).

In 1901, he founded the *Eugenics Education Society* based in the Statistics Department at the University College of London (Jones, 1980). This organization flourished, later even producing the journal *Biometrika*, which was founded and edited by Galton (and later Karl Pearson). Although still a leading journal today, its editors have since rejected the basic philosophy behind its founding.

Galton concluded that not only intelligence, but many other human traits, were primarily, if not almost totally, the product of heredity and thus by "nature". He also believed that virtually every human trait could be evaluated statistically, and that human beings could be quantitatively compared via many hundreds of traits. Galton also was fully convinced that the survival of the fittest law applied to humans, and that reproduction of the race should be under the control of those who were most intelligent and responsible (Pearson, 1924). This idea is not surprising, in view of the importance of social class in Britain. The social class ethos was that a laborer's son should not aspire to a better station in life. The reason was not because of a lack of social skills or education, but because most labor families were believed to be generally genetically inferior. Greene, after noting that many British were influenced heavily by the writings of people like Adam Smith and Thomas Malthus concluded that

it is no mere coincidence that all of the men who arrived at some idea of natural selection the first half of the nineteenth century—one thinks of William Wells, Patrick Mathew, Charles Lyell, Edward Blyth, Charles Darwin, A.R. Wallace, and Herbert Spencer—were British. Here, if anywhere in the history of science, we have a striking example of the in-

fluence of national habits of thoughts on the development of scientific theory (1981, p. 49).

Galton, a child prodigy himself, soon set about looking for other superior men to study—by measuring the size of their heads, bodies, and brains. He devised sophisticated measuring equipment for this purpose that supposedly quantified not only the brain and intelligence, but virtually every other human trait that could be measured without surgery. He even designed a whistle to measure the upper range of human hearing, now called a *Galton whistle*, a tool that still is standard equipment in a physiological laboratory. His work was usually anything but superficial; in fact, much of it was extremely thorough. He relied heavily upon the empirical method and complex statistical techniques, many of which he developed specifically for his eugenic work. In fact, Galton and his coworker, Karl Pearson, were regarded as the founders of the modern field of statistics (to which both made major contributions). Their thorough, detailed research was extremely convincing, especially to academicians. German professors were among the first to embrace wholeheartedly their philosophy, as well as the theory of Darwinian evolution.

One cannot attribute the acceptance of eugenics to British attitudes towards class, because *Biometrika* had far more subscribers in the United States than in Great Britain. Eugenist Karl Pearson (1857–1936) at one time even considered moving to the United States, where he thought people would be more receptive to eugenic ideas. The United States was separated from Europe by a large distance, and one of the most impelling goals since the new continent was settled was to avoid a repeat of the wars that tore Europe apart for almost 500 years. To avoid conflicts, vigorous efforts were made to ensure that the new society was white, Anglo-Saxon and, above all, Protestant (Taylor, 2001). Catholics were excluded, or at least were reeducated. Taylor notes:

Naturally, if the arguments could be backed by science then the appearance of bigotry would be avoided. Eugenics was thus the perfect answer and vigorously applied at immigration ports such as New York. The work of Franz Boas provided scientific data. Would-be immigrants were often refused entry on the basis of head measurements or finger-tip to knee-cap distance (if too short, the individual was clearly insufficiently evolved!) (2001).

The idea that humans could achieve biological progress, and eventually breed a superior race, was not seen as heretical to the Victorian mind, nor did it have the horrendous implications or the societal taint of Nazism that it does today. Galton saw the fruits of recent advances in technology and the results of the Industrial Revolution, which had proved humans could achieve mastery over inanimate nature (Kevles, 1985, p. 2). People understood that by careful selection, farmers could obtain better

breeds of both plants and animals, and so it seemed logical that the human race could likewise be improved (Jones, 1980).

Galton's conclusion was that, for the sake of the human future, pollution of the precious superior gene pool of certain classes *must be stopped* by preventing interbreeding with inferior stock. The next step was that humans must intelligently direct their own evolution, rather than leaving such a vital process to chance alone. Significantly, Galton was not alone in this conclusion; all of the major supporters of evolution, including Charles Darwin, Alfred Russel Wallace (often called the co-founder of the modern theory of evolution), E. Ray Lancaster, and Erasmus Darwin, believed that "evolution sanctioned a breeding program for man" (Haller, 1984, p. 17).

The route to produce a race of gifted humans was to control the marriages of people to one another (Galton, 1869, p. 1). In an effort to be tactful in his discussion of race breeding, Galton used terms such as "judicious marriages" and "discouraging breeding by inferior stock." He did not see himself as cruel, at least in his writings, but believed that his proposals were for the long term good of humanity. Galton utterly rejected, and wrote much against, the Christian doctrine of helping the weak, displaying a tolerable attitude toward human fragilities, and showing charity towards the poor. Although this response may seem cold and detached, it must be viewed in the scientific climate of the time (Kevles, 1985, p. 8). The mind of the eugenic's co-founder, Karl Pearson, has been described as mathematical and without feeling and sympathy. Galton received numerous honors for his work, including not only the Darwin and Wallace Medals, but also the Huxley and Copley Medals. He even was knighted by the British government, and thus became Sir Francis Galton.

Brain Size and Intelligence

To prove his theory, Galton first had to show how radically the races of mankind differed from each other. Then he had to demonstrate that these differences were inherited. Galton was influenced considerably by French physician Paul Broca, who maintained that human intelligence was related directly to brain size. Galton was aware that some brilliant men had small heads, and that many ignorant men had large heads, but he endeavored to explain away these cases, stressing that *in general* the relationship held.

We know today that some relationship between brain size and intelligence exists, but not for the reason that Galton supposed: better diets and environmental conditions produced children who were physically larger, and consequently had larger brains. Children of the upper classes also were often better educated, and had more lei-

sure time to pursue intellectual interests. Children reared in the slums often had poorer diets, and lived in more adverse mental and physical environments. As a result they often were of smaller stature, and consequently faced many other disadvantages. As is recognized today, children from families of eminence are far more likely to have more intellectually stimulating home environments, receive better educations, and attend better schools. They also have more support, encouragement and motivation to achieve eminence.

For this reason, many cases existed that Galton could use to support his theory. Obtaining a high correlation between brain size and intelligence, though, *does not* prove causation, a well-recognized statistical fallacy that Galton ignored. Although the absolute average size of the brain varies, it tends to be correlated primarily with body size. Except in cases of disease or abnormal development, gross brain size has little to do with intelligence (or any other observable trait), and thus evidently is a non-functional characteristic that fails to affect survival. Some of the most brilliant men in history have had very small brains, while others with large brains were mentally retarded, a fact that, as noted, did not dissuade Galton concerning the validity of his theory (Birdsell, 1972, p. 516; Lorber, 1980).

Galton even claimed that talent was rarely impaired by social disadvantage, and he selected examples of individuals that came from humble families who succeeded as "proof" (Kevles, 1985, p. 4). Galton concluded that because a few of these children *did* become successful, most of them *could have* if they had the intelligence, which obviously most did not. Nor did Galton adequately deal with the fact that those of high ability who rose from poverty might have done far better if they had been born in a privileged family and were given many more advantages.

One "proof" of eugenics came from America, where, Galton concluded, the rigid class structure that existed in Great Britain had been virtually eradicated. If culture prevented talented people from greater achievement, then the number of persons in the arts and sciences in America certainly would far surpass that of Britain. Galton concluded that it did not, and therefore if "the hindrances to the rise of genius were removed from English society as completely as they have been removed from that of America, we should not become materially richer in highly eminent men" (Galton, 1869, pp. 40–43). A serious problem with this generalization was the difficulty in judging a "first class work of literature, philosophy, or art." Galton largely ignored the fact that America and Europe possessed different art values and norms, which blocked the rise of people born into lower social classes. Many Americans produced art that was appreciated in the U.S., but not in Britain. Not many British would conclude that America had more superior artists, writers, etc. (Chase, 1980).

The Making of Galton

Francis Galton's own upbringing in many ways belied his theory. He was born in 1822 into an old family that originally had earned its wealth by manufacturing guns. Galton's father was a banker when he married the daughter of Erasmus Darwin, Charles Darwin's grandfather. His family invested considerable time and energy in Francis' intellectual development. Although Francis Galton's obvious inborn giftedness helped, his sister, who was twelve years his senior, tutored Galton so successfully that at two-and-a-half he mastered basic reading, at four he could write, and at eight he mastered basic arithmetic. In contrast to Francis Galton, his two brothers did not do very well as adults; he was the only one in his family who achieved any measure of public success.

The Galton family admired Erasmus Darwin, and often extolled his eminence in the field of medicine and biology. The family's religious background was Quaker, but Francis' father converted to the Anglican Church at the insistence of his wife, Violetta. This later worked to Francis' advantage, since he was able to attend England's leading universities (which at the time still were restricted to Anglicans).

Although Galton was a precocious child with high intelligence, he did not do well at school. He was sent to medical college at age 16, and did not do well there either (Pearson, 1914). He was evidently bored, unmotivated, and often "partied," attending most social gatherings and staying to the end. He evidently traveled, as is said today, "to find himself." It was only upon reading Darwin's *Origin* in 1860 that he found his true vocation, and for the rest of his life he applied all his considerable energies to advancing eugenics. Although his eugenics science was faulty, however his contributions to statistics, and especially to the field of fingerprints, are scientific milestones for which he should be far better remembered.

In 1844, when Francis was 22, his father died, leaving him a large inheritance. Even with a world waiting for him, and the financial means to explore it, his inclination to do so evidently came not from his genes, but from the influence of those around him. Brooding, depressed, and without goals, Galton consulted a phrenologist who reported that men of his head type were best suited for activities such as colonizing and exploring (Kevles, 1985, p. 6). Believing this obviously erroneous advice to be true, in 1850 Galton went off to explore a part of the world which at that time was largely unknown to Europeans—the forboding land of dark Africa.

Galton returned to England with a renewed curiosity about both the natural world and the ranking of the races. He soon was awarded a gold medal by the World Geographical Society, and was elected to a Fellowship in the Royal Society as a result of his achievements. This experi-

ence also led him to lecture and to write, two tasks at which he excelled. Most of his books went through many editions during his lifetime.

From this point on, Galton's ideas about eugenics rapidly jelled. The knowledge he had obtained during his African travels served to further confirm his beliefs about inferior races, and about how to improve society. This conclusion strongly supported the writings of both his grandfather and his second cousin, Charles Darwin. Galton was also highly rewarded for his scientific contributions, and likely felt that his eugenics work was another way that he could attain even more honors. He concluded that this work was more important than that which he had completed for the various geographical societies, and more important than even his research that helped the fingerprint system become part of the British method of criminal identification.

Eugenics theory is intimately tied to the history of evolution. Haller (1984, p. ix), the author of one of the most definitive works on the history of the eugenics movement, stated: "Eugenics rose out of the Darwinian theory of evolution and attempted to apply the theory to mankind... eugenics... involved the application—or misapplication—to man of the discoveries in genetics that were then transforming scientific understanding of living organisms and the ways that evolution operated." In a letter that he wrote to Darwin, Galton said: "The appearance of your *Origin of Species* formed a real crisis in my life; your book drove away the constraint of my old superstition as if it had been a nightmare and was the first to give me freedom of thought" (quoted in Haller 1984, p. 198). Another aspect of Galton's motivation was:

Galton, himself an agnostic, found in eugenics an emotional equivalent for religion. "An enthusiasm to improve the race is so noble in its aim" he declared "that it might well give rise to the sense of a religious obligation." He even advocated that law and custom should be utilized to support eugenics for the improvement of the race. This of course is exactly what the Nationalist Socialist Party did not too many years later in Germany (Haller, 1984, p. 17).

Galton called the method of race analysis that he developed "statistics by intercomparison." It later became a common system of scaling psychological tests. This scale permitted Galton "to make a number of general statements about the comparative abilities of different races, statements that were well in tune with" and in many ways were merely re-expressions of, the prejudices of his day (Stegler, 1986, p. 272). Interestingly, Galton rated the ability of the ancient Athenians "very nearly two grades higher than our own—that is, about as much as our race is above that of the African Negro" (Galton, 1869, p. 342). How Galton was able to do this is not entirely clear, but he likely relied almost totally upon the writings of literate Athenians

about whom we know something today (likely the more eminent and talented persons of that culture).

Although biologists of the time provided much of the intellectual and empirical support for the theory, the eugenics movement was supported heavily by the work of “superintendents of asylums for the feeble minded, insane, and alcoholic, of prison wardens and prison physicians, of sociologists and social workers” and those involved in the care of persons with mental or physical problems (Haller, 1984, p. 5). They generally believed that society had a responsibility to care for these persons, and they also felt that society should see to it that such persons did not contaminate future generations.

This conclusion is understandable: those who work with the feeble minded, the institutionalized criminals, epileptics, paupers, and others found their work incredibly frustrating (Dörner, 1981). It often is very difficult to help people change their ways, either by conversation or exhortation. Their general failure to help these people often was explained, not on the basis of the inadequacies or ineptness of the helpers (the social workers, institutions, and doctors involved), but because the patient’s condition *primarily* was the result of heredity, and consequently there was *little that one could do to help them*; the caregiver’s failure was not his or her fault. Assuming that the patients’ conditions were due to heredity, the next logical step was to find ways to restrict the propagation of these people. Numerous laws were passed that required sterilization of a wide assortment of individuals who, for a variety of reasons, found themselves in some institution. Looking back now, we can recognize clearly the reasons for the enormous failure of many of the so-called treatments, and the institution system as a whole (Valenstein, 1986; Doerner, 1981).

Around the year 1900, eugenics was fully accepted as valid by the educated classes. As Kevles stated “Galton’s religion [became] as much a part of the secular pieties of the nineteen-twenties as the Einstein craze” (1985, p. 59). There has now been over 200 books written on Galton and his eugenics ideas (Blacker, 1952). Books on eugenics became best sellers; Albert E. Wiggam wrote at least four popular books on eugenics, and several sold very well (Wiggam, 1922; 1924; 1925; 1927), and the prestigious Darwinian family name stayed with the eugenics movement for years (the president of the British Eugenics Society from 1911 to 1928 was Major Leonard Darwin, Charles’ son). The obsessional quality of Galton’s interest in quantifying every conceivable human activity was reworked by Eliot Slater, a psychiatrist, in his Galton lecture for 1960 (Slater, 1960).

The impact of the eugenics movement on American law was especially profound. In the 1920s, Congress passed numerous laws intended to restrict the influx of “inferior races,” including those from southern and eastern

Europe, as well as China. These beliefs also were reflected in everything from school textbooks to social policy. American blacks especially faced the brunt of these laws (Stanton, 1960). Interracial marriages were forbidden by law in most states, and discouraged by social pressure in virtually all states. The eugenicists concluded that the American belief that education could benefit everyone was unscientific, and that the conviction that social reform and social justice could reduce human misery substantially was more than wrong-headed, it was openly dangerous (Haller, 1984, p. 6).

According to Haller, it was only between 1870 and 1900 that “educated Americans took giant strides toward a fairly wide acceptance of varying forms and degrees of racism” (1984, p. 50). The year 1870 is an important date because

before the Civil War the lack of a well-developed racist philosophy in the Western World and a general belief that all men descended from Adam and Eve retarded the growth of race concepts. Only among those defending Negro slavery from increasingly bitter attack did specific biological theories of race become at all important. In the post-Civil War period, however, the general background of evolutionary thought and the writings of European racists provided a climate of opinion that nurtured race thinking (Haller, 1984, p. 50–51).

The conclusion was “the broad, flat nose, the slanted profile of the Negro face, and the smaller, average skull capacity—so it was argued—placed the Negro closer to the anthropoids,” (Haller, 1984, p. 52), and since they were inferior, miscegenation was considered the “road to racial degeneration.”

Galton not only spent much time studying the races in his extensive travels, but also read widely in the area of anthropology and was involved formally with the Royal Anthropological Institute. He concluded that the Anglo Saxons were far superior to the Negroes, who in turn were superior to the Australian Aborigines (Galton, 1880, p. 17). While Galton himself did not advocate the deliberate extinction of races, he did state that the sentiment *against* the extinction of an inferior race was unreasonable, clearly setting the stage for later abuses (Galton, 1897, pp. 605–606).

Many Jewish thinkers touted the same message; rabbi Henry H. Mayer expressed concern in a service in Kansas City, thundering, “our blood is being adulterated by the infusion of blood of inferior grade” (quoted in Kevles, 1985, p. 61). Even some Protestant and Catholic ministers joined the act, suggesting that the Bible taught eugenics and that we have an obligation to God to apply the “laws” that eugenics had “discovered.” As Kevles noted, many of those involved “cast off Biblical religion and, some with enthusiasm, others by default or in despair, had embraced a religion of science” (p. 68). And “with the modern mira-

cles went a modern priesthood: the scientists—no small number of them geneticists. In America, the eugenic priesthood included much of the early leadership responsible for the extension of Mendelism” (Kelves, 1985, p. 69).

An example of Galton’s analysis was his study of “the very curious laws of deviation from an average.” He employed data on height, and produced a graph using a bar and dot pattern to indicate each case. Each dot represented the height of one man, with the pattern showing a concentration in the middle, and fewer dots as deviation from the middle occurred. The same concept is expressed today in the normal curve theory. By 1875, Galton developed a new way to display these data which he called an *ogive*, a term he borrowed from the field of architecture. This distribution we now refer to as an *inverse normal cumulative distribution function*. Galton, because his goal was to show the dissimilarity of races, began to explore ways of evaluating these differences. The middle (or medium) score he assigned a value of zero (representing mediocrity or the medium), the upper quartile he assigned a value of one, and the lower quartile he assigned a value of minus one. This method later developed into the standard deviation concept.

Crucial in the development of his thinking about the normal curve was a series of experiments with sweet peas, and a tool that later became known as the *quincunx*, a flattened hourglass-shaped device that allows small balls to fall toward the bottom in such a way that, as the balls descend, they cascade through an array of pins. Each shot strikes a pin at each level, falling right or left with equal probabilities each time a pin is hit. The balls are then collected in compartments at the bottom, producing a normal curve. This vivid physical demonstration of the normal curve concept convinced many of the correctness of the eugenic world view (Stigler, 1986).

Conclusions

On occasion, the allegation is made that Darwinism was misused in support of eugenics, when, in reality, neither Darwin or Galton should be faulted for abuses of the theory. The fact is

Racism was only one step away from eugenics, a school of applied Darwinism founded by Francis Galton with the aim of improving the fitness of the human race by applying the “theory of heredity, of variations, and the principle of natural selection.” From eugenics, it was no large leap to genocide (Hsü, 1986, p. 11).

Ultimately the eugenics movement failed, partly because of the excesses arising from it (as in, for example, Nazism). Galton at first encouraged only the “fittest” men

and women to marry and produce children, a proposal that became known as “positive eugenics.” He later suggested that the unfit be segregated into monasteries and convents to prevent them from reproducing, a proposal called “negative eugenics” (Larson, 1995, p. 19). In time Galton’s disciples put more and more attention on negative eugenics, partly because it was simpler to apply!

The fact that negative eugenics became a primary focus of many later eugenicists exacerbated Hitler’s eugenic program, which resulted in the loss of millions of lives and widespread violations of human rights. In the words of Harvard biologist Ernst Mayr, “eugenics was conceived by its founders as a way of lifting humans toward greater perfection. It is sadly ironic that this noble original objective eventually led to some of the most heinous crimes mankind has ever seen” (1988, p. 80). Although Galton had founded the eugenics movement, he had not personally fulfilled his own eugenical obligations; the scion of two prominent English families, married to the daughter of a third, he never produced offspring of his own (Taylor, 2001).

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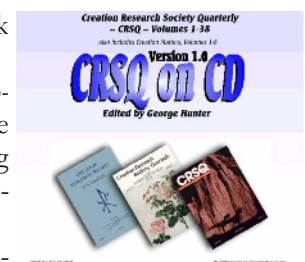


Photo Essay

The Saguaro: God's Desert Sentry A Van Andel Creation Research Center Report

George F. Howe and Stephen B. Austin*

When asked, "What plant do you associate with the desert in Arizona?" most people will quickly say "The saguaro cactus, of course." This giant plant captivates the human mind, and well it should! Multiplied thousands stand pointing upward from the slopes and hillsides of southern Arizona, looking like tall soldiers guarding their homeland; see Figure 1¹. Some of the oldest saguaros are up to 50 feet in height; see Figure C-1². This makes them the tallest cacti in the United States. Among cacti world-wide, saguaros are exceeded in size only by the cordon cactus, *Pachycereus pringlei*, of Baja California and by some other giant cacti of Mexico and Brazil.

The saguaros grow very slowly and the oldest are estimated to be about 150 to 200 years old. Although growth rates vary, it takes about 20 years for a seedling to reach a height of one foot (Hodge, 1991, p. 43). Young plants are unbranched, looking like upright clubs, and they resemble the barrel cacti (Figure 2 and Figure C-2), from which they can be readily distinguished. See Figures 2, 3, C-2, and C-6 as well as their captions for features by which to tell young saguaros from barrel cacti.

The branches of the main saguaro stem resemble arms and begin to form when the plant reaches a height of about 15 feet when the specimen is close to 75 years of age. Because of their shape and relationship to the main stem, the branches are said to be *candelabriform*, which means they have the shape of a candelabra. The oldest saguaros may have a dozen branches and some of those branches may have branches of their own (see Figure 4). These secondary branches are found generally on the largest plants and are not usually numerous. As a result of the effects of gravity, weather, and biological factors, some of the branches bend downward or become grotesquely contorted (Figure 5). Amazingly, the base of the saguaro stem is only six to eight inches in diameter. The oldest specimens reach their

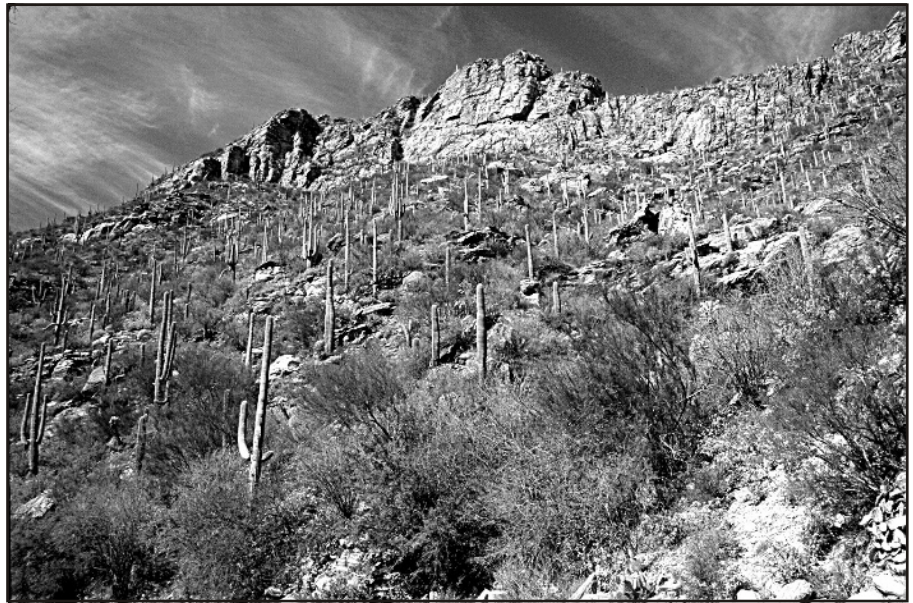


Figure 1. A breath-taking view of saguaros on a slope at Sabino Canyon in the Santa Catalina Mountains of Arizona. There was concern in the 1960's that saguaro populations around Tucson and elsewhere were declining in numbers, but Sabino Canyon is one of those localities where the saguaro populations have increased during the last 40 years (Hodge, 1991, pp. 61-62). Photograph by Carl Froede, Jr.

widest part, 11 to 16 inches, slightly above the middle of the plant.

The succulent outer portion of the saguaro stem has many "flutes". These flutes are long pleats like the folds of an accordion. This succulent portion surrounds the numerous wooden poles, which support the weight of the plant (Figures 6, 7, and 8). The flutes enable the cactus to expand and contract as it gains and loses water. The weight of large individual saguaro plants has been estimated to exceed nine tons, most of which is water. A typical saguaro ranges between 75 and 98 percent (of fresh weight) water. The water content is highest near the top and lowest at the base. A large individual plant can absorb hundreds of gallons of water after one good rainstorm. Saguaros that are over-exposed to water do not burst but have been known to split lengthwise (Desert Botanical Garden, 2001).

¹Note, in this article there are both black-and-white photographs and two pages of color photographs. Figure 1, Figure 2, etc. refer to the black and white photographs which are interspersed throughout the text.

²Figure C-1, Figure C-2, etc. refer to Figure numbers on the two color pages.

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Figure 2. A young saguaro has flourished in the center of a creosote bush (*Larrea tridentata*) which is serving as its ecological “nurse” plant. The creosote bush has supplied a measure of protection to the cactus from biological and meteorological forces over the years (Nobel, 1980a).



Figure 4. Branches of branches. Note at the left and the right there are branches that have produced their own branches.

When a Gila woodpecker or a golden flicker makes a hole and carves out a chamber in the succulent region of the stem, a saguaro ordinarily begins producing firm walls out of callus tissue. These walls become a gourd-shaped pocket called a *boot* (Figures 9 and 10). The cavity inside the boot provides an excellent nesting site for the woodpeckers or for other birds, like the little elf owl, that may borrow it as a nesting place years later. At least two graduate theses have been written about saguaro tree holes and the variety of life within them (Krizman, 1964; Soule, 1964).

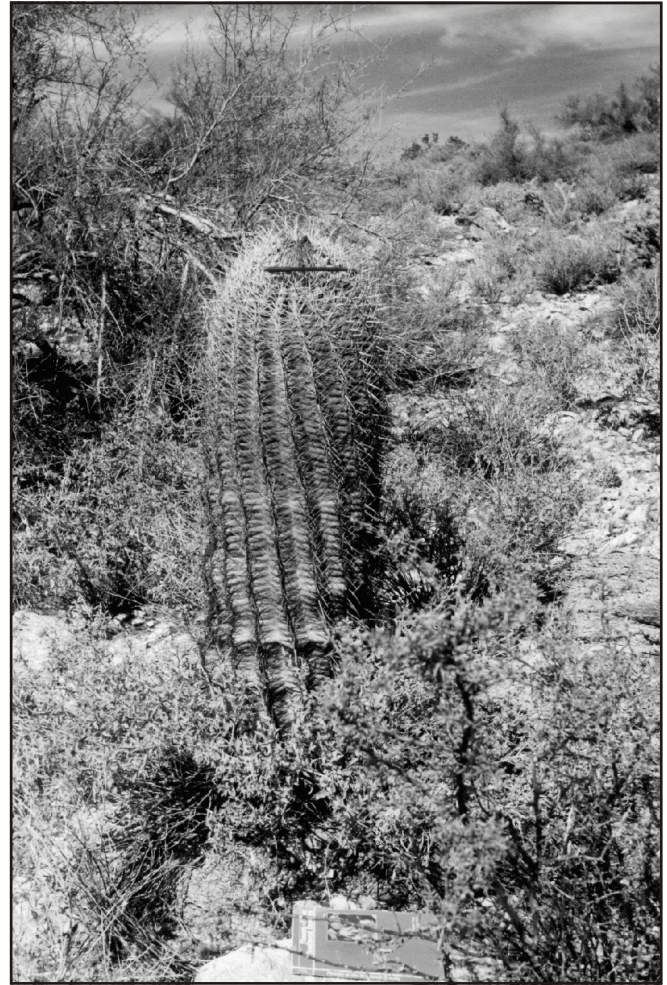


Figure 3. This barrel cactus with its curved spines and slightly twisted, rippled flutes, can be distinguished easily from young saguaros of about the same size (Figures 2 and C-2) which have straight spines and flutes which are not curved.

Birds like the purple martins and housefinches are known to build their nests in the open, among the arms of the saguaro cactus. The cactus wren builds its gourd shaped nests among the spines of the cholla cacti (*Opuntia* spp.); see George Austin (1974); Ricklefs and Hainsworth (1969). In all these cases, the well-armed cacti afford significant protection for their feathered friends.

A saguaro stem bulges slightly in and out many times along its length (Figures C-1 and C-2). It is said that the constrictions are formed in the dry seasons and the broader areas during the wet cycles. The *much deeper* constrictions sometimes found in saguaro stems (Figure C-3) probably result instead from severe frosts (Hazen-Hammond, 1997, p. 23).

Up and down the crest of each ridge there are numerous little locations, a short distance apart, called *areoles*, where spines occur. Unlike the areoles of some other cacti, those of saguaro do not occur on little mounds (called *tu-*



Figure C-1. Giant saguaros can grow up to 50 feet in height. This one shows the typical *candelabriform* branching pattern. Note the horizontal bulges on the fluted stems. These bulges are thought to correlate with the wet seasons. In the foreground, curious woodpecker holes can be seen. These provide lodging not only for the woodpeckers that make them but also for many other life forms (Krizman, 1964; Soule, 1964). The small shrub with yellow flowers is the creosote bush (*Larrea tridentata*), which grows extensively from west Texas to desert areas of California.



Figure C-2. Barrel cacti (*Ferrocactus* sp.) can be seen in the center and right foreground while a young saguaro is partly visible at the far right (South Mountain Park, Phoenix). Note that barrel cacti have curved spines while the saguaro spines (Figure 11) are straight. Barrel cactus spines have a reddish hue, while those of saguaro do not.



Figure C-3. The white flowers visible on the right branch of the saguaro in the foreground were blooming on June 2, 2001, along a road leading to a roadside rest area between Phoenix and Quartzite, AZ., close to mile marker 87, on westbound interstate 10. The very deep constriction seen two-thirds of the way up on the main stems, near the branch, probably resulted from a severe frost.



Figure C-4. This is a closer view of the flowering branch seen in Figure C-3. The flowers closest to the camera have already bloomed and their flower bases (ovaries) are beginning to ripen into fruit.



Figure C-5. The saguaro flower is seen here in full bloom. It produces generous supplies of pollen and nectar which attract bats, birds and bees as well as other insects. Such beauty is a tribute to the Creator.



Figure C-6. The flowers of the barrel cactus are clearly yellow and hug the stem more closely than those of saguaro.



Figure C-7. On this saguaro stem there are fruit that have ripened and split open revealing the sweet fibers which are mingled with seeds.



Figure C-8. A closer view of the saguaro fruits. They must be harvested from the tip of the stem or its branches. They are still used for human consumption in various forms, including jams and jellies often available in desert curio shops. The nutritious and tasty character of these fruits points to the generous and providential nature of the Creator.



Figure 5. This gnarled and twisted specimen is older than it looks. It shows that the saguaro can survive while its branches become bent and otherwise distorted by natural forces.

bercles) but exist in a row, as previously stated (Figures 11, C-4 and C-5). Botanists speculate that each areole spine cluster is a modified lateral bud and that the spines are modified leaves. Each areole has a group of up to 25 spines (Figure 11); the central spine is brown or black when young and about two inches in length. The spines of saguaro are not hooked like those of the barrel cactus nor are they barbed like the *Opuntia* spines.

Could it be that at least some of the original created kinds of cacti had leaves, as does *Pereskia*, a cactus of Mexico and South America? Genesis 3:18 states that God caused the ground to bring forth thorns and thistles due to Adams disobedience (Wolfrom and Williams, 1991, cover). It is tempting to assume this might be the time when thorns arose on cactus family members and other plants as well. Whatever may be speculated about their origin, the saguaro spines are an undoubted aid in its own survival. Spines on cacti likewise supply protection for birds and other animals that nest among the spines, as noted ear-



Figure 6. A dead saguaro photographed near Tucson, AZ. The outer succulent tissues have long since undergone decay while the inner rods of cactus wood still remain. This wood has many uses including that of knocking ripe fruits from the stem tips of living plants. For other uses, see the text.

lier. This is an illustration of how the Creator works good out of adversity and judgment.

Most saguaros form their whitish, cream-colored flowers during May and June in clusters near the stem or branch tip (Figures C-3, C-4, and C-5), where a few of the flowers open each night. The flowering areas are close to the tip, but they are actually part of the previous year's growth and are lateral rather than terminal. Saguaro blossoms are up to three inches across when they are open and they synthesize large quantities of pollen and nectar. Pollen is carried from flower to flower by the lesser long-nosed bats, white-winged doves, and several insects of which the honeybee is most effective. The bats feed at night by diving right into the flower and getting the nectar. With their faces covered with pollen, they are excellent pollinators. Studies by Fleming (2000, p. 434) indicated that individual saguaro flowers "...open one and a half to two hours af-



Figure 7. This living specimen has had its stem tip knocked off and has also received another series of wounds below the tip. The exposed area in the upper portion shows the relationship between the wooden rods and the thick outer region of succulent tissues. The massive wound has healed with apparent success.

ter sunset and do not close until late afternoon the next day.”

The barrel cacti, *Ferrocactus* sp., resemble young saguaros, but their flowers have a different appearance. They are yellow and fit snugly at the stem tip. The saguaro flowers are whitish and protrude from the spines: compare Figures C-5 and C-6. Furthermore, the first saguaro flowers are not produced until the plant itself is over 40 years old and about six feet tall (Gibson and Nobel, 1986, p. 113). The *Ferrocactus* can flower when it is well below six feet.

The beautiful saguaro blossoms are the state flower of Arizona and appeared on a United States postage stamp in February 1962, commemorating the 50th anniversary of Arizona statehood. The aesthetic appeal of the saguaro flower fits with the concept that the Creator put far more beauty into nature that is actually necessary for the propagation of the species. We believe He made flowers beautiful for His own pleasure and for the enjoyment of mankind as well.



Figure 8. This wooden inner core of a saguaro stem was on display at a drive-in restaurant. Note how the neighboring rods frequently connect with each other. Such an inner framework serves to support a heavy load of water.

When the ovary of a saguaro flower matures it yields an oblong fruit, which ripens by late June or July (Figures C-7 and C-8). Inside the fruit is a rich red pulp with black seeds. To one of us (Howe) its taste is intermediate between a strawberry and a fig and the fruit is readily eaten by birds. Years ago they were a staple in the diet of the Pima and Papago people who still use them to some extent, eating them either raw or cooked and rolling them to make a tasty food product. They use the long wooden poles of the saguaro to knock the ripe fruit off the tips of tall stems and branches. The seeds are oily, and when ground, they can be mashed into a spread for tortillas or bread. This curious desert cactus turns out to be a source of tasty food and a supply of useful poles for humans, just as one would expect if there were a providential Designer behind the origin of this species (Figure 8).

Saguaro seeds remain viable for several years. Like seeds of certain other desert plants, they contain a built-in chemical germination inhibitor. When there has been enough rain to leach the inhibitory substance out of the



Figure 9. A view of an outer portion of an old stem. The vertical rows of small spots are areoles from which the spines have fallen. The large hole in the center was evidently made by a woodpecker years ago and leads into an inner chamber (a boot) where birds can still build nests.

seeds, they will sprout. Thus the inhibitor prevents most seeds from germinating until after adequate rain has fallen to support seedling growth. This control system is difficult to explain by chance operating on gene mutations.

While the root system of the saguaro goes down only about three feet, it can extend laterally for a radius of 50 feet or more. This accounts in part for its amazing ability to absorb water. Note that the right type of extensive shallow root system needs be combined with the accordion-pleated stem to allow rapid water uptake and saguaro survival.

Problems Facing the Saguaro

The saguaro appears to suffer from very few diseases. Its stem, when struck by lightning or otherwise wounded, produces a heavy protective callus tissue over the wound, as in the case of the boot production. However, if the injury occurs in the dry season, there is a chance that *Erwinia*



Figure 10. Although partially decayed, this fallen and dead saguaro branch shows the outer hole (see arrow) and callus tissue leading into the boot.

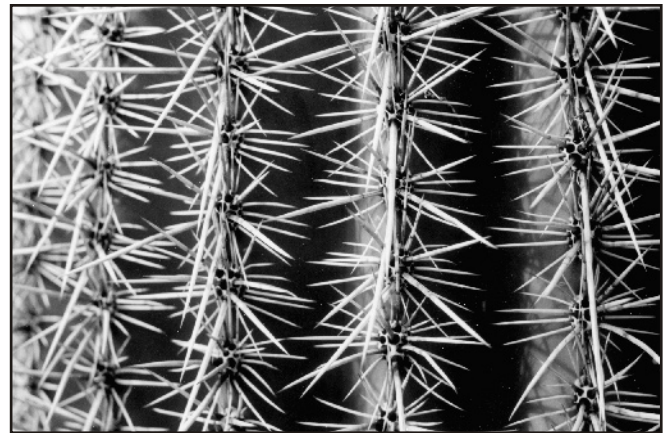


Figure 11. Up and down the saguaro's fluted ridges are the spine-studded areas called areoles. Each areole possesses one long straight spine and many shorter ones. The long spine is blackish brown when young but turns to a lighter shade with time, as seen here.

carneigiana, a decay bacterium carried by a moth, will cause a soft-rot disease which will destroy this large cactus in as little as one week. The infection travels up and down the stem, converting the succulent outer tissues to a slimy sludge and fermenting the juices that are formed. The bacterium has a cellulase enzyme that digests the cell walls of the soft tissues. The sugars and other decay products of this infection provide food for various insects and other creatures (Alcock, 1990, pp. 5–6). Very old plants are the ones most subject to infection.

Saguaro seedlings are trampled by cattle, and in lean years many are eaten by desert rodents like the kangaroo rat. A measure of protection from cattle, seedling eaters, and the extremes of weather is afforded to those cacti that germinate underneath palo verde or creosote bush shrubs (Nobel, 1980a). Often a young saguaro is found growing under its desert "nurse tree" (see Figure 2). While this is a very natural phenomenon, understandable as a feature of

ecology, it could also be viewed as an example of Divine providence.

Saguaros may be toppled in windstorms or destroyed by lightning strikes. Where the main stem of a saguaro has been demolished, one of the uppermost branches may continue to grow and become the leading stem (Figure 5).

Where Do Saguaros Live?

Being especially susceptible to heavy frosts, saguaros do not grow naturally very far north of Phoenix, Arizona, nor do they grow at higher altitudes in their own range. They live across southern Arizona, in northern Sonora, Mexico, and in extreme southeastern California near the Colorado River. This range corresponds closely with the boundaries of the Sonoran Desert, causing some workers to refer to the Sonoran Desert as the "Saguaro Desert."

The highest altitudes at which saguaros flourish are about 3900 feet. They can exist in diminishing size and numbers, however, up to altitudes of 4900 feet (1500 meters). According to Kearney and Peebles (1960, p. 569) the highest elevation at which a saguaro had been found naturally growing was 5100 feet. The northern limit of the saguaro (34°56'N) is governed to a major extent by the minimum apical temperature, which can be survived on cold nights (Nobel, 1980b). The saguaro's response to low temperatures is that in such colder regions the saguaro grows to greater widths, which helps protect it.

Saguaros grow best on desert slopes and flats having rocky soil, which supplies a firm anchorage for their roots. They do not thrive in deep alluvial soils. Their size and abundance is greater on south and southwest facing slopes. Travelers can observe excellent groves of saguaros, even from the freeways. Along Interstate Highway 10, between the Colorado River and the city of Quartzite, AZ, for example, impressive stands of saguaro grow on the lower slopes of adjacent hills. One also encounters several choice localities for viewing these cacti along Interstate 10 between Quartzite and Phoenix. Some of the favorable habitats are adjacent to roadside rest areas and are thus quite accessible for photography (Figure C-3). Thriving stands can also be found further east in South Mountain Park, Phoenix, and near Tucson (Figure 1).

What is the Scientific Name of the Saguaro?

In the literature there are two widely used Latin binomials (scientific names) applied to the saguaro: (1) *Cereus giganteus* Engelm and (2) *Carnegiea gigantea* (Engelm) Britton and Rose. *Cereus giganteus* was the name first applied to this plant and it was done so by Engelm. Later, revising the genus *Cereus*, Britton and Rose put this plant into its own separate genus. Britton and Rose's name (*Carnegiea gigantea*) is the binomial now in

widest use. The common name has been given several spellings among which is *sahuario*; Jepson (1951, p. 658) spelled it *suwarro*. By far the most widely accepted spelling is *saguaro*, which we use here.

Photosynthesis, Cacti, and Origins

Photosynthesis is a remarkable process in which the energy of visible radiation is trapped and utilized inside the chloroplasts of plant cells. This changes the oxidized carbon atoms of carbon dioxide molecules into the reduced carbon atoms of sugar molecules (usually glucose). As a result of photosynthesis, the energy of sunlight is harvested and stored in the form of the chemical energy of sugar for use by the plant and animals that eat plants. A moment's reflection will reveal that nearly all living organisms ultimately depend for their food supplies on this photosynthetic reduction of carbon, a process that shows marvelous complexity.

Like other green plants, saguaros have an enzyme system by which carbon dioxide molecules undergo a series of reactions called the C_3 cycle or the *Calvin cycle*. This is known as C_3 photosynthesis because it closely involves several molecules that are each three carbon atoms long; one of these is 3-phosphoglyceric acid.

Most plants that carry out C_3 photosynthesis have their stomates, which are pores found in the epidermis of stems and leaves, open during the daylight hours. This allows carbon dioxide to diffuse readily into the leaf tissues from the atmosphere, but it also allows the simultaneous loss of water by evaporation. When soil moisture is readily available, water loss through stomates presents no problem, but it can devastate plants in dry habitats.

In addition to the C_3 photosynthetic cycle, another photosynthetic pathway called CAM photosynthesis occurs in the saguaros, other cacti, and certain genera from various other plant families. CAM is an abbreviation for *Crassulacean Acid Metabolism*, which was given this name because the process was first studied in members of the Crassulaceae (stonecrop family).

Plants that have CAM photosynthesis also have their stomates open at night, during which time they are able to assimilate carbon dioxide and store it in the form of cellular organic acids. This allows for the storage of carbon dioxide during the night when temperatures and moisture stress on the plants are lower. During the warmer daylight hours saguaro stomates are closed, conserving water; yet photosynthesis can go on unhindered using the previously stored cellular organic acids. Plants, like saguaro, which have this added option of CAM photosynthesis are able to survive in hot, dry climates, while plants limited to C_3 photosynthesis die from excessive water loss.

By itself, CAM is a strong evidence favoring design in plant physiology because CAM needs a special series of

enzymes. It would have been unlikely for the saguaro to “stumble” upon the complex CAM pathway by natural selection and gene mutations because the system requires several enzymatic steps. Readers desiring to explore the chemical details of C₃ and CAM processes consult Stern (2000, pp. 174–177).

The saguaro plant would have also needed a mechanism to reverse the stomate cycle so they would be open at night and closed in the daylight. If these events did not occur simultaneously, the plants would have died in the hot dry conditions before evolution could have finished this adaptation for desert life.

But if by some very fortunate series of events a CAM system arose by chance in a plant group (cacti, for example), we would expect CAM to be present only in that one family or one group. Quite to the contrary, the CAM mechanism is scattered here and there throughout the botanical outline, being found in representatives of 30 different (and often widely separated) families including the: “...cacti, stonecrops, orchids, bromeliads, and other succulents that are often stressed by limited availability of water” (Stern, 2000, p. 177). It would be impossible then to build one “family tree” showing the origin and descent of CAM in plants. But it is also unlikely that the genes for CAM would have arisen repeatedly through “parallel evolution” in 30 diverse groups. A conclusion in closer keeping with the facts of science is that the Designer chose to incorporate the CAM process into many different sections of the creation outline as a provision for plant life in hot dry climates. Walter ReMine correctly sees such curious distributions of unique design systems throughout many widely separated groups as part of a “biotic message” sent by the Creator and subtly calling attention to His work (ReMine, 1993).

Design is Evidence for a Designer

In a later paper we will discuss evidence supporting the creation of cacti and other similar groups. We close with a poignant quotation from the writings of the desert botanist Volney M. Spaulding, who had no apparent intention of supporting creation by design:

The giant cactus, rising as it often does to a height of 50 feet in the form of a gigantic fluted column which may be simple or branched, is, mechanically speaking, a huge reservoir of water, subjected to the stress of high winds, and so constructed that for a long period of years it not only maintains securely its erect position and steadily continues its growth but also promptly expands whenever the soil is wet, even for a short time. The construction of such a tank represents an engineering feat which probably has no parallel in any artificial structure in existence and the case appears still more remarkable when it is considered that the whole system of storage in an adjust-

able tank is dependent for its highest efficiency on the peculiarities of its root system. Volney M. Spaulding, quoted by Jaeger (1957, p. 65).

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We have drawn liberally from many bibliographic sources listed here but we have not referenced each fact because our text would have been overburdened throughout with reference citations. Those wishing to pursue further study of the saguaro will find this bibliography a suitable starting point.

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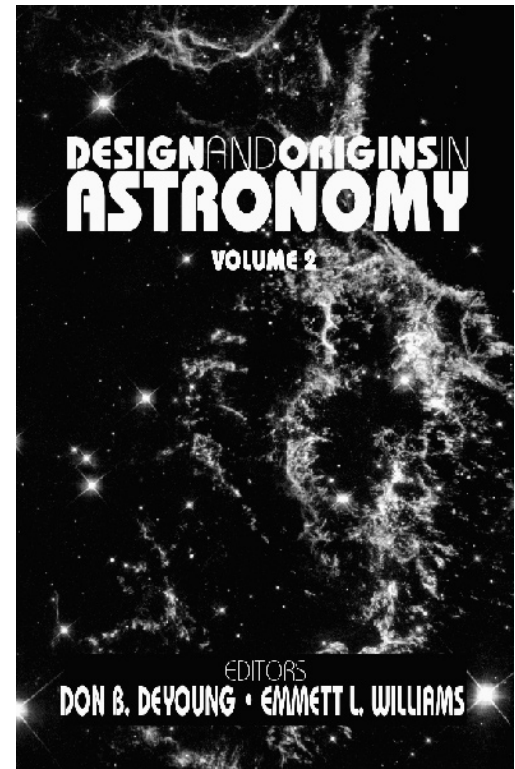
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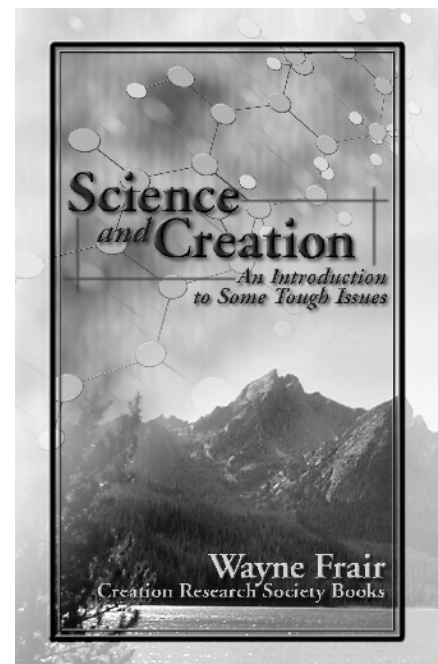
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Author Wayne Frair earned undergraduate science degrees from Houghton and Wheaton Colleges. His MA. is in embryology from the University of Massachusetts, and his Ph.D. in biochemical taxonomy is from Rutgers University. He is a fellow of the American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

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SETI and DNA

Walter I. Sivertsen*

Abstract

Four specific criteria for recognizing intelligence as the source of a coded signal from outer space have been delineated by Carl Sagan. When those criteria are applied to the genetic code, one may

logically conclude that there is an intelligent source for the code. To conclude otherwise is to abandon the criteria that are so vital to the search for extra-terrestrial intelligence.

Introduction

The late Carl Sagan (1980, p. 296) identified several criteria to be used in the Search for Extra-Terrestrial Intelligence (SETI). He proposed to use these criteria to discover evidence for extraterrestrial intelligence when evaluating signals from outer space. Could these criteria also be applied to codes found in other fields in a search for evidence of intelligence? That is what has been proposed by several authors in the creation literature (Batten, 1997; Ham, 1992; 1994; Laughlin, 1996). They suggested applying SETI criteria to the genetic code in deoxyribonucleic acid (DNA), but did not mention what those criteria were. In this article Sagan's criteria will be discussed and applied to the molecular biology of the gene. I intend to show that intelligent design is the probable source for the genetic code and its expression in the synthesis of proteins in a cell, as described in common biology textbooks (Campbell, 1994, pp. 171–210).

Further, I plan to introduce only as much discussion of DNA and other nucleic acids as is necessary to evaluate Carl Sagan's criteria adequately. Much more detail about the structure of DNA and the creation science aspects of nucleic acids can be secured by consulting the following papers in CRSQ: Anderson, 1980; 1989; 1991; Bergman, 1999; 2000; 2001; Frair, 1967; 1968; Gish, 1967; 1979; Grebe, 1967; Lammerts, 1969; Lumsden, 1992; Moore, 1972; Quinn, 1975; Sharp, 1977; Smith, 1985.

If we should receive a radio message from an extraterrestrial civilization, Sagan (1980, p. 296) suggested that such an intelligent message would be: 1) elegant, 2) complex, 3) internally consistent, and 4) utterly alien. In the late 1960's, for example, amazingly precise signals from pulsars were first considered as possible indications of intelligent beings. The pulsars were ultimately shown to be a natural phenomenon; they failed the criteria.

I shall examine the message of the DNA code itself, to see if it satisfies Sagan's four criteria of intelligence. In doing so, I am aware that the results will not be absolute "proof" of design. The DNA data, however, can be evaluated to see if they meet the criteria, implying that we are observing the handiwork of an intelligent mind.

Elegance

The first characteristic of a coded message from an intelligent source is elegance, which means exhibiting tasteful richness of design or organization. The elegance of the genetic code is reflected by its efficient storage in a double-stranded spiral molecule. The two strands are constructed in a way that permits complete replication of the code with each strand acting as a template for replication. Each strand contains four different chemical bases which bond in pairs between the strands.

These four compounds [G=guanine, C=cytosine, A=adenine, T=thymine in DNA, and U=uracil instead of thymine in messenger RNA (mRNA)] also serve as "chemical letters" to form three-letter "words" in the DNA and/or mRNA code. The letters are read in sets of three to form words or codons. The first letter of the codon could be any of the four, so there are four possibilities. By adding a second letter the possibilities increase to 16 because each of the original four can be combined with four letters ($4 \times 4 = 16$). By adding a third letter, each of the 16 combinations is supplemented by four possible letters ($16 \times 4 = 64$). This arrangement produces 64 possible codon combinations (Denton, 1985, p. 244), and all of these code for specific amino acids or functions. Thus, "...there is redundancy in the code but no ambiguity." (Campbell, 1994, p. 187). The code is elegantly simple and functionally optimal.

If codon words had only two letters, thus allowing only 16 combinations, there would be too few to code for the 20 kinds of amino acids plus the instructions for starting and

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stopping protein synthesis. On the other hand, if codons had four letters, there would be 256 codons ($4^4 = 256$), which would be unwieldy and wasteful. The three letter code with 64 codons is elegantly simple and functionally optimal. This in itself is an evidence favoring direct design in its origin.

The mechanism for transcribing, reading, and expressing the code in the synthesis of proteins is also elegantly efficient. The information for manufacturing the proteins is in the DNA. Portions of it must be copied (i.e. transcribed) as mRNA molecules to transport the information from the nucleus to the cytoplasm surrounding the nucleus. The process of transcription requires an enzyme, RNA polymerase and a supply of RNA nucleotides. The RNA polymerase binds to a specific site, called a promoter, on the DNA to unwind the DNA at the beginning of a gene. One of the two strands of DNA serves as the template for the mRNA synthesis from the given gene. The completion of the transcription of the gene is signaled by a terminator region in the DNA. When the transcription is terminated, the RNA polymerase and the newly formed, single stranded mRNA are released from the DNA, and the DNA helix reforms.

The RNA polymerase enzyme, which initiates the process, is a protein which is also made from an mRNA molecule created from a gene by this process. Which came first, the mRNA that is made by the process or RNA polymerase which initiates the process? They are each dependent on DNA for their synthesis and they are interdependent, exhibiting richness of design and organization.

Complexity

Sagan's second evidence for intelligence as the source of a code is complexity. He was looking for something complicated, intricate or involved. Complexity in DNA is reflected by the fact that there is no punctuation in the genetic code, which is a continuous stream of information. A shift of one or two base pairs in reading the codons results in a totally different protein being produced. For example, the sequence UCUGCAGGCUGA in mRNA codes for serine-alanine-glycine-"stop". If the sequence is delayed by one base and starts with the second base (i.e. C or cytosine rather than U or uracil) the amino acid sequence in the polypeptide would be leucine-glutamine-alanine. The polypeptide would be entirely different. Thus, the starting point is critical and must be marked.

Also, there are several large molecules (e.g. polymerase enzymes, mRNA, tRNA, ribosomes, and many other enzymes) that are necessary to open the DNA strand in order to transcribe the gene as mRNA in the cell nucleus. This host of other molecules is required then to transport and read the copy in the cytoplasm outside the nucleus, and to

express the code by way of forming a protein molecule. Note that all the molecules that are required for this biochemical process to function are made by the same copying process, and the process is much more complex than outlined here.

Complexity is also seen when we further consider the translation of the copied information in the mRNA to make proteins. First, free amino acids in the cytoplasm of the cell become bonded to specific transfer RNA (tRNA) molecules. This requires a specific enzyme and adenine triphosphate (ATP) to provide the energy. The second step brings together the tRNAs, with their amino acids attached, and the mRNA with its codons. This occurs when the mRNA is fed through the ribosomal unit. The union between the sequence of codons in the mRNA and the complementary anticodons on the tRNA places the amino acid that is attached to the tRNA in a specific position to form the peptide bond and lengthen the protein that is being produced. The synthesis is complete when the ribosome reaches a stop codon on the mRNA, and the completed protein is released into the cell's cytoplasm as the product of this complex process. Much more detail exists in the processes of transcription and translation, but even this brief description of those processes underscores their amazing complexity. This supports a belief in intelligent action in creation.

Furthermore, DNA is also found in mitochondria and in chloroplasts where there are some minor code differences. Still, coding complexity is present and speaks for itself.

Internal Consistency

Sagan's third characteristic is internal consistency. This is reflected by the fact that usually each of the 64 codons has a single meaning in all organisms (Campbell, 1994, p. 187). The codons usually code for the same amino acids and functions. For example, in mRNA the codons AAA and AAG usually code for lysine. Also, UAA, UAG, and UGA usually code for the stop or termination process. The codon AUG does have a dual function, however. It codes for methionine and can also signal for the start of a polypeptide chain.

The many recombinant DNA applications of microbiology are dependent upon a code that is consistent. In one of these many applications, microbiological engineers can extract a gene of interest or produce a synthetic gene. That gene, which can code for a protein like somatostatin, for example, would then be inserted into the plasmid of a bacteria. When the genetically altered bacteria are grown in a culture, they produce somatostatin. Finally, as in this example, the somatostatin can be isolated from the culture and purified for use in a pharmaceutical product (Tortora, 1995, p. 237). The internally consistent

code for amino acids makes these commercial ventures possible and successful.

Utterly Alien

In the fourth place, Sagan required that an intelligent message from space should be “utterly alien”. By this Sagan (1980, p. 311) meant the coded message might contain “...insights on alien science and technology, art, music, politics, ethics, philosophy and religion...”.

This fourth criterion raises several complex questions. Does “alien” mean another rational mind besides a human mind? If so, we would need to find ways to distinguish these non-human signals and to classify them as “intelligent”. In the case of DNA, I submit that the *determinative* code relationships evident between codons, anticodons, and the amino acids in the resulting proteins are complex in a manner that is different or “alien” in comparison to the *symbolic* code relationships in human code systems.

In some instances the codons of DNA have been shown to code for such esoteric or “alien” phenomena as animal behavior. An example is the Tarantula Hawk, a blue wasp that preys on tarantulas. As seen in the Walt Disney Home Video, *The Living Desert* (1953), the female wasp, when ready to lay an egg, finds a tarantula and stings it, causing the tarantula to go into suspended animation. The wasp then digs a hole in the ground, places the spider in it, lays her egg on the spider, and covers it. The egg hatches into a larva that feeds on the tarantula. The larva then pupates to become an adult. The adult female subsequently repeats this unusual behavior. This is not a learned behavior because the mother leaves after laying the egg and never associates with her offspring. The only connection between the mother and daughter is the egg, indicating that the behavior is coded in the DNA in the egg in some fashion. Perhaps this sequence also classifies as alien with respect to ordinary coding relationships.

Conclusion

Sagan and other evolutionary astronomers have set up clear criteria for recognizing intelligence in messages from space. If the DNA code beautifully satisfies these same criteria, should we not embrace its intelligent creation? The characteristics observed in the genetic code and the mechanism for transcribing, reading, and expressing it, exhibit to a superlative degree all four of Sagan’s criteria for identifying intelligence. For this reason the evidence for intelligence as the source of the genetic code is quite convincing.

On the other hand, claiming that the existence and functioning of the genetic code is attributable to the ran-

dom reactions of natural processes is to disregard the criteria used in SETI to distinguish intelligence of a high level.

How will we interact with the codes? Sagan (1980, p. 311) suggested that we are not obliged to reply to a message received in the SETI program, particularly if the contents are offensive or frightening. As for the genetic code, there is no way to reply, yet it does elicit a response. One may respond by attributing the code to random natural processes because the incredible intelligence required to establish it is frightening, or because accountability to that Intelligence is considered offensive. Alternatively, one can logically attribute the genetic code to intelligent design by a Creator and seek Him.

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Book Review

The Universe in a Nutshell by Stephen Hawking
Bantam Books, New York. 2001, 216 pages, \$25

This book follows the highly successful *A Brief History of Time* (Hawking, 1988). Once again, many copies will be sold but very few actually will be read. Hawking calls his approach to nature *the positivist view* (p. 31, 127). He describes this as the construction of models of nature and then extraction from them of assorted details and predictions. It doesn't matter if these evolving models exactly fit reality or not. Hawking optimistically believes that in this way, science approaches ever closer to the truth. This ultimate goal is sometimes called the "theory of everything."

Good descriptions are given of hypothetical black holes, higher dimensional "branes," and relativistic time travel. Almost every page includes color illustrations, although many are not explained very well. Much of the book concerns the quantum theory of gravity, Hawking's current interest, and he attempts to explain the underlying mathematical theory. I would give him a "C" for effort, but 99 percent of readers are unprepared for Hawking's brief mention of wave functions, Schrodinger Equation, singularities, and string theory.

One chapter concerns biological evolution which Hawking fully accepts. After reading all of Hawking's intense philosophical reasoning, I was amazed at his naïve answer to how our minds developed: "we don't know" (p. 161). There is no hint of suggestion that the Creator may have clearly explained the origin of life to us in the Bible. Also, in spite of Hawking's sharp mind, he fully accepts the computer-generated evolution nonsense promoted by

Richard Dawkins (p. 162). In prewritten software called a *biomorph*, Dawkins produces an insect from raw atoms in just 29 generations. How Hawking can swallow this artificial non-evidence is incredible. I would suggest a challenge for Dawkins: Produce an insect from raw elements in the laboratory, given unlimited numbers of iterations. We will have a long wait.

In a further interaction with creation, Hawking shows an awareness of the young earth position. However, he denies this possibility because of the large size of the universe (p. 73). Apparently he is unaware of several creationist explanations for the distance-time paradox.

Hawking describes space as multidimensional. He sees the universe as "entirely self-contained; it wouldn't need anything outside to wind up the clockwork...This may sound presumptuous, but it is what I and many other scientists believe" (p. 85). There is clearly a great gulf between man's natural intellect and his wisdom concerning God.

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Notes from the Panorama of Science

Time Warp II: Basalt Flows at the Midcontinent Rift System

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Although time is commonly presented as a dilemma for creationists, this series is documenting that to the contrary, it is a bigger problem for uniformitarians. A consistent Naturalist is also a positivist and must argue from positive physical data; when absent, he is guilty of arguing from a lack of evidence. Where there is no field documentation of a particular span of time in the rock record, then that time can only be inferred or assumed as the Naturalist leaps to the next bit of physically documented time—a “time warp.” Christians, of course, do not share this dilemma, since history is guaranteed by revelation, not forensic study. In this contribution, we will see that almost 23,000,000 years of so-called deep time are missing in the basalt flows of the North American Midcontinent Rift System (MRS).

The MRS is a regional tectonic feature of the Proterozoic basement of the upper midcontinent. It ranges up to 150 km wide and extends more than 2000 km from central Kansas through Nebraska, Iowa, Wisconsin and Minnesota, then under Lake Superior before diagonally bisecting Michigan and ending at the Grenville Front near Lake Ontario. The MRS includes thick basalt flows with associated clastic, nonmarine sediments. A description of the structure and fill of the MRS is presented in Reed (2000).

Uniformitarians interpret the MRS as having formed between 1109 millions of years ago (Ma) and 1067 Ma, in two stages: active downwarping and predominant volcanism followed by inversion and sedimentation (Figure 1). Basalt flows range up to 20 km thick in the Lake Superior Basin, and the presence of “feeder” dikes up to 200 km away from the basin axis (Cannon, 1992) suggests significant later erosion. Cannon (1992) suggests an original uneroded volume of $2 \times 10^6 \text{ km}^3$ of igneous rocks as compared to the estimated $1 \times 10^6 \text{ km}^3$ remaining. Uniformitarians derive the rates of historical eruption by analogy to modern volcanic cen-

ters such as Iceland and Hawaii. Their analogy is vindicated by dividing volumes of basalt within specified intervals by isotopic age dates checked by magnetostratigraphy (Davis and Paces, 1990). These calculations result in “rapid” rates of volcanism of between 0.02 and $0.05 \text{ km}^3/\text{year}$ (Hinze et al., 1997). However, physical field evidence contradicts the uniformitarian scenario, and an assessment of the minimum time really needed to produce these flows demonstrates that most of the 23,000,000 years resides in the assumptions of the uniformitarian researchers.

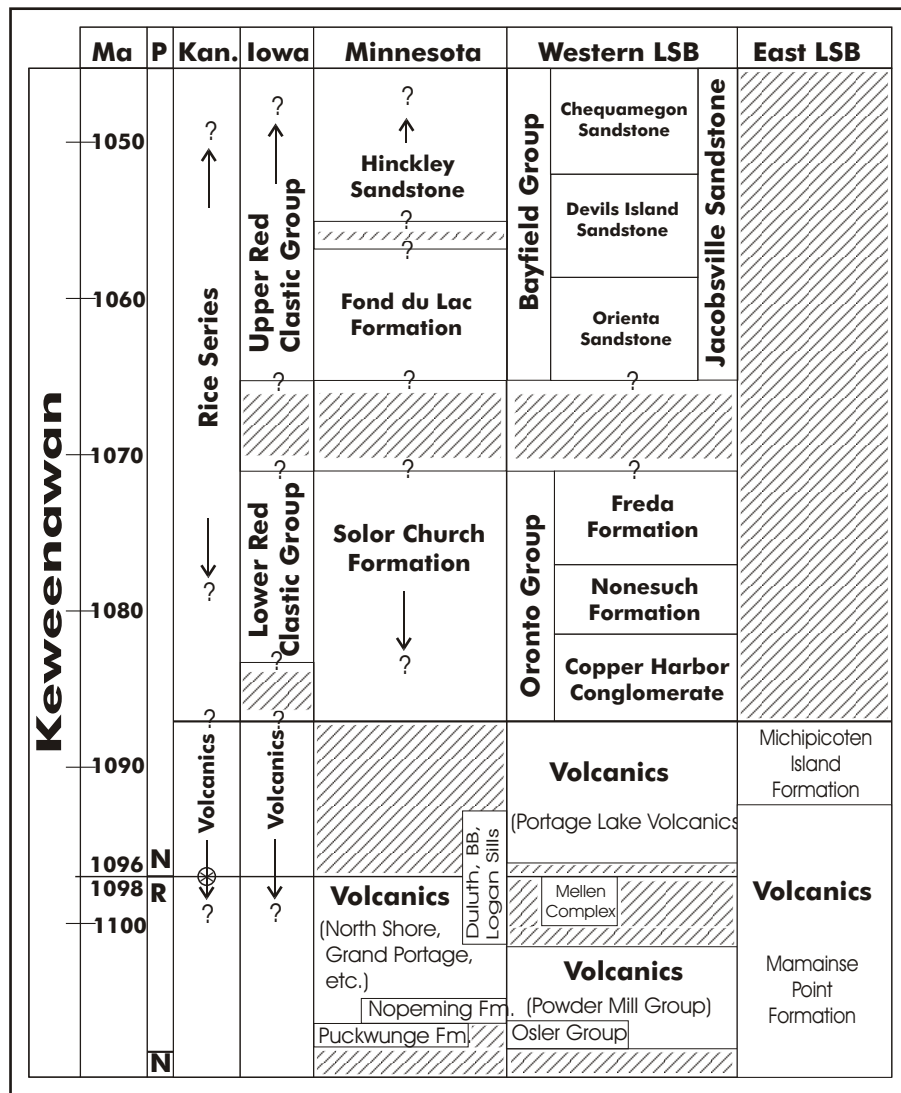


Figure 1. Stratigraphic Chart of Proterozoic Midcontinent Rift Rocks in central North America. From Reed (2000). “P” is magnetic polarity and “LSB” is Lake Superior Basin.

How Much Time is Really Needed?

Instead of creating a scenario based upon extrapolation from modern examples, an examination of the actual field evidence can tell us much about the timing of the MRS basalt flows. The onset of volcanism was rapid; underlying sediments are thin to nonexistent and interbedded and deformed by the basalt lava flows. The relationship between the lava flows and tectonic structure of the rift also strongly supports a rapid onset of eruptions (Reed, 2000).

The time required for the eruptions themselves can be broken down into three segments: (1) ascent of magma to the surface, (2) eruption from a surface vent, and (3) solidification and cooling of the flow. If the conditions of volcanism were sufficient to produce steady fire-fountains, then the rate of ascent probably ranged between observed rates of 0.2 and 2 m/s (Rutherford and Garner, 2000). At the time of the basalt flows, the crust at the MRS was less than 10 km with possible crustal separation in zones of the rift axis (Cannon, 1992). Assuming a 10 km thick crust, observed rates of ascent imply that the magma would reach the surface in between 1.4 and 14 hours. Ascent through even a much thicker crust would still be measured in hours.

Although the eruption rate at the surface would have been dependent upon several variables, the one that most strongly controlled the rate was the size of the vent (BVSP, 1981). Vents up to 4 m across erupted up to 30,000 kg/sec/m length of vent at the Columbia River Plateau (BVSP, 1981). Just the Roza Flow (over 400 km³) could have erupted from its 100 km long vent in a few days (Courtillot, 1999). Tolan et al. (1989) estimated a rate of up to 3 km³ per day along vents during the emplacement of the largest flows of the Columbia River Province. At these rates, the estimated volume of the MRS basalts could easily have been emplaced in a matter of days along a vent system of 8,000 km total length. Although this number initially appears great, consider that the MRS is over 2,000 km long, feeder vents have been found up to 200 km away from the rift axis, and in places the crust was probably completely attenuated. Reed (2000) assumed a vent opening of merely 10 m and estimated that the entire volume of MRS basalt could have been emplaced in 40 days from just one 25 km long vent.

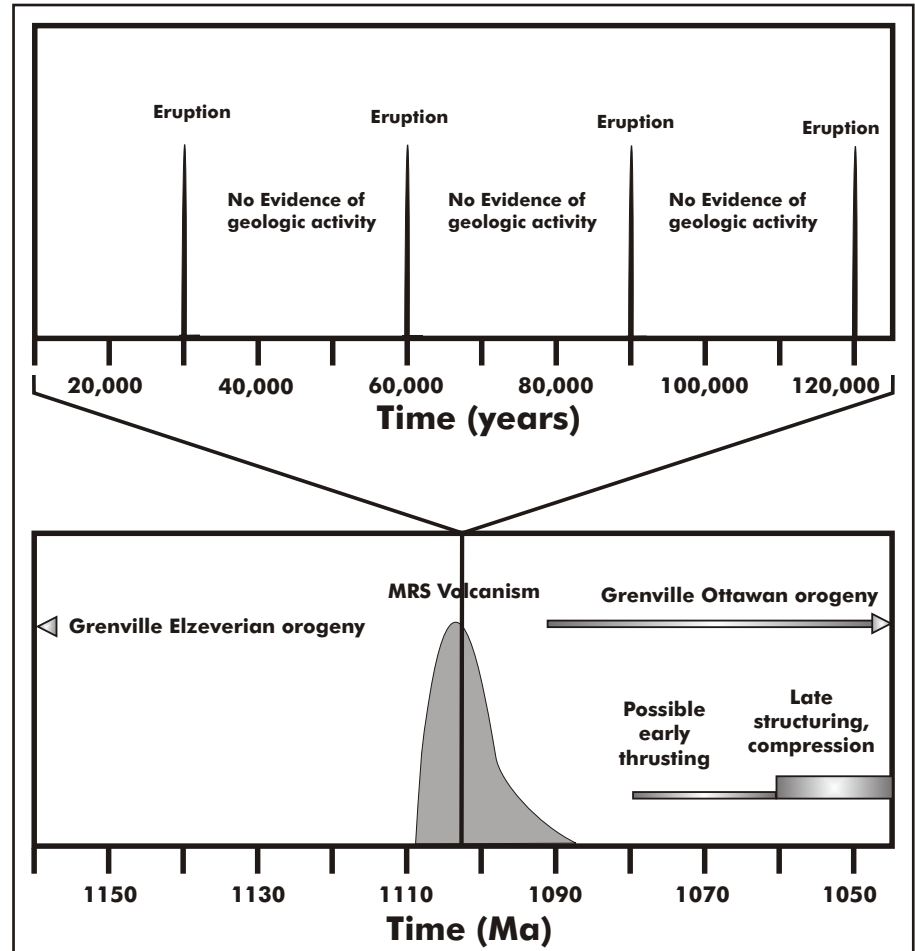


Figure 2. Unmasking “scale masking” in a uniformitarian presentation of the North American Proterozoic. Note that the time scale is so compressed in the lower figure that intervals of even hundreds of thousands of years are easily covered by line width. The top figure expands a small part of this figure to demonstrate that most of the time attributed to MRS volcanism is really dead time for which no physical evidence exists. From Reed (2000).

The morphology of lava flows is generally dependent on the discharge rate. High rates result in large sheet flows, and lower rates lead to small, compound flows (BVSP, 1981). Individual flows at the MRS are quite large, suggesting high discharge rates, which correlates well with other evidence. Large flows at the Columbia River Plateau are thought to have formed in a matter of days (Oard, 1999). In the context of the Genesis Flood, it is even possible that some flows at the MRS could have occurred under subaqueous conditions. Froede (2000) reported that basalt flow morphology often is quite similar between subaqueous and subaerial flows.

What about the time needed to cool and solidify the basalt? Uniformitarians have argued that eons are required for the solidification and cooling of igneous bodies. However, new research is showing that rapid cooling and emplacement is common in igneous settings (Woodmorappe, 2001). Woodmorappe and Snelling (1998) demon-

strate that heat is rapidly attenuated by water, especially in the presence of fracturing. Water, infiltrating the fractures, greatly speeds up heat transfer. But the crystallization of large basalt flows does not depend on simple cooling from the outside in. It has been shown to occur quickly with dropping yield strength and the expulsion of volatiles (BVSP, 1981).

Sediments found between lava flows also do not necessarily indicate long ages between flows; the processes could have simply occurred simultaneously, with sediment accumulations representing only short intervals between individual flows.

Punctuated Uniformitarianism and Scale Masking

If individual flows can occur in a matter of hours or days, how much time is required for the total number of flows? There are probably fewer than 750 flows in the Lake Superior Basin, and fewer than 200 in the southernmost (Kansas) section of the MRS (Reed, 2000). Given the rapid eruption of individual flows, in the uniformitarian scenario, the 23,000,000 years must have been composed of rapid basalt flows followed by between 30,667 (750 flows) and 115,000 (200 flows) years of quiescence. Perhaps all of the flows occurred in the first few days; perhaps they occurred in the final few days; perhaps the flows were spread over the entire time. Regardless of how the numbers are manipulated, uniformitarians face the same problem – almost all of the proposed 23,000,000 years are unsupported by physical evidence. An appeal to the isotopic age dates does not help because the field evidence of rapid and intense volcanism casts doubt upon the dating methods themselves (Reed, 2000).

How have uniformitarians avoided these conclusions? One method is by what I call “scale masking”. Figure 2 illustrates this sleight-of-hand method. When the X scale covers tens of millions of years, then it is impossible to draw a line whose thickness is not measured in hundreds of thousands of years. For example, Figure 2 shows the time line for the MRS in uniformitarian time. Notice how the “burst” of volcanism reasonably extends over 23,000,000 years with just a small blip. But the upper part of the figure unmasks the illusion by expanding the scale to the extent that “dead” time between the individual flows is shown. Even at this scale the time consumed by each lava flow is exaggerated, but it more clearly demonstrates that almost all of the proposed 23,000,000 years exists only in the mind of uniformitarian geologists.

Conclusion

Once again, a close examination of a small part of the geologic column reveals that most of the proposed time is *dead* time, not *deep* time, and unsupported by field evi-

dence. In the two time warps that I have written so far, I have removed 43,000,000 years. At this rate, if creationist geologists write 100 contributions to this series, then the uniformitarian time scale will cease to exist! I encourage other researchers to examine the field evidence for other parts of the stratigraphic record and demonstrate the proportion of time that is supported by physical evidence vs. that existing simply in the minds of men.

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Book Review

The Theory of Everything by Stephen W. Hawking
New Millennium Press, Beverly Hills, CA. 2002, 176 pages, \$19.95

This book is a republication of Hawking's lectures titled *The Cambridge Lectures: Life Works* originally published as audiotapes by Dove Audio, Inc in 1996. It includes a series of 7 lectures that chronicle his contributions to cosmology in the period from 1965 to 1995. The *Introduction* gives the purpose of these lectures, as "an outline of what we think is the history of the universe from big bang to black holes" (p. ix). Since Hawking is a devout evolutionist and humanist we are given explanations for everything without any need for the Creator. In fact Hawking explicitly makes this point in lectures 5 and 7. But it is interesting to read the bizarre explanations and assumptions required to arrive at his theories.

In the first lecture *Ideas About The Universe* Hawking starts with the usual history of scientific discoveries which man has made about the universe beginning with Aristotle in 340 BC. He ends the lecture with Hubble's discovery in AD1929 of the relation of the velocity of stellar objects to their distance from earth (Hubble's law). This discovery implied that the universe was expanding and started theorists looking for a beginning point or big bang event. One assumption the scientists made is that the universe would have had to start at a single point and therefore would have been much hotter and denser than now. These were steps away from the requirement that there was a creator. As Hawking states, "An expanding universe does not preclude a creator, but it does place limits on when He might have carried out his job" (p. 15).

Lecture 2 *The Expanding Universe* is used to explain Einstein's theory of General Relativity and its relation to what is seen in the stars. The universe was shown by Hubble to be expanding by measuring the redshift of stars, which is greater as the distance to the star increases. The explanation for this expansion is a force "which, unlike other forces, did not come from any particular source, but was built into the very fabric of space-time" (p. 25). It was a Russian Alexander Friedmann who first proposed solution models to Einstein's equations in 1922 that showed that the universe should be expanding as Hubble observed. He made two assumptions to simplify the equations: (1) the universe looks identical in any direction we look and (2) it would look that way from anywhere we were located in the

universe. Evidence for these assumptions was lacking until 1965 when the cosmic microwave background radiation was measured and shown to be uniform in every direction. Friedmann's model (one of three possible solutions) has a feature in which the universe is not infinite but also has no boundary. This means the universe has a singularity in one dimension (time) but is continuous in three dimensions (space) much like the surface of a sphere has a center of curvature in one dimension (radial) and is continuous in two dimensions (longitude and latitude). Hawking's contribution to the big bang theory was a proof that the observations of the density of matter in the universe shows that it had a beginning.

Lectures 3 and 4 *Black Holes* and *Black Holes Ain't So Black* describe many years of work that Hawking pursued during the 1970s. He helped define a black hole and determined many of their characteristics theoretically. So far indirect evidence indicates that black holes exist and that they give off radiation when they absorb materials from stars nearby. One of the reasons for including these chapters is to bring quantum theory into cosmology. The theory of the collapse of stars into white dwarfs, neutron stars and black holes depends strongly on the Pauli exclusion principle for its explanation. The exclusion principle says that two particles of the same type (i.e. electrons or nucleons) within matter cannot have both the same position and velocity. In general terms this means matter, by contraction, can reach a density only great enough that those particles are still allowed to move away from each other. At that density further contraction by gravity is counteracted by the repulsive force resulting from this exclusion principle. Once gravity increases in magnitude beyond the repulsive force between nucleons the density of the matter becomes infinite and a black hole (singularity) is formed. The reason they are called black is that light paths are bent so much that light travels perpendicular to the radial direction of the gravitational force by the time it reaches the event horizon and does not escape into space. Out of this work on black holes Hawking developed his theories on quantum gravity and a model for the universe to have a beginning that is not a singularity. This allows him to make the following statement; "The state of the universe and its con-

tents, like ourselves, are completely determined by the laws of physics, up to the limit set by the uncertainty principle. So much for free will" (p. 94).

Lecture 5 *The Origin And Fate Of The Universe* begins the tale of Hawking's main contributions to big bang cosmology. He got his real impetus to develop this area of cosmology from the Catholic pope while attending the 1981 Vatican sponsored conference on cosmology. According to Hawking the pope told the conferees they "should not inquire into the big bang itself because that was the moment of creation and therefore the work of God" (p. 97). The standard big bang model takes us back only to about one second after the event and does not leave us with evidence to go back further in time. What is missing of course is an explanation of how the entire universe started and grew to its enormous size from zero size as an infinitely hot singularity. Hawking took the pope's decree as a personal challenge to broach that final barrier. He attempts to answer these four questions in the remainder of the book: (1) Why was the early universe so hot? (2) Why is the universe so isotropic on a large scale? (3) Why did the universe start out with a critical expansion rate so that it avoids recollapse? (4) What is the origin of local lumps such as stars and galaxies? His main problem is that without an intelligent designer he needs to explain the resulting universe but has no known physical laws that operate near the singularity at time zero. So he uses his imagination and develops concepts like random quantum fluctuations, the inflationary model, multiple universes, string theory and the anthropic principle as a selection agent to answer the above questions. In this lecture he addresses the inflationary model with a unified force made up of three of the four known forces we see today. He explains how the universe initially expanded after the quantum fluctuation event and then recollapsed all within the first second to initiate the standard big bang and the resulting universe we now see. He explains that a law of quantum gravity must have existed at the beginning to control these events and that there could be no existing boundary conditions. He then attempts to demonstrate how this all is possible if we accept his concept of an infinite imaginary time. At the end of the lecture he gives us the resulting effect of his theory by stating: "But if the universe is really completely self-contained, having no boundary or edge, it would be neither created nor destroyed. It would simply be. What place, then for a creator?" (p. 126).

Lecture 6 *The Direction Of Time* gives Hawking's view of time as it relates to quantum gravity and the role of imaginary time in the origins of the universe. He includes three arrows of time by which humans tell the direction time is flowing. First there is the thermodynamic arrow, then the psychological arrow, and finally the cosmological arrow. He states that the thermodynamic and psychologi-

cal arrows are based on the same premise that entropy (disorder) increases with time. The cosmological arrow is more difficult to explain because there would have to be a time when there was very high order in the universe if it follows the second law of thermodynamics. This is where he brings in imaginary time prior to the quantum fluctuation that started our universe, as we know it. If time started before the big bang then everything could have started with disorder and was ordered in the previous time period before the quantum fluctuation proceeded to form our universe. According to this theory the universe is self-contained and fluctuates from disorder to order and back again in a never ending cycle which reflects that it has no boundary conditions or singularities in all four dimensions.

Lecture 7 *The Theory Of Everything* attempts to tie all his theories about the universe together into a neat package. He would like to see a complete, consistent, unified theory that would include all the partial theories and approximations we have now as subsets. He thinks man is on the threshold of developing this grand unification theory with the parts he has just reviewed in this series of lectures. The first step is combining general relativity with the uncertainty principle. This has been attempted but without success since it includes singularities again. One way he has found to remove the singularities is a mathematical process called renormalization. However when he applies this process to remove infinities, what remains has very little information about the universe. In other words instead of ending up with a theory that explains everything he obtains a result explaining nothing! He and other cosmologists are presently trying to input observational data back into the theory after the renormalization, hoping to produce a viable theory that explains observations again. This is leading them into the areas of string theories and multiple (10 or 26) dimensions beyond the four known dimensions to explain what is observed. He suggests there is a limiting value to all this research and once that can be determined humans will be able to understand everything about the universe. The ultimate goal he states as: "Then we shall all be able to take part in the discussion of why the universe exists. If we find the answer to that, it would be the ultimate triumph of human reason. For then we would know the mind of God" (p. 167). If I remember correctly that was going to be the result Adam and Eve were told they would gain if they ate of the fruit of the tree of the knowledge of good and evil. I guess some humans will never learn God's first lesson this side of the end of this creation.

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Letters to the Editor

The Age of the Universe

Regarding my book *The Age of the Universe: What Are the Biblical Limits?* and Exodus 20:11, Russell Humphreys asks, "Can you point to any use of the phrase (heaven and earth) in the Scripture in which the heavens clearly do not include the stars?" (CRSQ, 2002, pp. 136–137)

The answer is, "Yes, and it is clear." At the outset, I should emphasize that we agree on practically everything regarding creation with one, and only one, big item of difference. Also, I gratefully acknowledge an extreme and continuing debt to the pioneers and supporters of creation science who love the Lord and who are dear to me.

In the beginning God created the heaven and the earth. Just as we commonly say, "stars and stripes" to refer to the U.S. flag, so "heaven and earth" usually means "universe," but each entity is still independently retained as stars are one part of the flag and stripes are another part of that one flag. So also, "heaven" is sun, moon, and stars as defined by David, and "earth" is the planet earth itself. Together, we agree, they make up the universe in Genesis 1:1. Using two nouns to make a single thought is called a hendiadys. Similarly, expressions like far and near, thick and thin, are called merisms, but in the nature of both a merism or a hendiadys there must be two distinct elements.

However, an important and obvious distinction arises in Exodus 20:11 and Psalm 135:6–7. Adding a third element "sea" destroys both merism and hendiadys. The very nature of both requires two, and always two, either polar opposites or contrasting nouns. I agree that Thayer's lexicon is correct to regard "heaven and earth" as "universe," but only when used as a hendiadys. Therefore, Thayer's definition is irrelevant when three elements are present or when required by context. The argument that "heaven and earth" must mean "universe" is, therefore, null and void in Exodus 20:11.

Additionally, a far more persuasive reason compels interpretation of Exodus 20:11 to mean "air, land, and sea." Consider: "Today we drove out to the country and met Joe Doakes, the top news anchor in the country." In one sentence we have used the word "country" with two different meanings. We must accept two definitions of heaven in Genesis as well. All languages have multiple meanings for many words. Because of that, to leave no room for misunderstanding, God chose to define the very simple words like night, day, air, sea, and land *relative to the six-day work*. We could argue about the meaning of heaven and earth in verse one of Genesis, but there can be no debate when God Himself defines the terms within the six-day context.

"Heaven and earth and sea" in Exodus 20:11 cannot be other than "air, land, and sea" because they are deliber-

ately defined that way by God Himself, during days one through three. "Sea" simply does not fit in the same context as "universe," but it easily fits in the context of air and land. Good hermeneutics *require* that we use the definitions which God Himself gave us during those very same six days in our interpretation of Exodus 20:11. Exodus 31:17 uses "heaven and earth" but cannot refer to the entire cosmos either, because, again, the reference specifies *work during the six days* where God Himself has defined both entities. Further, 31:17 is a reiteration of chapter 20:11.

It is like saying, "Listen up, my children, just in case someone misses what I mean in the fourth commandment (Exodus 20:11), here it is, spelled out ahead of time in the first chapter of Genesis, right in the middle of the six-day context. *Earth* means 'the dry land which appeared on the third day,' and *heaven* means 'the atmosphere which was created on day two and in which birds fly on day five'."

When God defines something He expects us to understand it in everyday terms, straightforwardly, on its face-value, to use Dr. Humphreys' often exhorted language. Hence *heaven* must mean something understandable to primitive listeners as well as to us, even as day, night, dry land and sea are all everyday concepts. *Heaven* must be equally understandable, and it is—the air where birds fly. All peoples throughout the ages and in every culture can easily understand what air is. What is more expanse-like than expandable and compressible air? If not air, then God left no record of the creation of air at all. Light is recorded, seas, land formations, vegetation, animals, and man but no air? That would be an inconceivable omission in an inspired record. We may be sure God does *not* say, "I am defining the expanse now, but none of you will understand it until the 20th century, and then you can start arguing about what I mean." If it is not a simple, everyday entity like all the other items, then the definition has not helped anyone. Words must be defined *in terms well known to the hearers* so everyone can understand. Moses' readers knew nothing about the space-time continuum, so that should not be considered.

These references to heaven and earth and sea are "clear" and do *not* refer to the universe. This is far more than a mere assertion. Dr. Humphreys' complaint is baseless. Our Heavenly Father Himself defined air, land, and sea clearly for us; the only place in the Bible, that I recall, where He defined any words.

Before day one, "The earth was deserted and empty and darkness was on the surface of the ocean (Genesis 1:2). A "cloud of thick darkness" (which later became the "waters that were above the expanse" of Genesis 1:7) enveloped

the earth like a baby's blanket (Job 38:9) for an undefined time before the first day. The creation of the cosmos, therefore, stands outside the six-day activity. This, I concede, is an assertion; it would extend this letter too much to offer a full proof here, but it is fully defended in my book.

Humphreys objects to some of the ways I deal with the Hebrew words *asah* and *bara*. He says *asah* means "make." It really means "do," in its most basic meaning, which I determine, not from lexical sources only, but from an exhaustive search of hundreds of uses of the word in the Hebrew Bible. *Asah* is translated 74 different ways in the KJV with widely varied applications. Context is sovereign in determining the specific meaning in each case. Jonah the prophet says that Yahweh "made" the dry land (*asah*). Genesis 1:9 describes God "making" the dry land on the third day: "Let the waters be gathered together in one place and let the dry land appear." He brought forth the dry land by deepening the ocean into a sea, thus exposing the land *without necessarily creating any new material*. Who can prove that God did not "make" the sun, moon, and stars by a similar process without *creating* any of those bodies on the fourth day? The ocean could not be illuminated until the cloud of thick darkness was partially abated to give light for day one, and certainly at some time in the creation days, that cloud blanket *had to be brought to complete transparency* for us to see the stars. God created the cosmos before day one in the undefined beginning, and He "made" the stars on day four just as He "made" the land on day three by commanding them to emerge from an obscuring cover.

If the day-three context and Jonah's statement are ignored, a "straightforward" interpretation of a less-than-perfect translation could lead the interpreter straightforwardly in the wrong direction to the extent of the imperfection of the translation or its faulty interpretation. In my opinion, there are better words that could be chosen to suit the context of Genesis 1:16 than to say, God "made" the stars on the fourth day, because "made," without caution and vigilance, forces many readers to think "created" or close to that. I suggest that *in this case*, some better translations would be, "God did or accomplished or prepared or executed or furnished or worked or brought forth the stars on day four." Any of these are valid, commonly used translations of *asah* throughout the Old Testament. The best single word choice in my opinion would be *did* used in a transitive verb as when we "do" the dishes (without "making" them). God *did* the greater and lesser lights and the stars on day four. He *created* them "in the beginning." It's a bit awkward in English to use "did," but not at all awkward in Hebrew usage. Most might prefer, "God *brought forth* the great lights and the stars," for both meaning and readability. If you must choose "made" for Genesis 1:16 (I am well aware that all the versions use it there), then use it as God made the dry land the previous day by uncovering it.

"Made" is tolerable but not ideal because we cannot expect all readers to see all of these connections. Context is *everything* when using flexible verbs like *asah* which has dozens of applications. "Made" is alright if understood with the Jonah reference and day three in mind.

Again, this is not a complete explanation, but it is fully established in the book. Thus the only two verses which can be misread to say "young universe," (Genesis 1:16 and Exodus 20:11) are shown to say no such thing.

Humphreys wants a verse from me which specifically says the universe is old. A universe that is undefined in age cannot be defined as "old." God did not define the *dimensions* of His creation and neither did He define its *time* of origin which are related phenomena. The age of the universe, if we ever determine it, will be determined by honest inquiry in science, such as interpreting light from distant galaxies or perhaps radioisotopes, or something untried as yet.

Humphreys suggests that perhaps some expert may feel like "critiquing this new variant," with which I agree. Truth has nothing to fear under investigation. I have suggested parameters for such a discussion in Appendix E—"Language Challenge for Hebrew Students" which I request be read by prospective contributors before engaging in debate.

Humphreys continues, "(Gray) does not seem to realize that in doing so (accepting recent Flood geology) he does away with a half billion years of that long-ages timescale he may deeply fear is correct." I am astounded by his statement. Nothing could be farther from the truth. Dr. Humphreys has missed my position by miles. I am as thoroughly creationist as any who reads *CRSQ*, with only one dispute—the biblical limits for the age of the galaxies and the prebiotic planet earth.

He says further, "The Neo-Gap theory (I much prefer YBC—young biosphere creationist, to distance me from the old Gap theory) is just another member of the long series of often-clever compromises we have seen over the centuries. It wearies me and I often wonder if it grieves God. Why is it so hard for men to simply take Him at His word. O, fools, and slow of heart to believe all that the prophets have spoken, Luke 24:45

We have to determine precisely what the prophets spoke before we can believe or not believe, rather than to imbibe the translations and interpretations of others without critical study. To fail to determine Bible meaning precisely, in my opinion, has led to all sorts of fantastic attempts to explain factual, scientific data to suit a faulty paradigm.

But with whom have I compromised? I am a pariah with evolutionists because I embrace Flood geology (hardly a compromise with them), and I am a pariah with young-earth creationists because I refuse to date Genesis 1:1. Creation is not imperiled in any way by my view, rather

it is strategically secured. It is not difficult for me to “simply take Him at His word.” I believe every word of the Bible to the jot and tittle, but I certainly do not believe all the human interpretations or theories. Many are self-contradictory or scientifically unsound or hermeneutically specious. When there is a simple, literal interpretation understandable to children, when the *original Hebrew* supports it at its “face value,” and when it resolves major scientific problems, *why not accept it?*

Use of Statistics and Extrapolation

Despite the work he is trying to do, I must point out some problems with Dr. Mastropaolo’s use of statistics in “Evolution is Lethal Antiscience” (CRSQ 38:151–158). Specifically, his use of data relative to genetic birth defects and deaths due to genetic defects.

There has been much advancement in identification of genetic defects in the last 40 years. I suggest that much of the increase of reported genetic disorders is due to identification of already existing genetic defects not to the actual development of new ones. Forty years ago only gross abnormalities in chromosome were identified. There were also some identified as genetic because of inheritance. No matter what, extrapolation is not scientifically sound. Even if there are strong theoretical justification for the equation used, my experience is that the extrapolation shown in Figure 3 would have estimated errors as large as the values themselves by the middle of the 21st century and therefore the predictions would be meaningless. We were fighting this problem thirty years ago in spectroscopy when we had just begun using computers for curve fitting. We would have a very accurate fit for thirty or forty spectral lines but it would still not make good predictions beyond the next three or four lines. We were requesting that all parameters be reported with 95% confidence intervals so that estimated errors could be calculated for extrapolated values.

The other problem is with the use of percentage of infant deaths due to genetic defects. This tells me two things: the identification and reporting of deaths due to genetic defects have improved and the number of deaths due to

It is my opinion that every problem has been met on every front (not here but in the full treatise). Those who retain objections are invited to engage in friendly dialogue. Chapter one can be found on the web, www.ageoftheuniverse.com.

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malnutrition, disease, and prematurity has decreased. I would expect that the addition of the quadratic and cubic terms did not significantly improve the R^2 value for that curve. At any rate, the trends of the data do not justify an extrapolation with anything other than a linear fit. This should be investigated with the use of error analysis and error estimation. In addition, I would only accept a model that approaches 100% asymptotically. The statistic that would be appropriate for the point he is trying to make is the percentage of all births that resulted in death due to a genetic defect.

To get further insight into this problem let me give an example. The data report that in the nineteen teens the percentage of deaths attributed to genetic defects was seven percent. In the eighties, it had increased to twenty-two percent. On the other hand, the infant mortality in the nineteen teens was about ten percent. By the eighties it had been reduced to two percent and is currently at seven tenths of one percent. Let us look at the number of deaths due to birth defect per 100,000 live births. In the teens this would be 100,000 times the infant mortality times the percentage due to birth defects, that is $100,000 \times 0.10 \times 0.07$ equals 700. In the eighties this would be $100,000 \times 0.02 \times 0.22$ equals 440. This would indicate that the overall infant mortality due to genetic defects has actually decreased during the century, contradicting the implied conclusion.

I appreciate what Dr. Mastropaolo is trying to do but this section of the paper is easily contradicted and therefore detracts from his arguments.

Duane Steiner

Use of Statistics and Extrapolation—Response

In his comments on “Evolution Is Lethal Antiscience” (CRSQ 38:151–158), Dr. Steiner states that the medically documented genetic disorders continue to rise exponentially mainly because the medical community has been in a continual state of discovery for the past 40 years. He feels that much of the reported increase is from medical identification of genetic disorders already in the population, not new ones. He does not cite a reference to support his intu-

ition. Neither does he refute with evidence the data reported by McKusick and others, the reported revisions and the new genetic disorders, not intuition, upon which the paper and the equations were based. In my view, the medical community is not naive and their revisions and new genetic disorders are more compelling than intuition. Dr. Steiner then argues that the extrapolations in the article are not scientifically sound because they are bound to

have errors as large as the values themselves. He cites experience with spectroscopy curve fitting but not with the medical data of McKusick or Sever upon which the paper was based. He cites no studies linking spectroscopy with medical data. To refute extrapolations based on medical data, rival medical data or rival treatment of those data are needed, not some analogy based on completely unrelated spectral lines.

Dr. Steiner speculates that the apparent rise in the proportion of infant deaths from birth defects is caused by improved identification and reporting and a decrease in other causes of death. He cites no evidence. He then speculates without evidence that the quadratic and cubic terms in the reported equation did not significantly improve the equation of best fit and therefore only a linear fit can be justifiable. He gives no comparison of goodness of fit, R^2 , with his linear model. I did try the linear, quadratic, exponential, logarithmic, power, and third degree polynomial models and the best fit was with the third degree polynomial reported. I next examined the genetic disorders, reported by McKusick, the likely drivers for birth defect fatalities, and found again that the third degree polynomial, which I reported, gave the best fit. Consideration of the Leakey reference and the mass extinction reference suggested that the entire biosphere is currently in the throes of the greatest mass extinction of its history and that gave additional support to the third degree polynomial predictions. Subsequent to the publication of the article, McCandless has reported that 71.5 percent of children admitted to hospitals had an underlying disorder with a significant genetic component. Many of these children will have children with earlier and likely more severe manifestations of their genetic disorders. Such data additionally support accelerating devolution as the reported equations predict and contraindicate the use of linear or quadratic models associated with more optimistic predictions.

Without evidence, Dr. Steiner requires that any model of infant deaths from birth defects approach 100% asymp-

totically. That would mean that extinction would be progressively approached but never attained. However, prior to that shot in 1681, the dodo was extant and an instant after that shot it was extinct. From observation, it is well known that extinctions do occur precipitously.

According to Dr. Steiner's estimations, the actual number of infants dying of birth defects in the 1910s was 700, in 1980s it was 440 and a decade later fewer than 440 according to his method. However, Sever et al. was referenced in the article and reported, "Each year in the United States, an estimated 100,000 to 150,000 babies are born with a major birth defect.... Of these babies, 6,000 die during their first 28 days of life, and another 2,000 will die before reaching their first birthday." Furthermore, "Birth defects were considered to be a contributing cause in approximately 1,000 other deaths." Furthermore, the survivors account for 25% to 30% of pediatric hospital admissions (Sever et al., 1993). Dr. Steiner's unreferenced estimation of (likely fewer than) 440 infant deaths from birth defects varies significantly from the 8,000 reported by Sever et al. and I leave it to Dr. Steiner to sort it out with Sever et al.

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The Pre-Flood/Flood Boundary and the Geological Column

I refer to Carl Froede's papers "Precambrian plant fossils and the Hakatai Shale controversy" (Froede, 1999) and "The pre-Flood/Flood boundary scholarship and clarification" (Froede, 2000). I wish to set the record straight as to how my views regarding the presence or absence of fossils as a criterion for classification of Precambrian strata as Flood deposits differ from those of other Creationists who seek to explain the Precambrian in a Genesis Flood context, and as to my views on the Uniformitarian geologic column and the location of the pre-Flood/Flood boundary in the geologic record.

In his CRSQ paper Froede discusses how young-Earth Creationists explain the Precambrian strata which contains fossils in a Genesis Flood context and referring to my paper (Hunter, 1992), includes me as one of those creationists who have proposed that the Precambrian strata containing (plant) fossils formed during the global Flood, and have no link to the Uniformitarian stratigraphic/geologic column. Froede thereby, probably unintentionally, implies that I consider the presence of fossils in Precambrian strata to be a necessary criterion to classify them as Flood deposited strata, and that I consider the fossil-bear-

ing Precambrian strata to have no link to the Uniformitarian stratigraphic/geologic column. This is not so.

In my 1992 paper, after noting that (Snelling, 1983) cites the fossil content of many Precambrian strata as evidence for their Flood deposition, and proposing that the Archaean strata were deposited during Stage I of the Flood (days 1 to 40), I state categorically that, regarding the Archaean (the lowermost Precambrian strata); "Lack or paucity of fossils in Archaean strata might be attributable to the destruction of organisms...and should perhaps be considered an expected characteristic of these strata." I thereby make it very clear, as I have done in several previous and subsequent papers and letters, (Hunter, 1996; Hunter, 1997; Hunter, 2000a, 2000b; Hunter, 2001) that, contrary to Froede's implication, I consider all Precambrian strata to be Flood deposited, not just those that contain fossils. In his CENTJ paper Froede, in a dialogue with Austin (Austin, 2000) and again referring to my 1992 paper, discusses the location of the pre-Flood/Flood boundary in the Grand Canyon and suggests that my model might assist in explaining where the pre-Flood/Flood boundary lies in the Grand Canyon, moving the boundary; "...downward toward the contact between the (Precambrian) igneous/metamorphic rocks and initial over-lying (Precambrian) sedimentary layers."

The small exposure of Precambrian metamorphosed strata and intrusives seen at the base of the Grand Canyon is part of a much more extensive area of Precambrian strata and intrusives which probably underlies the whole of the western United States. In other areas of the world these characteristic Precambrian strata, which always occur at the base of the geological column, are seen to contain volcanic sequences up to 20km. thick, which are unlikely to have been deposited during Creation Week as many creationists believe. Creationists are interpreting these Precambrian strata, and their relationship to the unconformably overlying Cambrian strata, in the Grand Canyon, out of their true context as a laterally very extensive, stratified, characteristic Precambrian sequence. I have suggested (Hunter, 2000b) that the pre-Flood/Flood boundary probably does not occur in the visible stratigraphic record, but rather in the Earth's mantle, at the 660km. discontinuity. It is then probably pointless trying to locate the pre-Flood/Flood boundary in the Grand Canyon, or anywhere else on the surface of the Earth.

Froede also claims that my approach is counter to what he calls, "the uniformitarian column based approach." Again, this is not so. In the same paper I used four diagrams (Figures 1, 4, 6 and 10) to illustrate where I consider the Flood-deposited Precambrian strata fit, at the base of the Uniformitarian geological column, which I consider to be, despite relatively minor exceptions, a generally correct representation of the relative positions of strata throughout the geologic record (Hunter, 2002)

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An Answer to John Baumgardner's Review of *Plate Tectonics: A Different View*

In a recent edition of the *Answers in Genesis Technical Journal (TJ)*, the new CRS book, *Plate Tectonics: A Different View*, was reviewed by Dr. John Baumgardner (2001), one of the proponents of catastrophic plate tectonics. We believe that his review was neither objective nor representative of the book's contents, and we appreciate the

opportunity to set the record straight. Dr. Baumgardner's criticisms in the review can be further evaluated by his statements in the recent forum in the *TJ* between himself and Michael Oard (*TJ* Editors, 2002). We encourage readers to evaluate the literature and decide for themselves.

Catastrophic plate tectonics had its genesis in computer modeling studies (Baumgardner, 1986; 1990) and was later developed and presented as the geophysical model of the Genesis Flood (Austin et al., 1994). Reed et al. (1996) raised questions about plate tectonic concepts and in 2000, the CRS book was released. Then earlier this year the *TJ* presented their forum.

After briefly addressing some of Dr. Baumgardner's specific comments, we would like to discuss several general issues that transcend the plate tectonics issues.

Hostile?

Dr. Baumgardner accuses us of being "hostile" rather than skeptical of plate tectonics, when he says, "I believe that it is fair to say that the four young-Earth creationist authors take not just a skeptical view but an openly hostile view." (p. 36)

He would do better to avoid *ad hominem* comments. Our position is simple. We do not believe that plate tectonic theories of any stripe have presented sufficient evidence to justify their sweeping assertions. Perhaps some aspects of plate tectonics are historical fact, perhaps not. Absent compelling data we will continue to remain skeptical.

He goes on to state, "A notable consequence of this hostility is a serious lack of objectivity." (p. 36) We are left to wonder if a similar "lack of objectivity" would then apply to those biased in favor of plate tectonics.

Authors Ignore Evidence

Dr. Baumgardner believes that we have ignored evidence for plate tectonics. The literature on plate tectonics is voluminous. Our book is a compendium of specific articles and does not claim to be an exhaustive treatment of the topic. However, it seems that if Dr. Baumgardner had a strong case against our book, that he could criticize what was in it, instead of what was not. He speaks specifically of the ocean drilling programs. Contrary to his implications, there are no silver bullets in data obtained from those studies. Chapter 2 of our book contains a spectrum of references for the interested reader, Dr. Baumgardner's review, unfortunately, does not. Since he refers especially to Chapter 1 of our book, we must note that the "deficient" evidences for plate tectonics cited there are quoted from a *proponent* of plate tectonics!

Fossil Correlation from Deep Ocean to Continents Determine Age of Sediments

Dr. Baumgardner believes that one benefit of the ocean drilling programs is that they:

...have provided a wealth of data relating to the history of the world's ocean basins. These data make it possible to correlate fossils in the deep ocean sedi-

ments with the marine microfossil record on the continental shelves and hence with the overall fossil record. (p. 36)

We are puzzled at the basis for fossil correlation mentioned by Dr. Baumgardner as evidence for plate tectonics. As far as we are aware, marine fossil and microfossil correlation is performed by reference to evolutionary position. Dr. Baumgardner does not specify another correlation method, and so we are forced to interpret his assertions as a support for evolutionary succession, which we cannot support. If he is correlating by some other means then he needs to elucidate it for the benefit of all.

Sediment Distribution, Heat Flow, Volcanism, Topography, Etc. Prove Sea Floor Spreading

Dr. Baumgardner rehashes the simple arguments for plate tectonics. However, they have the flavor of *non-sequitur* arguments. He cites the existence of physical phenomena (the history of which no human has observed and about which no explicit biblical pronouncements are made) and believes that merely the existence of these phenomena demonstrates his model of their origin and history. His reasoning seems to boil down to logic such as, "there is a Mid-Atlantic Ridge, therefore, plate tectonics is true." While historical reconstructions must infer event from product, historiography demands appropriate uncertainty and consequent caution.

Plate Tectonics Has a Mechanism?

Dr. Baumgardner states:

In Chapter 2 [of our book] an entire section is devoted to the claim that plate tectonics has no driving mechanism. But certainly this is not the case. I myself have shown for many years, even in the creationist literature, how the density variations in the plates at the Earth's surface naturally drive a pattern of flow just like plate tectonics predicts. (p. 37, brackets added)

Dr. Baumgardner failed to notice that this section of Chapter 2 of our book cited many references by advocates and opponents of plate tectonics regarding the lack of a mechanism. The assertion is not the invention of the authors, but a concern shared by many geologists and geophysicists. Dr. Baumgardner states that he has discovered a mechanism. Unfortunately, we have seen no indications that any plate tectonics advocates other than Dr. Baumgardner and his co-authors agree. If his mechanism is so compelling, why does it not enjoy wide support? In both his review and in the *TJ* forum, he stated that his mechanism was a credible technical defense of the Flood. If his mechanism meets that standard, then should it not enjoy at least some degree of support in the plate

tectonics community? We believe that it is not supported by uniformitarians because they see the same clear distinction between uniformitarian and catastrophic plate tectonics that we do.

What about the modeled solutions published by Dr. Baumgardner? We would echo the caution of Cleland (2001, p.989):

Similarly, it is important not to conflate the computer-aided modeling that has become popular in historical research with performing controlled laboratory experiments. The most a computer can do is determine the consequences of a hypothesis under a small number of explicitly represented hypothetical conditions. It cannot determine which of these hypothetical conditions actually exists in the concrete physical system being modeled, nor can it represent all the other, possibly relevant, physical conditions present in the concrete physical system.

Argument about African Plate Wrong

Dr. Baumgardner dismisses concerns about the motion of the African plate.

What this author refers to as an enigma is the lack of subduction zones to balance the seafloor spreading that is occurring on both the eastern and western sides of the African plate... Part of the answer is that both North and South America have moved in a dramatic manner to the west as a consequence of the large amount of subduction that has taken place on their western margins. In response to this... motion...the spreading ridge centered in the Atlantic has migrated westward relative to Africa. (p. 37)

However, this answer and its weaknesses are discussed in the chapter! The asymmetric spreading answer is only one possible solution to the Mid-Atlantic Spreading Ridge problem, and was clearly not anticipated in the formulation of sea-floor spreading as originally proposed. There is no clear consensus among plate tectonics advocates on the manner in which the Mid-Atlantic Ridge spreads apart (see references for Chapter 3 of our book). The task of balancing asymmetrical spreading to opposing subduction zones has not been addressed, even by plate tectonics supporters. Asymmetrical spreading suggests a mobile source plume within the mantle, another issue that has not been defined within plate tectonics. The explanation of asymmetric spreading looks suspiciously like another plate tectonics “just so” story. Sound science demands coherent and defensible theories. To date, the potential mobility of the Mid-Atlantic Ridge remains speculative and has not been demonstrated. The fact that the African Plate is surrounded on three sides by spreading ridges has always been a problem for plate tectonics advocates, and no amount of special pleading changes that.

Argument about Continental Fit not Understood

Similarly, Dr. Baumgardner does not appear to understand the argument in Chapter 4.

Chapter four seeks to discredit the obvious similarity of the shape of the eastern and western margins of the Atlantic basin by showing some eighteen other ‘continental fits’... Most of these the author admits are ‘spoofs’. But he avoids any serious discussion of primary physical features of the Atlantic basin, for example the Mid-Atlantic Ridge, which cry out for an alternative explanation if one rejects the notion of seafloor spreading. (p. 38)

For many centuries, the apparent crossword puzzle fit between the eastern coast of South America and the western coast of Africa had been noted. More recently, this had been seen as evidence for the onetime union of the two continents. In Woodmorappe’s contribution to the volume, he critiqued the evidentiary value of the “continental-fit” argument for plate tectonics by showing that many fits are possible. Some of these are at least as convincing as the one between South America and Africa, yet no one considers them real. That is why Woodmorappe called them spoof fits. (Dr. Baumgardner mentioned the “spoof” without elaborating why Woodmorappe had used that phrase).

Continents can fit together in many ways. Most of these fits are rejected out of hand as evidence for a onetime continental union. Consequently, those fits that are accepted as evidence for the indicated continental union cannot legitimately count as evidence for the accepted union. Dr. Baumgardner’s *logical* errors undermine his technical points. He appears to have completely missed the point on this: he dodged the issue of fitting coastlines and instead brought up seafloor data. But each line of evidence must be considered by itself. We believe that Woodmorappe’s attack on the evidentiary value of fitting continents remains valid.

These and other specific issues have, of course, been addressed in our book and in Mr. Oard’s contributions to the *TJ* forum (Oard, 2002a; 2002b; 2002c). We encourage the interested reader to evaluate the arguments and draw their own conclusions. In addition to these specific issues, there are several general issues that arise from Dr. Baumgardner’s review and his contributions to the *TJ* forum (Baumgardner, 2002a; 2002b; 2002c). We believe that these issues transcend the plate tectonics debate and are germane to creationism in general.

Data and Evidence

Dr. Baumgardner’s does not clearly distinguish between data and interpretation when citing evidence for plate tectonics. He presents data that do not logically demand a

plate tectonics explanation, without appearing to appreciate the uncertainty inherent in the leap from data to speculations about earth history. This problem leads to another—the question of certainty in historical reconstruction. Dr. Baumgardner's certainty in his reconstruction is quite high. We maintain a higher standard for confidence in historical scenarios, and thus are much less certain that his model represents what actually happened during the Flood. Dr. Baumgardner should realize that a feasible explanation of a potential Flood mechanism is the best that he (or anyone else) will ever achieve. Furthermore, God was not limited to mechanical causes congenial to our scientific investigation and mathematical modeling when He initiated and directed the Flood event. It is this possibility that makes creationism so objectionable to the modern materialist mind—not the lack of a credible technical explanation. Computer models can never address this theological difficulty.

Tainted Evidence

Another problem is the inability to distinguish between lines of evidence that are tainted by uniformitarian and evolutionary presuppositions and those that are not. We challenge the reader to carefully study Baumgardner's assertions and find the clear distinction between catastrophic and uniformitarian plate tectonics when he discusses evidence. How can creationists see the difference between the two tectonic models if he does not make it clear, and absent any difference, how can we accept uniformitarian plate tectonics, with its built-in necessity of evolution and uniformitarianism?

The Role of Apologetics

Dr. Baumgardner's implies a serious theological error in both the review and the *TJ* forum when he states:

In conclusion, a major barrier to a credible technical defense of the Genesis Flood... has been the lack of a plausible mechanism... I believe that we are now able to model and understand and defend the Flood in a positive way that has not been possible for more than 200 years. (Baumgardner, 2002a, p. 62)

Credible to whom? In context, it appears that he is referring to an unbelieving audience. In that case, his statement that a credible defense for the Genesis Flood has been stymied for lack of a mechanism is itself incredible. Men reject the truth of the Genesis Flood (as they reject the truth of the rest of Scripture) because of sin—a willful rebellion against God's authority and ability to judge. A logical inference from his statement would be that any creationist argument that cannot win over the unbelieving world is deficient!

Unity?

Dr. Baumgardner issues a call for unity in his writing, when he says, "In regard to this monograph, I believe it is urgent that as young-Earth creationists we all begin to pull together..." (p. 38) The implication is, of course, that our book is divisive and an impediment to such unity. We emphatically disagree with this implication. Forced unity around particular models of earth history stifles forensic investigation, as has been evident within the uniformitarian camp for many years. Does "unity" require everyone to rally around catastrophic plate tectonics?

We believe that creationists are free to disagree about historical scenarios for the Flood (within the constraints of Scripture) because our true unity is spiritual, not scientific. Considering the level of our present knowledge, we agree with Oard (2001) that multiple competing hypotheses would be better for creationism than one model 'to rule them all.' Reason and evidence should certainly sway, but they are often no clearer than in this particular debate. In summary, we are happy to work in concert with Dr. Baumgardner as creationists, but are free within that context to agree or disagree with his model.

Unique Explanatory Power?

Dr. Baumgardner deflects criticism of catastrophic plate tectonics by claiming unique explanatory power for the theory. He describes an array of geological and geophysical phenomena and then states, "These are all elegantly explained by plate tectonics and by no other geophysical theory." (Baumgardner, 2001, p. 36)

Apart from the weakness of the empirical premises of this proposition, there is a logical flaw in the inferred conclusion. It does not follow that catastrophic plate tectonics is true. He ignores the two alternate possibilities: 1) no theory can explain these phenomena, and 2) only some other as-yet-developed theory will explain them.

In addition to this formal flaw, Dr. Baumgardner's claim of virtually universal explanatory power presents several problems. First, it is uniformitarian plate tectonics that claims to explain the cited phenomena, within a uniformitarian framework. He does not explain how the catastrophic model explains the same phenomena in a catastrophic framework. Thus, he runs the risk of praising uniformitarianism! In our book (and earlier, Reed et al., 1996) we challenged advocates of catastrophic plate tectonics to describe the points of commonality and dissimilarity between uniformitarian and catastrophic plate tectonics and demonstrate what lines of existing evidence for uniformitarian plate tectonics were pertinent to catastrophic plate tectonics and which were not. So far that challenge has not been addressed, but Dr. Baumgardner continues to assert that plate tectonics (or is it catastrophic

plate tectonics?) explains everything. The failure to differentiate the two models in a consistent and comprehensive fashion remains a serious defect of catastrophic plate tectonics, and is reason enough to remain skeptical.

Second, Dr. Baumgardner appears unfamiliar with literature that presents alternative explanations to the phenomena he cites. For example, Keith (2001, p. 318) after a voluminous discussion concludes:

There is a wide array of structural, geophysical and geochemical evidence that is contrary to the plate tectonics hypothesis. The above three-chapter summary is deliberately one-sided, presented with the intent of generating controversy, the life-blood of science. With similar intent I propose a topic for debate: *resolved that plate tectonics is the most fantastic house of cards that has ever been erected in science.*

Advocates of the expanding earth hypothesis (e.g., Carey, 1976; 1988), advocates of the hydroplate hypothesis (Brown, 2001), and those just plain skeptical of plate tectonics (c.f., Chatterjee and Hotton, 1992; Oard, 2001) all falsify that claim that there are no other explanations for the cited phenomena. Whether or not Dr. Baumgardner agrees with the alternate explanations is his prerogative, but he cannot legitimately say that they do not exist.

Finally, we made the logical point in the first chapter of the book, "A theory that purports to explain everything must". (Reed, 2000, p. 20) Dr. Baumgardner's undue confidence in catastrophic plate tectonics has provided it with a fragile pedestal. All that is needed to demonstrate failure is one contrary piece of evidence. If he would merely recognize the inherent uncertainties in his model and allow the possibility of alternate explanations, then his would not be held to such a strict standard. If, on the other hand, he wants to claim that his model, and only his model, explains everything about the geophysics and geology of the Flood, then he should be ready for frequent empirical disappointments.

Now What?

As geologists, we would be much more convinced of the power of catastrophic plate tectonics if it provided a positive and helpful interpretation of field data without having to assume its truth *a priori*, and tailor the data to fit the model. Our skepticism could be ameliorated by the publication of articles applying catastrophic plate tectonics to specific field data and demonstrating that it provides a uniquely superior interpretation for those data. Mr. Oard's vertical tectonic hypothesis, which Dr. Baumgardner (2002b) claims is not a serious alternative to catastrophic plate tectonics, has at least been tested in the field (Oard, 2001). If Dr. Baumgardner eschews field investigation, then perhaps he could at least rerun his model under conditions of continental stability and report the results.

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Catastrophic Plate Tectonics Has a Problem: Boiling Water

The theory of Catastrophic Plate Tectonics (CPT) requires that all of the ocean floors in the world would have been newly formed from hot mantle rock in a matter of a few months. The model proposes that the earth consisted of one supercontinent and one ocean. (In Genesis 1:10, God called the gathering together of the waters "Seas." If there was only one ocean, why did God use the plural?) Presumably, slabs of the ocean floor broke off and sank into the mantle, with new ocean floor being generated from hot mantle rock. This would permit the supercontinent to break apart and the new continents move to their present locations. Baumgardner (1994, p. 35) states that tectonic changes could conclude "... lateral displacements of the continental blocks themselves by thousands of kilometers, formation of all of the present day ocean floor basement rocks by igneous processes ..."

Continental crust averages at least 30-35 km in thickness so if it started to separate, a chasm of that depth would immediately open. Since oceans are normally about 3-5 km deep, hot mantle rock would rise in the gap to form new ocean floor and water from the oceans would flow in very rapidly to create a new ocean.

CPT theory has received some acceptance in the creation movement, but also some criticism regarding the dispersal of heat (Froede, 1998; Herrmann, 1998; Froede, 1999; Herrmann, 1999). Froede (1998, p. 46) asked, "What happened to the heat generated during this period?" He stated that, "This freshly-extruded ocean floor ... would generate intense heat, perhaps sufficient to vaporize the overlying Floodwater." In answer to Froede, Herrmann (1999) proposed that "... the General Theory of Relativity is applied as a possible mechanism for many of the Flood related physical scenarios." Further, (p. 110) "... that all the ordinary modes of internal heat transfer, ... will increase greatly during the Flood period." But what if CPT never occurred?

The crucial failure of CPT is founded on the fact that new ocean floor was supposed to be formed from hot mantle rock. When water touches any material, such as mantle rock which has a temperature that exceeds 100° C, the water heats rapidly and converts to steam. Therefore, if created ocean floor subducted and was replaced by hot mantle rock, at the bottom of the oceans, steam would be generated. As it percolated upward, the ocean would be forced to absorb its heat. If all the water at the bottom of all the oceans in the world was at the boiling point and steam was rising through the water, how could it fail to heat the oceans?

Water as a Coolant

Water has long been known as a marvelous coolant. One calorie is the amount of heat required to heat one gram of water 1° C. However, one gram of water previously heated

to the boiling point will absorb 540 calories as it converts to steam. That is the reason firemen pour water on a fire; immense amounts of heat will be absorbed and carried away as steam. How does this fact relate to CPT?

As previously stated, the theory that cold ocean floor would break into slabs and subduct into the hot mantle rock below, would require new ocean floor to form below the oceans. To quote Baumgardner (1990, p. 35), "Huge volumes of sea water were converted to pressurized steam where the ocean floors rifted apart to provide intense global rain." This statement recognizes the great heat of mantle rock, but one fact has been ignored. When the hot rock touches water, it would indeed generate steam, but that steam would rise through the ocean before it reached the atmosphere. Does anyone believe the ocean water would not be heated? Moreover, in a few months' time, all the water at the bottom of all the oceans would be at the boiling point, so the question arises, how much could the ocean water be heated before marine life would be destroyed?

There is no question that the created ocean water could quickly cool the hot rock that it touched, but only to 100° C, for heat would be carried away as water converted to steam. The real problem is the heat in the rock just below the new crust. Heat migrates from hotter to cooler regions. Therefore, as heat in the mantle moved upward through the water-cooled rock, the ocean would continue to absorb heat. It is true that as mantle rock cooled, it would have some insulating effect, but initially the cooled rock would be very thin. The cooled layer could only increase in depth as the water absorbed additional heat. Insulation slows the movement of heat, but does not prevent it entirely.

Not all of the water would boil, necessarily, but water at the ocean floor would remain at the boiling point for an unknown length of time. Obviously, most marine life would be killed if subjected for only a short time to a temperature somewhat less than boiling. For example, the early process to pasteurize milk required heating to only 145° F for a few seconds. Since the oceans today possess a vast array of marine organisms, it appears that CPT is not a part of history, since oceans have not been sterilized.

A substantial number of creationists have been convinced that a supercontinent broke up and moved to present locations. The theory of CPT may have been developed to show that this happened very rapidly at the time of the Flood. If continents did not separate, such a theory is not necessary.

Does Plate Tectonics Theory have Basic Errors?

In a Letter to the Editor (Honeyman 2000), I presented scientific evidence that Greenland had never separated from the British Isles. If they had, either slowly over millions of years or rapidly, the ocean floor between would

have been formed from hot mantle rock rising between them, forming thin, basaltic ocean floor as they moved apart. Actually, between North America and Europe in that area are Iceland, the Faroe Islands and six ridges, some of which are specifically identified by geologists as continental. These facts indicate that the whole theory of Pangea is not historical. Continents cannot move without creating new ocean floor. A second problem is the Pacific Ocean Floor. The theory proposes that new floor is created at the East Pacific Rift, moves northwest about 12,000 km and then subducts under the Hawaiian and Kurile Islands. Theoretically, the floor also moves north under the Philippines and Ryukus, at the same time it moves southwest under the New Hebrides. The subduction is also supposed to generate the force which pulls the ocean floor apart to form trenches in front of these islands.

The forces at work during the Flood present another possibility. God said in Job 38:8, "Who shut up the sea with doors, when it broke forth . . . ?" If ocean water rolled onto the continents, it would load them and unload the ocean floors. Continents would be depressed and displaced mantle rock would force ocean floors upward. The Pacific Ocean floor covers nearly half the globe; it is in effect a huge dome. If that dome was forced upward, it could be lifted away from the islands mentioned above and open trenches in front of them. Certainly, the force would be operating in the right direction.

Plate Tectonics claims that ocean floor moves outward from a midocean rift and subducts under islands and continents, following a descending line of earthquake foci called the Benioff Zone. Consider the force of buoyancy, the upward force which prevents the continents from sinking toward the center of the earth. Subduction would have to force ocean floor downward against the upward force of buoyancy, a force exactly equal to the downward pull of gravity. If an earthquake occurred along the Benioff Zone, rock might be expected to move up rather than down.

Conclusion

It is an amazing fact that when Scripture states in Genesis 7:19, "... all the high hills, that were under the whole heaven, were covered," many creationists do not realize

that the continents were below sea level. At some time in the past, mid-ocean rifts opened and pushed upward, displacing massive amounts of water onto the continents. This would change the equilibrium between continents and oceans. Water rolling onto continents would depress them and mass displaced from under the land would force ocean floors upward. The combination of these forces present solutions to several problems of geology which are superior to the theory of plate tectonics. The part of the theory that claims the Pacific Ocean floor is moving in several directions at the same time should be seriously questioned.

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Accidents Upon Accidents

If the solar system was brought about by an accidental collision, then the appearance of organic life on this planet was also an accident, and the whole evolution of Man was an accident too. If so, then all our present thoughts are mere accidents—the accidental byproduct of the movement of atoms. And this holds for the thoughts of the materialists and astronomers as well as for anyone else's. But if

their thoughts—i.e., of Materialism and Astronomy—are merely accidental by-products, why should we believe them to be true? I see no reason for believing that one accident should be able to give me a correct account of all the other accidents.

C.S. Lewis
God in the Dock, p. 52

Erratum

The table of contents for the September, 2002 CRSQ lacked the entry for "Frank Lewis Marsh: His Life and His Legacy" by Wayne Frair on p. 94. A corrected first column of the table of contents is at right. It could be copied and pasted over the original to correct the issue.

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Creation Research Society

History—The Creation Research Society was organized in 1963, with Dr. Walter E. Lammerts as first president and editor of a quarterly publication. Initially started as an informal committee of 10 scientists, it has grown rapidly, evidently filling a 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* has been gradually enlarged and improved and now is recognized as the outstanding publication 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 solely a research and publication society. It does not hold meetings or engage in other promotional activities, and has no affiliation with any other scientific or religious organizations. Its members conduct research on problems related to its purposes, and a research fund is maintained to assist in such projects. Contributions to the research fund for these purposes are tax deductible. As part of its vigorous research and field study programs, the Society operates The Van Andel Creation Research Center in Chino Valley, Arizona.

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.