EDITORIAL

THE ENIGMATIC GEOLOGIC COLUMN

The geologic column contains so many puzzling features that the word enigmatic comes to mind. Sudden disappearances of numerous taxa (interpreted as mass extinctions) are an example. What process could cause the global disappearance of the dinosaurs, plesiosaurs and ammonites, but not wipe out the mammals, crocodiles or frogs? Another example is the sudden appearance in the Cambrian of all the major groups of durably skeletonized marine invertebrates, except the bryozoans. Why the bryozoans? A third example is the non-random stratigraphic distribution of storm deposits. The number of storm deposits is relatively high in the lower Paleozoic, then declines in the upper Paleozoic and Triassic, then increases again in the Jurassic and Cretaceous.[1] What accounts for such a pattern? Numerous other examples could be given.

Given the complexities of the geologic column, it may be no surprise that creationists have a diversity of views on how the column relates to the Biblical flood. Many attempts have been made,[2] including a paper by Wise and Snelling published in this journal in 2005.[3] The present issue of *Origins* contains an article with a different viewpoint on the flood, and a few comments might be in order. First, publication in *Origins* does not necessarily reflect endorsement of either view by the Geoscience Research Institute, but is intended to help foster discussion. Second, it is hoped that discussion of a diversity of viewpoints will help to identify points that merit additional exploration and encourage further study. Third, exchange of ideas from different viewpoints may stimulate new ideas previously not considered.

Differences of opinion in relating the geologic column to the Biblical flood reflect some rather severe deficiencies in our knowledge. First, since the geologic column represents prehistory, explaining it is a historical question rather than an experimental question. It is not that experiments cannot contribute to our understanding, but we cannot know whether our experiments are accurate replicates of the events in question. Interpreting historical events depends more on *post hoc* explanation than on experiment.

A second problem is we do not have any good idea of what the world was like before the Flood. We do not know how the continents and oceans were arranged on the globe, nor do we know how living organisms were distributed. Were deep ocean basins and continents dispersed around the earth? Or were there only one or two deep ocean basins, with most of the surface covered with granitic rocks, much of them covered with epiconti-

nental seas? Numerous other possibilities come to mind. Were living organisms distributed in global life zones that extended around the world? Or were they, as in modern zoos, organized in separate regions – "dinosaur-land," "marsupial land," etc? The possibilities are almost endless, and we do not know either the important patterns or the details.

A third problem is our lack of knowledge about the nature of geological processes before the Flood. Were there earthquakes and tsunamis before the great Flood? How much sediment accumulated in the ocean before the Flood? Were there local floods? What about volcanoes? Many of us are inclined to doubt such things occurred before the flood, but we really do not know. Leonard Brand's article challenges to re-consider whether our assumptions are justified.

A fourth major difficulty in attempting to decipher the geologic column in the context of a global catastrophe is our lack of knowledge about the sequence of events during the Flood. Was the onset of the Flood sudden and global? Was it sudden and local at first, gradually encompassing the entire world? Some creationists have concluded that the Flood began with a huge "bang" in which the greatest intensity of violence occurred at the beginning:

> *In the 600th year of Noah's life, in the 2nd month, on the 17th day of the month, on that day all the fountains of the great deep burst forth, and the windows of the heavens were opened* (Genesis 7:11).

But does this text justify the conclusion that the violence of the flood was greatest on the first day of the Flood? Consider Genesis 11:18, 19:

> *The waters prevailed and increased greatly upon the earth; and the ark floated on the face of the waters. And the waters prevailed so mightily upon the earth that all the high mountains under the whole heaven were covered.*

Another text suggests great violence at the end of the flood:

> *And God made a wind blow over the earth, and the waters subsided* (Genesis 8:1).

Who can say with certainty whether the greatest violence occurred when the fountains of the deep opened, or when the waters prevailed over all the high mountains, or when the wind blew so hard it caused the waters to subside? Or who can say with certainty that there were not other major events that occurred during the flood? For example, the sediments of the geologic column record more than 150 impacts of extraterrestrial objects, yet they are not mentioned in the Biblical account of the flood.

A fifth major difficulty with understanding the geologic column is that we have no modern analogue of a global catastrophe. A global flood is not necessarily merely a scaled-up version of a local flood. A globally rising sea might produce effects never observed in historical times. A global ocean could have currents of over two hundred kilometers per hour.[4] Such speeds could have unexpected effects because the volume and grain size of the sediment load carried by water is directly related to the speed of the flow.[5] Moreover, a globe completely covered by water might have patterns of oceanic currents drastically different from those in our modern ocean basins, which are bounded by continents.

The potential role of the supernatural is another challenge to relating the geologic column to the flood. Science is generally considered to restrict itself to the study of events and processes regulated by the ordinary rules of nature. It does not consider the possibility of supernatural events or processes. Yet the global flood seems to have been supernaturally caused,[6] so we need more than materialistic science to understand it. Even if God used physical processes to destroy the earth, He may have caused a series of specific events that we cannot infer from the results because we would not expect them to occur spontaneously. This places another difficulty in our pathway toward understanding the geologic column and its relationship to the flood.

Our incomplete knowledge of the details of the geologic column is a seventh problem for attempts to understand the flood and the geologic column. What geologic evidence is buried out of reach in the earth? What evidence has been subducted beneath the crust? How complete is our knowledge of the fossils preserved in the sediments? These and many other questions remind us that our hypotheses are tenuous at best.

These factors, and undoubtedly others as well, complicate all efforts to correlate the geologic column with the flood. Because our knowledge is so incomplete, we sometimes find it useful to make certain assumptions and then follow the implications of these assumptions to build ideas of earth history. These ideas may potentially be tested against both Scripture and observation.

The use of assumptions is especially important in interpreting the past. Leonard Brand cautions us against depending on old assumptions. He suggests there may have been significant geological activity before the flood and proposes how one might compare that idea with evidence in the rocks. Wise and Snelling's paper utilized a number of assumptions regarding the flood, leading to their suggestion that a particular stratigraphic horizon in the Grand Canyon might represent the first sediments deposited by the flood. Making assumptions and proposing interpretations are legitimate processes in science, but the measure of progress is whether such

exercises lead to broader explanations and better predictions. Both papers point to the need for additional study by those who wish to decipher the puzzles of the enigmatic geologic column.

Jim Gibson

ENDNOTES

1. Gibson LJ. 1996. Fossil patterns: a classification and evaluation. Origins 23:66-99.
2. For example, several papers on this topic were published in Creation Ex Nihilo Technical Journal 10(2).
3. Wise KP, Snelling AA. 2005. A note on the pre-flood/flood boundary in the Grand Canyon. Origins 58:7-29.
4. Baumgardner JR, Barnette DW. 1994. Patterns of ocean circulation over the continents during Noah's flood. In: Walsh RE, editor. Proceedings of the Third International conference on Creationism, p 77-85. Pittsburgh, PA: Creation Science Fellowship.
5. The size of particles that may be entrained and transported by flowing water increases exponentially with the velocity of the current (see Hjulstrom's diagram in any standard textbook of sedimentology). Measures of river discharge show that both bedload and suspended load tend to increase with increasing flow (Reid I, Frostick LE. 1994. Fluvial sediment transport and deposition. In: Pye K, editor. Sediment Transport and Depositional Processes, p 89-115. Oxford: Blackwell.
6. According to Scripture, the flood was divinely caused, for a specific purpose: "For behold, I will bring a flood of waters upon the earth, to destroy all flesh in which is the breath of life from under heaven" (Genesis 6:17). This is equivalent to saying the flood involved supernatural activity.

ARTICLES

WHOLISTIC GEOLOGY: GEOLOGY BEFORE, DURING, AND AFTER THE BIBLICAL FLOOD

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ABSTRACT

Traditional flood geology theory interprets much or all of the Phanerozoic part of the geologic column as formed during the one year of the biblical flood. Some geological and paleontological data are, in my opinion, difficult to explain in this theory. Wholistic geology endeavors to explain more of the earth science data while remaining true to a literal understanding of biblical creation and a global flood. In this view, geological processes such as erosion and sedimentation begin soon after creation or the entrance of sin, and continue for several thousand years. This time interval includes a literal global flood as described in Genesis, but this event did not produce as much of the Phanerozoic record as in traditional flood geology theory.

INTRODUCTION

After the rise of Darwinism in the mid 19th century, George McCready Price was a prominent pioneer in developing a flood theory of geology. In his theory the flood explained all geological phenomena. He rejected glaciation and the presumed stratigraphic order of the fossils. Price was convinced that this evolutionary sequence of fossils was an unsubstantiated device of the evolutionists to support their theory. Whitcomb & Morris's book *The Genesis Flood* (1961) presented much of Price's flood theory in a way that caught the attention of a significant portion of the Christian world and brought flood geology into prominence (Numbers 1992, 1999).

Harold Clark followed closely in Price's footsteps for a time, but Clark spent time in field study and recognized weaknesses in Price's concepts. Clark decided there was indeed a time of more intense glaciation in the Pleistocene, and the fossils really do occur in a predictable sequence in the fossil record. In order to explain how this sequence could be produced by a global flood he proposed his ecological zonation theory (Clark 1946). According to this theory, all basic types of created animals and plants

were alive at the beginning of the flood, and they were killed and buried in a sequence determined by the ecological zone in which they lived. As the flood waters rose, low elevation ecological zones were destroyed first, and successive higher elevation zones were affected in turn. This has become the standard explanation for many believers in a literal flood.

As we look more closely at the details of the geologic record it becomes more difficult to reconcile the evidence with Clark's theory. Not only the sequence of fossils, but current scientific interpretations of many geological phenomena also are a challenge to this theory. Examples include features at many levels in the geologic column that each take time to develop, such as reefs, fossil hard grounds (marine sediments that appear to have been burrowed, etc., when already cemented to form rock on the ocean floor, before being covered by new sediments), and tidal cycles in sediments. It is my purpose here to propose some modifications to traditional thinking that could lead to an improvement in our understanding of the Flood.

TOWARD A NEW UNDERSTANDING OF THE FLOOD AND THE GEOLOGIC COLUMN

I begin the search by summarizing the concepts that we can derive from Scripture. I choose to accept the events in Genesis as literal events (this paper will not defend that view, but will only show how it can be applied). The following is my list of biblical anchor points:

1. A literal creation week of seven consecutive, 24-hour days.
2. At the end of creation week, Earth contained a variety of plants and animals, including invertebrates, fish, reptiles, mammals, birds, and trees, including at least some that are considered to be the more "highly evolved" types such as humans and fruit trees (angiosperms).
3. The creation week occurred only a few thousand years ago. There are uncertainties about the completeness of genealogical lists and differences between ancient biblical manuscripts, but although we do not know the exact time span, I conclude that Scripture clearly portrays a short history of life on Earth.
4. Sometime since the creation there was a catastrophic flood of global proportions. Noah and his family and representatives of the terrestrial vertebrates survived in an ark, while the others died in the flood.

Most creationists have been guided by a fifth point: the geologic column was mostly deposited by the global flood. However, this is not based on any Biblical teaching, and it may be time to reconsider the relationship between the Biblical flood and the geologic column. Perhaps there could have been significant geological activity before the Flood, as well as after it. Thus, I propose a fifth principle to be considered:

5. There may have been extensive geological activity before and after the Flood. The geologic column contains fossil and sediments produced by the Flood, and also those produced by processes acting before and after the Flood.

I propose this approach, incorporating point 5 above, be called "wholistic geology", in contrast with "flood geology", since it attempts to explain the geologic column by taking into account potential geological activity during the whole history of the earth rather than restricting it to only the Biblical year of the flood. Others have also begun to think in similar terms (Snelling 1996, Gentet 2000).

HYPOTHESES TO CONSIDER IN DEVELOPING A WHOLISTIC GEOLOGY THEORY

At present I do not believe that we have a satisfactory understanding of how to relate the geologic record or its fossils to the biblical flood. Before we can do so there seems to be need for a better theory of what might have happened, geologically, throughout history since creation. Then we must seek ways to test our theories, and finally, practical field research to do the testing and to feed back into an improved theory of geological history.

The development of theories of geological history consistent with Scripture must be based on sound geological evidence. It should involve original field research specifically designed to test concepts of the theory and find criteria for accepting or rejecting various ideas.

As a starting point for developing an alternative flood theory, the following ideas are suggested elements of a theory that includes significant geological activity between creation and the flood, and after the flood. This article is not presenting a detailed theory, but suggests a different set of parameters for developing a theory. These ideas can be helpful as long as we do not become too attached to them. This is not a theory to be defended, but a suggestion of an approach to the study of geological history that could lead in time to an alternative theory, that can be fruitfully compared with more traditional geological theories. Chamberlin's concept of multiple working hypotheses (Chamberlin 1965) is very useful, especially

in the initial phases of evaluating which direction to go in our theorizing. The following points are intended as a basis for developing one of the possibilities.

1. Perhaps processes forming the Phanerozoic record began soon after sin, and continued to the present day.
2. Perhaps during the hundreds of years before Noah's trip, a part of the geologic record formed in the ocean basins and lowland areas not inhabited by humans. This is supported by the fact that some of our modern continents are largely covered by Paleozoic marine sediments, indicating they were lowland basins before the flood (Brand 1997, p 274-276). These basins were largely occupied by shallow oceans and nearshore environments, and it is not clear where the preflood continents were. This may seem extreme, but if our present continents were originally covered by ocean, how could the people and other terrestrial plants and animals have been living there? They had to be somewhere else. The basaltic rocks forming modern ocean basins are no older than about Jurassic time, so we are not sure what occupied that area before Jurassic time. Perhaps there were some type of continents in these parts of Earth.

   The time available for this would be up to about 1500 years if the time span since creation was roughly 6,000 years. If the time since creation was closer to 10,000 years, the time for "preflood" geological processes could be up to 5,000 years, or the time since the flood could be longer than we have thought.
3. There was a global flood as described in Genesis. Some dramatic change took place at that time, destroying the inhabited parts of Earth, in a process involving Divine activity, very different from normal earth processes. Perhaps that dramatic change involved the breakup of part of Earth's crust, with rapid subduction of old continental areas (ala Baumgardner? [Clausen 1998]), or loss of continental area by some other process. If this destruction of the continental areas inhabited by humans was rather complete, then it may be difficult to find or to recognize evidence for this subduction event.

   Is it possible that continents could be subducted into the mantle? It seems that this would require that preflood continents were different in composition from modern continents. Continents now have a foundation of granitic rock, which is too light to sink down into the denser basaltic material under them. One possibility is that

at least some of the original continents were of basaltic material, but with abundant pore spaces for water movement, resulting in a net specific gravity lower than solid basaltic rock. A continent of this composition would be light enough to stay above the ocean water level, but if the water system collapsed so that it became solid basalt, it could then be subducted into the mantle.

Another option to consider is that the original parts of continents occupied by upland terrestrial ecosystems, including humans, were located in parts of our continents that are now called shields. These are areas that have no rocks younger than Precambrian. Northeast Canada and a large part of Greenland compose one of these shields. Are there other possibilities that we have not thought of, that should be considered?

4. After that major crisis, the earth was again stable enough to support life, but much catastrophic action continued as crustal plates moved to their current positions and the crust gradually reached a new equilibrium. This period of readjustment after the flood produced the more recent part of the geologic record, over a time period of hundreds to perhaps a few thousands of years.
5. Portions of the fossil record, before and since the flood, may have accumulated slowly enough for evolution within lower taxonomic levels to occur, and to be recorded in the fossil record. Possible examples of this could be the series of species of trilobites in successive units of Cambrian rocks, or ammonite species in successive ammonite zones in Cretaceous sediments. This suggests that microevolution and speciation can occur within created groups *much* faster that most scientists believe possible, especially when environments are changing rapidly (genetic evidence may support that idea) (Brand 1997, ch 12; 2006, ch 5). One difficulty with this idea is that so often species appear in the fossil record with no intermediates linking them to ancestral species. Also we need to determine if there is a portion of the fossil record that does not have any such succession of species, and if this represents the flood.
6. The sequence in the fossil record resulted from a combination of (a) changes in the ecological zones affected at various times (a sort of stretched out version of ecological zonation. This may be more realistic than Clark's version, since the less catastrophic processes in the wholistic geology theory might be less likely to mix organisms from very different habitats), (b) actual microevolution and speci-

ation within created groups as organisms adapted to changes in water chemistry, temperature, plant associations, etc., (c) migration of organisms and perhaps competitive replacement of some groups, and (d) die-offs occurring as changing ecological conditions (involving episodes of volcanism, continental movements, and other events) reached successive crisis points for different groups of organisms.

The theory built on the concepts listed above is called the wholistic geology theory, because it incorporates a wider range of information than other geology theories. It includes the biblical global flood, and the possibility of extensive geological action before and after that flood. All the available geologic data are utilized in developing the theory, while also gaining insights from biblical constraints. This results in suggestions for new research to test this new theory. Part of this research will be done in areas where there are unresolved conflicts between conventional geology and biblical insights, and in some cases this analysis makes predictions as to what the findings of new research will ultimately be.

COMPARING WHOLISTIC GEOLOGY WITH CURRENT DOMINANT THEORIES

Wholistic geology can be compared (Figure 1) with a traditional flood theory with the Paleozoic and Mesozoic formed during the flood and the conventional long ages theory. Each has advantages and disadvantages in its consistency with the scientific and biblical data (Table 1).

These three theories are testable. Testing them will not happen quickly, as it will require some effort to develop better ideas of just what processes would be involved in a wholistic geology theory. But some basic aspects of the theories can be tested even now, with good field work. One definite advantage of considering new options, e.g., a wholistic geology theory, for comparison with the traditional flood theory is that we are not boxed in by unnecessary constraints. If we make the extrabiblical assumption that all fossil-bearing geological deposits began at the flood, then there are many situations where we have no choice but to interpret entire rock formations as deposited in hours, days, or a few months at most. However, if we are comparing two or more theories, like the traditional flood theory and the wholistic geology theory, we can open-mindedly evaluate (while still working within a conservative biblical framework) whether each rock formation was deposited within hours-months, or whether they each took many years (years to hundreds of years) to form.

Of course if we remain within a time frame of thousands, rather than millions, of years, this still requires the prediction that there are entirely

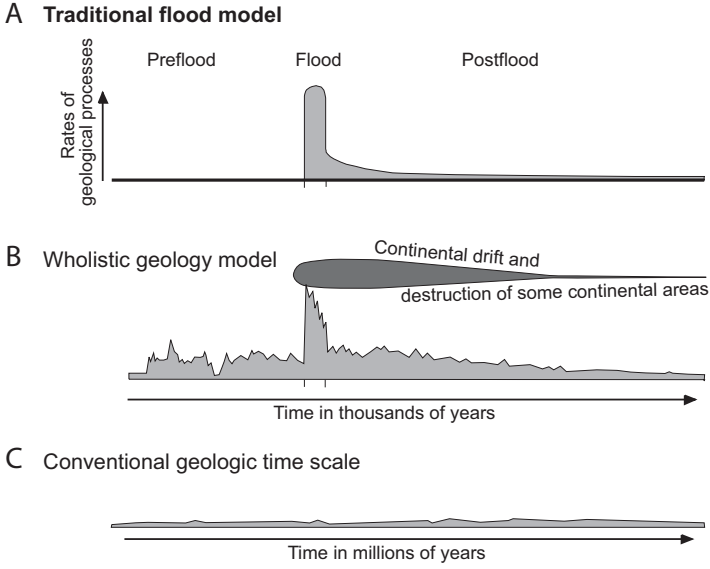


Figure 1. Rates of erosion, sedimentation, and other geological processes, according to three theories of earth history. A - most of Phanerozoic geologic record in a one-year flood; B - wholistic geology theory, with active geological processes beginning soon after creation and extending for several thousand years; C - geologic record formed over the conventional geologic time scale.

new interpretations needed for some geological processes. That is true even for those who prefer a longer time frame, like a few hundred thousand years, and the data available to us from scientific study may not be able to establish whether it was <10,000 years or >100,000 years anyway (there will always be personal faith convictions involved), so I hope that all who care about the Genesis account can work together on this, no matter just what time frame we believe is best.

PREDICTIONS OF THE THEORY

A theory, including the one proposed here, is only useful if it encourages research that improves our understanding of the subject. A useful scientific theory will make predictions of what will be discovered if the theory is correct. If these predictions stimulate discovery through research that would likely not have been done otherwise, the theory has become a productive scientific theory.

TABLE 1. COMPARISON OF THREE GEOLOGIC THEORIES

A. Flood theory with Paleozoic and Mesozoic in a one-year flood

Advantages

Consistent with Scripture
Easier to reconcile with human reactions to Noah's flood message

Disadvantages

Not consistent with radiometric dating
Very difficult to reconcile with many lines of scientific conclusions
Such a catastrophic process should mix up organisms from widely different ecological zones

B. Geological processes over several thousand years from sin to the present

Advantages:

Consistent with Scripture
Fits much more of the scientific conclusions:
- Explains sedimentology and paleontology data more easily than theory A
- Explains the abundant data requiring some time (but not millions of yrs):
  - Stromatolites
  - Reefs
  - Extensive bioturbation
  - Fossil hard grounds
  - Non-catastrophic sedimentology

Perhaps easier to explain the consistent sequence of fossils, since it is not nearly as catastrophic as theory A
More of the fossil species sequences could be result of real adaptation

Disadvantages:

Not consistent with radiometric dating
More difficult to reconcile with human reactions to Noah's flood message
Still faces challenges before it will explain most of the data:
- Cooling of laccoliths, etc.
- Radiometric dating
- Moving continents rapidly
- Others

C. Conventional long ages geological theory

Advantages (in scientific terms):

Consistent with radiometric dating
Easier to explain much of the geologic data
Easier to explain more of the fossil sequences of organisms
Time can solve any problem, just as God can be used to solve any difficulty in a creationist view.

Disadvantages:

Not consistent with straight-forward Scriptural account
Difficult to reconcile with some important lines of data:
Not nearly enough sediment for that much time
Much sediment seems to reflect relatively rapid processes
Very widespread sedimentary formations
Worldwide correlated events (e.g., Ager 1980)
Some well preserved fossil deposits seem to require rapid geological processes

The traditional flood theory and wholistic geology theory each make predictions, many of which should be testable by field research. The following list includes examples of general predictions or conclusions, and they could be subdivided into more specific, testable, predictions. Further study will no doubt generate additional types of predictions.

Predictions following from any type of short age geology theory (within a time frame compatible with a literal biblical history):

1. Radiometric dates do not indicate real time for at least the Phanerozoic rocks. They seem to indicate relative age (which event came before which other event), but not absolute age. I do not think the challenge of radiometric dates will be answered by piecemeal explanations, different for each method, but will require some basic new discovery of a process that uniformly affects all dating methods.
2. If Noah's ark is ever found and is dated with carbon 14, the date will not be a few thousand years, but will indicate nearly infinite age. This is because the ark was built from pre-flood wood, which was apparently living before living things contained significant amounts of carbon 14.
3. Most geological processes occurred relatively rapidly — much more of the geologic column was formed more rapidly than most scientists now believe.
4. Features in the rocks interpreted as Milankovitch cycles (cyclic climatic processes controlled by solar variation, representing cycles of hundreds to tens of thousands of years each) did not result from such long cycles. They formed rapidly, from some other process. Other cyclic processes in rocks also were rapid, not occupying eons of time.
5. Some finely laminated rock is generally interpreted as varves, which are laminations formed one per year, as occurs today in some lakes in glaciated areas. Our prediction is that these cycles of thousands of fine laminations in ancient deposits were not varves. There are other mechanisms to be discovered that will explain these finely laminated rocks.

Predictions following from a wholistic geology theory, in addition to those listed above:

There are not many additional predictions, beyond those listed above.

1. Stromatolites, reefs, trace fossils, dessication cracks, etc., will generally be explained by processes the same or similar to those used by conventional geologic theory. They can be explained within the time frame of the wholistic geology theory without straining the theory.
2. There will be some part of the geologic column, formed within the one-year flood, without features requiring significant time. These features include true stromatolites, reefs (underlain by sequences of fossiliferous sediments), sediments clearly representing an *in situ*, established ecology, or *in situ* hardgrounds.
3. Tidal cycles in the rocks, with about two lamination formed each day, will be more common in ancient rocks than now recognized.
4. The average thickness of sediment deposited per year was a couple of meters or less. The rate may have varied, from some truly catastrophic episodes to some time periods with no net accumulation or erosion of sediment.
5. Sequences of species or genera of organisms resulting from microevolution during the deposition of the sediments may be found, in many, and perhaps most, parts of the fossil record. The time frame for this deposition could have been long enough for rapid microevolution and speciation to occur.

QUALITATIVE PRELIMINARY TESTS OF THE POWER OF WHOLISTIC GEOLOGY TO EXPLAIN RATES OF GEOLOGICAL AND BIOLOGICAL PROCESSES

The wholistic geology theory allows more time for explaining some geological and paleontological phenomena than a traditional flood theory that requires much of the record to be formed in one year. Several thousand years is three orders of magnitude more than one year, and there is a big difference in what can occur during those two different time periods. The following discussion lists several of the important types of evidence pertinent to questions of time, with some preliminary analysis (other lines of evidence are also important, but this is a beginning).

Methods are needed for testing between different biblical hypotheses of geologic history. The following lines of evidence will then be utilized in proposing such tests.

Sedimentation rates

As Sadler (1981) pointed out, there does not seem to be nearly as much sediment in the geologic column as is expected from modern sedi-

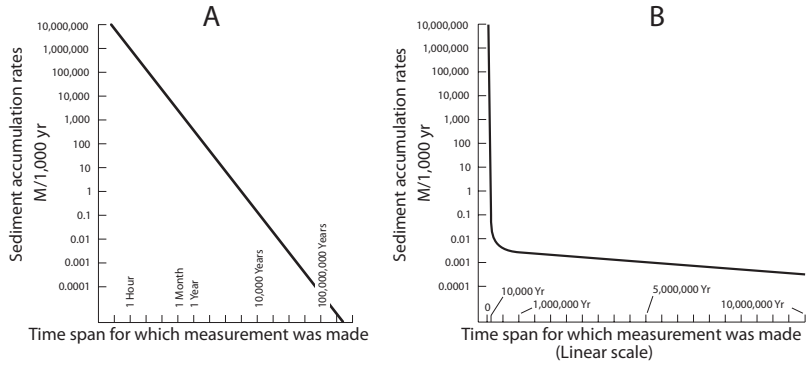


Figure 2. Relationship between sedimentation rates and the time span over which the measurements were taken (after Sadler 1981). A - average sedimentation rates, on a log/log scale; B - same data but with time plotted on a linear scale.

mentation rates. The wholistic geology theory proposed here gives an explanation for that observation. Ancient rates of sedimentation in Sadler's graph were determined by measuring thickness of sediment between radiometrically dated units (far right side of graph in Figure 2). The wholistic geology theory proposes that radiometric processes do not give a true measure of time, at least for the Phanerozoic, and the average rates of geological processes in the past were much faster than shown in the graph in Figure 2.

Table 2. Sample rates of sediment accumulation for different amounts of time for accumulation of the geologic column, based on the average modern rate. These are only averages, and do not imply that sedimentation was uniform through time.

Average modern rate (Sadler graph, measurement over one year)
~ 150 m/thousand years = 0.15 m/yr

Time for Phanerozoic:	*2,000 yrs*	*5,000 yrs*
Average of 1,500-1,830 m of sediment in Phanerozoic	0.6-1 m/yr	0.3-0.5 m/yr
3,000 m of sediment	1.3 m/yr	0.7 m/yr

Grand Canyon sediments deposited in 1,500 yrs
preflood; 1,530 m of sediment = 1 m/yr

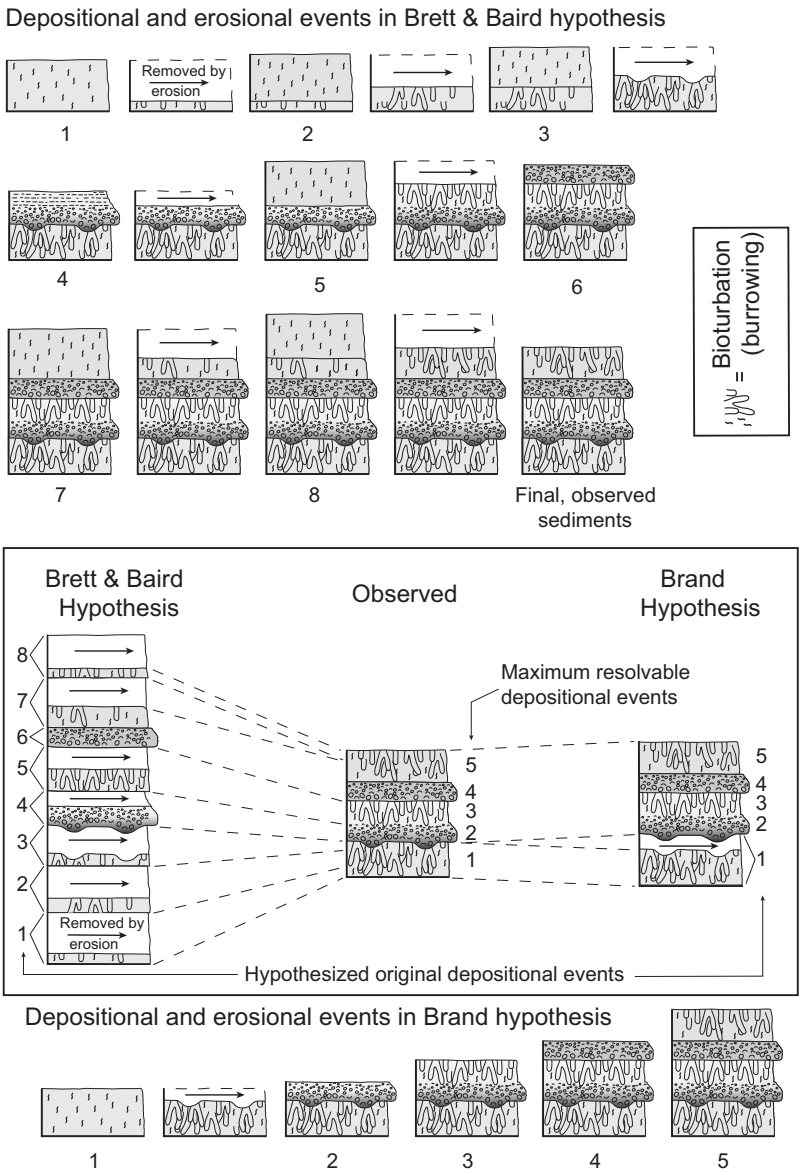
If the thickness of sediment present in the geologic column is measured (average Phanerozoic sediment thickness is 1,500-2,000 m), and compared with Sadler's graph in Figure 2, it appears that in the wholistic geology theory the existing Phanerozoic sediments could be deposited by average sedimentation rates that are not more than one order of magnitude higher than modern sedimentation processes averaged over a time period of one year (Figure 2; Table 2). This should probably be increased to up to 2 orders of magnitude faster than modern rates, because in some places the sediment is much thicker than the average of 1,500-2,000 m.

This is possibly realistic, and probably rather conservative, if my impression is correct that at least some (and perhaps much) of the Phanerozoic rocks were deposited by more rapid processes than we observe today. This is, however, a very preliminary way of looking at sedimentation rates. We do not really know what was happening without a comprehensive analysis of the effects over time of sediment supply, basin subsidence, and whether basins are draining (closed vs. open basins) (Carroll & Bohacs 1999) in different areas. These are also only *average* rates, and do not mean that processes were occurring at steady rates. There could have been episodes of rapid sedimentation and periods of little activity. There would have been times with very catastrophic processes, especially during the year of the flood proper. However, during the rest of the time *average* sediment accumulation rates may have been only one or a few meters per year, and that can hardly even be considered catastrophic.

It seems to me, from the literature and from my own study, that some significant types of evidence in the rocks point to rates of geological processes that are much too fast for conventional theory based on the radiometric time scale. A wholistic geology theory may come closest to explaining this, since the time frame of this theory can account for the existing sediments with geological processes that are not much faster than is observed today, even in our relatively stable earth.

Figure 3. Comparison of two models to explain the shortage of sediment in the geologic column. Diagrams in box portray the hypothesized original amount of sediment deposited, for each model, and (center) the observed sedimentary record. In the Brett & Baird model (diagram modified from Brett & Baird 1986) there were successive episodes of sedimentation followed by the erosion of part of the sediment before the next sedimentation event. Extensive burrowing by animals obliterated some contacts between sediment layers so that individual layers cannot be distinguished. In the Brand model no sediment erosion is assumed except where indicated by definite evidence of such.

FIGURE 3



The sequences of drawings above and below the box portray the sequence of events in each model. Numbers indicate depositional events, and arrows indicate erosion of the sediment outlined with dotted lines.

The following are some examples of data that do not fit conventional theory well, and may be better explained by a theory that is closer to what I am suggesting:

1. Eocene Bridger Formation, SW Wyoming — radiometric dating requires about 200,000 year cycles between limestones, while taphonomy of the abundant fossil turtles, stromatolites, sedimentological data, etc. can, I believe, be better explained in perhaps 20-100 year cycles (3-4 orders of magnitude difference).
2. Sadler's (1981) data on rates of sedimentation indicate that ancient rates based on the radiometric time scale are 4-8 orders of magnitude slower than modern rates measured over one year (Figure 2).
3. Brett & Baird's (1986) theory (ad-hoc hypothesis) for explaining the missing sediment is shown in Figure 3 (Sadler 1993 proposes a similar theory). His proposal is that there were many episodes of additional sedimentation, but the extra sediment was eroded away and thus not preserved in the rocks. This additional, hypothetical, sediment does not need to be included in the theory I am proposing. We can suggest that the existing sediment is generally close to what was originally deposited, except when there is definite evidence of a significant erosional unconformity.

Rates of biological change

These relatively rapid geological changes and resulting ecological change might also generate faster rates of biological change. Rates of evolution observed today (microevolution and speciation) are much faster than the rates calculated from the fossil record as dated by radiometric dating methods (Figure 4), by 7-10 orders of magnitude. Acceptance of the radiometric time scale requires one to conclude that observed modern evolutionary rates do not reflect reality (e.g., Gould 1997-1998) (another ad-hoc hypothesis?). However, acceptance of the wholistic geology theory would suggest that rates of biological change in the past may have been as fast, and quite possibly much faster on the average, than the rates measured today. If Earth today is more geologically and ecologically stable than it was during much of its history (this would be true in either a traditional flood or wholistic geology theory), it is likely that rates of evolution in the past would have been faster than today (Brand 1997, ch 12; Wood 2002).

In other words, perhaps the geologic and biological data are hard to reconcile with either alternative — most of the geologic record in a one-year flood at one extreme, and millions of years at the other extreme. Real rates of geological and biological change may fit best with a time span of the order of magnitude that this proposed theory suggests.

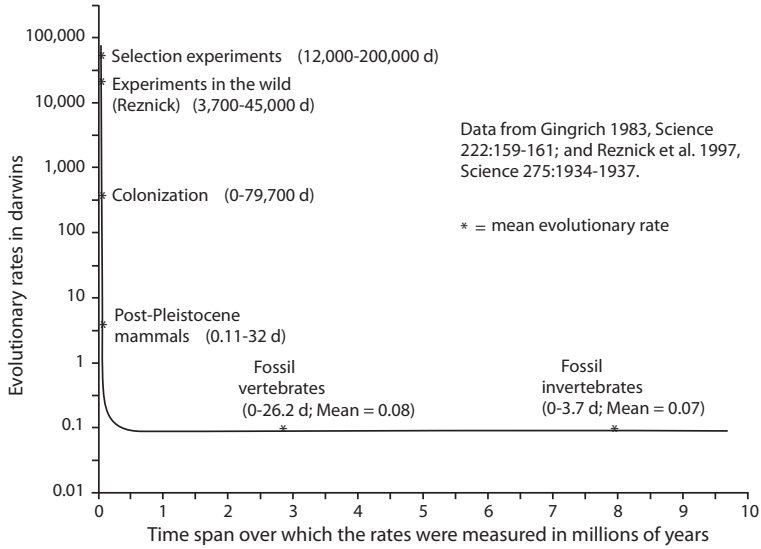


Figure 4. Evolutionary rates measures in modern settings and calculated from the fossil record (fossil calculations based on radiometric time scale). Evolutionary rates are measured in units called darwins. A darwin is a specific, measurable, amount of morphological change.

Paleontological features with time implications

Stromatolites, reefs, extensive bioturbation of some sediments, fossil hard grounds, and other features of biological origin seem to require some time, but not millions of years. Stromatolites (Cooper et al. 1990, p 229-233) and reefs (James 1983, Kiessling et al. 1999) seem to be distributed throughout the fossil record (Figure 5), and this seems impossible to explain in a one-year flood (because each stratigraphic level of reefs, if the reefs formed *in situ*, would require several years to hundreds of years to grow). More study is needed, but it seems likely that these features can be more readily explained in the time frame of the wholistic geology theory.

Carbonate sediment accumulation rates

Separate from the question of whether a carbonate structure is a wave-resistant reef, is the time required to form extensive amounts of carbonate sediment that formed *in situ*, containing unsorted organic remains that do not appear to be transported assemblages. Ancient reefs (and other carbonate accumulations) are usually much smaller than our biggest modern reefs (e.g., those in the Pacific Ocean), and any that did form *in situ*

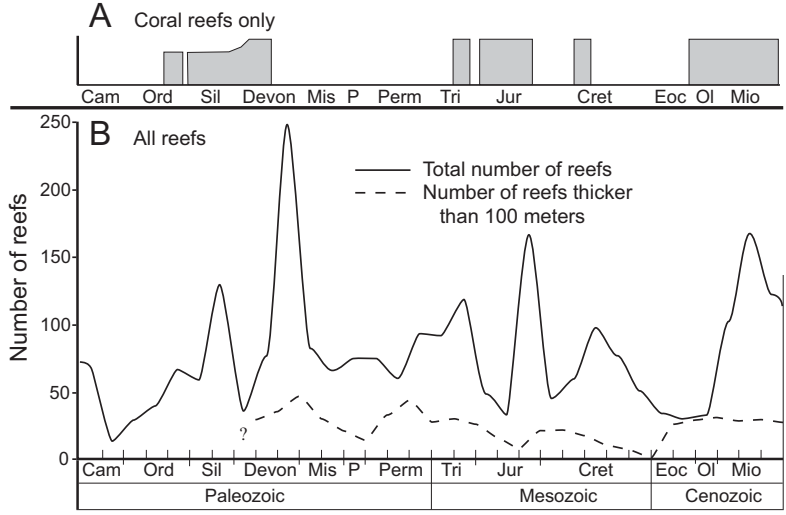


Figure 5. Distribution of reefs in the Phanerozoic fossil record. Data from James 1983, and Kiessling et al. 1999.

would require some time, but perhaps they could develop in a short time frame. This needs much more study.

Evaporite formation

To evaluate the time required to form deposits generally interpreted as evaporites (accumulations of salts from evaporation of large volumes of water) requires that we know what was the actual mechanism that formed them. A geologic record forming in a few thousand years could explain some evaporites, but still predicts that the processes that formed some of these deposits (e.g., the thick sequence of laminated evaporites in the Permian Castille Fm.) are not yet adequately understood. There are still aspects of these processes that are hard to understand within even a wholistic geology theory.

Time to form cyclic sedimentary features

Sediments with tidal cycles (one lamina deposited with each high tide) may represent a time frame consistent with the theory suggested here. Discovery of these tidal cycles has changed the interpreted time for deposition of some rocks from thousands or millions of years, to a few years (e.g., Archer & Kvale 1989, Archer et al. 1995, Brown et al. 1990).

This is still a challenge to a traditional flood theory, but fits well into a wholistic geology theory.

Finely laminated sediments usually interpreted as varves (one layer formed per year) need more study, as this theory predicts that extensive deposits of many thousands or tens of thousands of "varves" do not represent actual annual deposits. In some cases there is already evidence that challenges the varve interpretation. For example, some deposits commonly interpreted as varves contain very abundant fossils that are exquisitely preserved (e.g., the Eocene Green River Formation). There does not seem to be an adequate explanation for how these fossils could be so well preserved unless they were buried rapidly (see below, under taphonomy).

Sedimentary cycles are characteristic of much of the geologic record. These cycles (e.g., successive packages of sediment with repeating features usually interpreted as cycles of raising and lowering sea level over many thousands of years per cycle) are very numerous in some formations. To evaluate the time implications requires that we understand the mechanisms behind these cycles. Some may be actual cycles of water level change, but other mechanisms should also be considered, including possible mechanisms not yet discovered. Turbidites were once thought to represent cycles of several years each, but are now known to form in minutes from underwater mudslides. Perhaps there are cyclic processes yet to be discovered that are quite different from turbidites, but are as undiscovered as turbidites were prior to the 1950s.

Taphonomy

The field of taphonomy (study of the processes from death to fossilization) is producing much fascinating data. Research has shown how important rapid burial is for producing fossils, especially for well-preserved vertebrate fossils. It appears that the implications of this have not been fully explored. Many formations with superbly preserved vertebrates in large numbers (e.g., Green River Fm. fish etc., Bridger Fm. turtles, ancient diatomites with well-preserved whales and other vertebrates [Esperante-Caamano et al. 2002, Brand et al. 2004]) are often interpreted as accumulating very slowly, perhaps centimeters/thousand years with the fossils escaping decay because they are in anoxic water (no oxygen). However, experiments have refuted the hypothesis that anoxic water slows or eliminates decay. Decay is not slower in anoxic conditions, it just involves anaerobic bacteria (Plotnick 1986, Allison & Briggs 1991, Allison et al. 1991). These well-preserved fossils seem to require very rapid sediment deposition.

The other side of the taphonomy data needs to be also thought about. If at least the Paleozoic and Mesozoic were deposited within a year, with systematic ecological processes killing and burying organisms, then most animals must have been buried very soon after death — within hours or days. The problem with such consistently rapid burial is that it should have preserved mostly intact, articulated specimens. However, the vertebrate fossil record (with definite exceptions, as mentioned above) consists mostly of disarticulated, scattered bones and teeth. Most of these disarticulated remains probably required several weeks or months of decay and disarticulation before burial. Is it possible to fit that many episodes (dozens or hundreds of episodes) of several months of disarticulation into a one-year Cambrian to Cretaceous process?

However, if many animals were not buried quickly after their death, how could animals from different ecological zones have been killed and buried in the precise sequence that we see in the fossil record, without mixing up animals from different zones? This is a puzzle for any short age geology theory.

Relationships between fossil living areas and burial sites, and amount of transport

Some flood theories require that many or most organisms be transported up to thousands of kilometers to the areas where they were buried and fossilized**.** This concept introduces problems in explaining some fossil deposits. The wholistic geology theory may not require as much long distance transport, but this needs much more study.

SUGGESTIONS FOR APPLYING WHOLISTIC GEOLOGY THEORY

It seems doubtful that we can or even should try, to use science to disprove conventional geology theory and the evolution of life (in study of the ancient past, proof or disproof is especially unlikely). Rather, our task is to develop alternate explanations for the evidence. That is always a first step for any scientific theory. These theories are unique in having been launched from a platform of faith, but if our faith is based on truth, it will point us in the right general direction. Our search for truth may at times follow a winding path as we test and refine or reject various ideas, but it will in time lead us to more satisfactory explanations for the data. As we search, the farther we get in developing a theory that is able to suggest constructive new research to be done, the more it will have promise of making real progress.

What is the reason for thinking this is important? Some of us believe that Biblical revelation is reliable, even on the topic of the origin and history

of life on Earth. We would be missing something if we fail to utilize these insights to steer us in productive directions in research.

I believe several things are needed at this time to make our flood theorizing efforts productive. A concerted research effort is needed to raise our prospects of success. In recent decades geology has improved its understanding of many processes, and this improved understanding is helpful to us also. And yet there are still many areas where a faith-based theory predicts that new, even radically different, processes are yet to be discovered. If we would do justice to this work, the research must be done with impeccable care and scientific rigor, benefiting whenever possible by the quality control of peer review.

APPLYING THE THEORY TO SPECIFIC PROBLEMS

I believe the following are examples of approaches that will be beneficial and important:

1. Continue, and expand, the types of current or recent research, on specific rock formations such as the Pisco Formation in Peru, the Yellowstone fossil forests, Bridger Formation and Green River Formation in Wyoming, or specific phenomena like paleocurrents.
2. Learn more about geology in other parts of the world. We often base much of our thinking on North American geology. This is a good start, but knowing more about other places will also be helpful. For example, in at least part of the Middle East the Paleozoic is represented by one continuous sandstone which was originally of immense size (Burke 2000). Above that is Cretaceous limestone, and then the Pleistocene Lisan Formation in the Dead Sea rift valley. What can this sequence, so different from the rocks in North America tell us?
3. Concerted study of phenomena that appear to be "constraints" on the amount of needed time — phenomena that require a considerable amount of time. Examples of these (discussed in more detail below) are the reefs, stromatolites, taphonomic processes like degree of disarticulation and preservation, etc., and what they tell us about time for growth, death and burial. Ultimately these questions should be answerable, if we take our faith-based insights seriously, so we do not need to avoid these challenges.
4. Part of the research on the above mentioned "constraint" phenomena should be asking if they are really constraints, or just clues to the existence of undiscovered processes.

5. Learn more in general about all parts of the geologic column, and the geographical and stratigraphical distribution of features that do seem to remain as genuine constraints.
6. Quantitative comparison of ancient rock formations with equivalent modern analogues. Some ancient formations seem to be of a size scale (individual formations covering over 250 km^2) or character (differences between modern and fossil sand dune fields) that is very different from any modern analogues, and some features seem to imply a faster rate of accumulation than occurs today, or than the radiometric time scale suggests. Careful documentation of these formations and analogues, including quantitative comparisons, would allow more realistic evaluation of how similar or different ancient geological processes were from modern processes.
7. Increased study of changes within various groups of organisms through geologic time, and the sequences of changing forms. Use improved methods to evaluate which types of changes seem to represent actual evolution within created groups of animals and plants (e.g., Scherer 1993, Wood 2002, Wood & Murray 2003). For example, is the sequence of fossil horses an actual postflood evolutionary sequence?
8. Field study of specific locations, applying our theories to one basin at a time. Study stratigraphic sections through the deposits in the basin, and also lateral variations in the sediments and fossils. This type of field work has promise to greatly improve our efforts to understand flood processes.

This research effort would benefit from a managed science approach, in which research funding is available for research directed to the specific goals of the project.

EXAMPLES – APPLICATION OF THE THEORY TO TWO SPECIFIC GEOLOGICAL FORMATIONS

Eocene in the Green River Basin, Wyoming: Bridger and Green River Formations

Eocene deposits in the Green River Basin of southwestern Wyoming include the Green River Fm. and the Bridger Fm. The Green River Fm. (GRF) was deposited in ancient Lake Gosiute, and the lower part of the Bridger Fm. represents the flood plain along the edges of the lake. In the concluding phase of the formation of Lake Gosiute, as usually recognized, increasing volcanic episodes from the north began to fill the lake periodically

with thick packages of volcaniclastic sediment which was partly redistributed by fluvial (flowing water) processes. This fluvial deposition formed most of the Bridger Fm., which extends across a significant part of the basin. The Bridger Fm. also contains a series of limestone units, representing basin-wide lakes which existed between episodes of volcanic deposition (Brand et al. 2000, Brand 2007).

Radiometric dates for the GRF and Bridger give a total time span of about 15 million years (Murphey 2001, Smith et al. 2003). The GRF contains tens of thousands of thin laminations (~ $^{1}/_{10}$ mm thick) that are often interpreted as varves, understood as one lamination per year. The Bridger Fm. is interpreted as flood plain deposits from rivers, ponds, marshes, and periodic lakes formed over extensive time periods. The abundant turtles are assumed to have lived in the ponds and marshes, and to have died in large numbers as individual water bodies dried up.

However, several lines of evidence suggest that these long time spans may not be correct. The "varved" deposits in the GRF contain millions of exquisitely preserved fossils. They are mostly fish, but there are also crocodiles, turtles, bats, palm fronds, cattails, insects, insect larvae, and a horse. The vertebrate fossils are typically complete, with bones articulated and well preserved, and the insects and plants are complete with fine details preserved. Even the abundant vertebrate coprolites (fossil dung) are well preserved and 3-dimensional, probably from rapid mineralization initiated by bacterial decay. Such excellent preservation speaks of rapid burial and fossilization. The traditional explanation was death and preservation in a deep, cold lake with anoxic water that prevented decay. But there is evidence that the lake was not very deep (Eugster & Surdam 1973, Surdam & Stanley 1979). Parts of the lake could have still been anoxic, but experiments have shown that anoxic water does not prevent decay or even significantly slow it down (Plotnick 1986, Allison 1988, Allison & Briggs 1991, Briggs & Kear 1994). Also, a study in a GRF site that was in shallow water at the edge of the lake has the same exquisitely preserved small fish, insects, and insect larvae, preserved in the same laminated sediments (Biaggi 2001). The shallow water conditions at this site eliminate the possibility of anoxic water, and the organisms must have been buried in days, not years. Also, the complete horse skeleton and large animals like crocodiles require rapid burial to account for their preservation. In some places there are soft-sediment deformation features in which the laminated GRF was distorted vertically by many meters because of the weight of the overlying sediment. If the laminations represent one layer per year, then the sediment remained soft and un-cemented for millions of years, which seems very unlikely.

In the Bridger Fm., Unit B, most turtles consist of complete or nearly complete shells, almost no skulls, and few limbs. The turtles are not spread vertically through the formation, but occur in several distinct horizons. Each turtle horizon (with up to several hundred turtles per hectare) was a mass mortality event all across the basin, and field and experimental study of turtles (Brand et al. 2000, 2003) indicate the turtles were buried within a few months after their death. Each turtle bed consists of many turtles concentrated in the first few meters of mudstone above a limestone. Above that the turtles do not become more decayed and disarticulated, as we might expect if conditions changed from a mass mortality to more normal conditions. Instead, there are no turtles or extremely few turtles for the next 20-40 vertical m above that, until the next limestone. Most turtle deaths were not from slow dehydration as local ponds dried up, but from catastrophic death all across the basin of several hundred square miles, at the beginning of an episode of volcanism (Brand 2007). The sediment above the turtle layers indicates conditions suitable for turtles, so why are there almost no turtles in the sediment above these mass mortality layers, if there was an average of 200,000 years between limestone-producing lakes? It appears more likely that there was not sufficient time between deposition of successive limestones for turtle populations to build up and produce fossils. Also, the sediment is not of a type that would require thousands or millions of years for its deposition, but could probably accumulate rapidly if there was a sufficient sediment supply and supply of flowing water to distribute it.

This does not prove that the GRF and the Bridger Fm. were rapidly deposited, but the evidence cited here is difficult to explain if at least significant portions of each formation were not formed rapidly. The evidence is not compatible with the geological processes usually assumed to have produced each formation.

Looking at the other side of this issue, could these formations have been deposited in a few days or weeks, as would be required if they and all the rock formations older than them were deposited in a one-year flood? Several lines of evidence do not seem compatible with that interpretation, but seem to require at least several hundred years for the GRF to form. For example, the fossils and sedimentary features in the GRF are distributed in a way that indicates an established lake ecology persisting over a significant amount of time. In the middle of the lake are large fish, and the edge of the lake contains fish fry, cattails, stromatolites, etc., as would be expected in normal living conditions. Fossil burrows of bottom-dwelling animals are abundant in the sediments near the edge of the lake, but not in the middle of the lake. The nature and distribution of stromatolites

is consistent with a lake that periodically expands and then shrinks, from changing water levels, with the stromatolites growing only along the shore. This occurs repeatedly at successive intervals, each stromatolite bed several meters above the previous one.

The Bridger Fm. also contains features that are consistent with a time span of perhaps a few hundred years, but not a one-year flood. The turtles in each turtle layer show evidence of several months between death and burial, because of the amount of decay and disarticulation of their skeletons. Also there are a number of stratigraphic intervals in the Bridger with abundant tufa or stromatolites, including some intervals with tufa growing on turtle shells. The turtles had time to partially disarticulate, and then tufa formed on the shells by chemical precipitation before they were buried. This would not require long ages of time, but more than a few days or weeks.

The evidence discussed above, and other features of these formations, seems most consistent with a time frame of perhaps hundreds of years, rather than either of the extremes of millions of years on one hand, or a few weeks at the other extreme. Radiometric dates are the principal reason why they are interpreted as involving millions of years, but this is hard to reconcile with other lines of evidence. Attempts to explain them as part of the one-year flood seem to arise strictly from a particular religious but extra-biblical philosophical position on Earth history.

Miocene/Pliocene Pisco Formation, coastal Peru

Along the coast of Peru is a sequence of marine sedimentary formations and fossils, from at least Eocene to Pliocene. The Pisco Formation is part of this sequence, beginning in the Miocene and extending into the Pliocene. The accepted interpretation of the Pisco Formation involves about 5 million years for the accumulation of its sandstone and diatomaceous sediments and fossils. This scenario would indicate an average sediment accumulation rate of a few centimeters per thousand years.

The Pisco Fm. contains abundant marine vertebrate fossils, including whales, porpoises, seals, ground sloths (interpreted as semi-aquatic), penguins and other marine birds, turtles, bony fish and sharks. These are typically extremely well preserved, with skeletons articulated or in some cases partly disarticulated but with the bones still closely associated and well preserved. The bones show almost none of the destructive effects of chemical corrosion or burrowing by organisms that occurs quite rapidly in the modern marine environment (Allison et al. 1991, Esperante et al. 2002). The fossil evidence requires burial of each animal within weeks or months at most (Brand et al. 2004). Also, where the sediment is well

exposed there is often evidence that its deposition occurred rapidly from storms or tidal currents, not compatible with slow deposition of a few centimeters per thousand years.

On the other hand, the Pisco Fm. contains evidence that requires more time than is consistent with its accumulating in a few days or weeks. The vertebrates were buried rapidly, but a number of them show evidence of at least several months of decay before burial. Many of the whales are buried in sediment that is mostly diatom skeletons. There is evidence that the diatoms multiplied rapidly in tremendous blooms offshore, and were concentrated, along with the whales, by storms and tidal currents that transported them into shallow bays where the whales sank and were buried (Brand et al. 2004). In spite of the unusual blooms and the concentrating currents it would take some time to produce such a large volume of diatomaceous sediment.

Also there are horizons with features requiring some time for their formation. These include large colonies of small marine tube worms, up to at least two meters across and a meter thick. Such a colony forms from many generations of these very small worms building their calcareous tubes on top of the previous generation of tubes. Some smaller colonies occur on rocks that also have attached oysters and barnacles. These required time for the organisms to grow on the hard rock surfaces on the ocean bottom before burial. These same intervals have layers of phosphate nodules, which require time to form on the ocean bottom. They are accompanied also by abundant flat-pebble conglomerates formed of layers of sediment, approximately a half centimeter thick, that were abundantly burrowed by bottom-dwelling invertebrates. These pieces of burrowed sediment were ripped up by the current and transported, with their edges rounded during the transport process.

The vertebrates in the Pisco Fm. show changes in size and morphological features as one goes upward in the formation. These changes indicate either some type of sorting action during the deposition process, or rapid microevolution and speciation during the time required for its accumulation, or perhaps movement during climatic changes.

The primary reason why the Pisco Fm. is believed to require millions of years is radiometric dating. The sediments and fossils have features that are difficult to reconcile with this long time period. On the other hand, they also contain features that don't seem to fit a time frame of days or weeks. Perhaps a few hundred years would be a more realistic time period for the Pisco Fm.

CONCLUSION

My personal philosophy regarding the attempt to reconcile ancient history with Scripture is that it is not wise to change one's position too readily. If a given theory of geology, e.g., is based on and consistent with Scripture but we do not know how to fit it with the scientific data, that may just reflect the lack of adequate knowledge of ancient processes and especially of how those processes may differ from our modern analogues. This is even more relevant if we have reason to think that ancient processes (e.g., global catastrophe) were quite different from anything we have ever observed. On the other hand, if this impasse does not seem to ease up with more study, and perhaps gets worse, it may be necessary to decide there is something important missing in our theory.

There are those who have done that, and have decided that we need to reinterpret Scripture to fit science as understood by the majority of scientists today. I understand their reasons for doing so, but believe there is reason for some of us to try a different approach — seeking a geologic theory consistent with a more literal understanding of Scripture that includes the global flood. I believe God knows much more about earth history than we do, and has shown a level of interest in communicating with us that is not consistent with an allegorizing of Genesis.

Many puzzling questions remain. For example there were mass extinctions in both the Paleozoic and the Mesozoic. Can any of those fit into a pre-flood scenario? Can they be adequately explained by the hypothesis that these extinctions affected only oceanic environments while mammals, birds, angiosperms etc. were living on the continents, in upland areas? Other questions like these beg for answers.

However, unanswered questions are not unique to wholistic geology, but exist in all geologic theories. Wholistic geology is the hypothesis that a literal one-week creation, literal global flood, short age geology theory does not require that all or most of the geologic column be placed within the one-year of the flood. This opens up other possibilities that should be carefully and prayerfully pursued and tested by comparison with the data.

Even this concept will require extensive research and consideration of new ways of explaining some phenomena, different from already understood geological processes. This wholistic geology theory should be studied, not assumed to be correct, but also not rejected out of hand because it is different from what we have believed.

ACKNOWLEDGMENTS

The basic ideas presented here are not new with me, but have come from discussions and time in geology field work with various persons,

representing varying philosophical perspectives, who may or may not wish to have their names associated with this topic. Most important, I am thankful that God cares enough to give us guidance to help us find our way through the challenges that some scientific interpretations present to Scripture.

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ANNOTATIONS FROM THE LITERATURE*

BIOGEOGRAPHY: HIGH DIVERSITY IN DEEP ANTARCTIC WATERS

Brandt A, Gooday AJ, Brandão SN, Brix S, Brökeland W, Cedhagen T, Choudhury M, Cornelius N, Danis B, De Mesel I, Diaz RJ, Gillan DC, Ebbe B, Howe JA, Janussen D, Kaiser S, Linse K, Malyutina M, Pawlowski J, Raupach M, Vanreusel A. 2007. First insights into the biodiversity and biogeography of the Southern Ocean deep sea. *Nature* 447:307-311.

Summary. The fauna of the deep sea around Antarctica is more diverse than previously expected. Three sampling expeditions were conducted in the area from 2002 to 2005. A high proportion of the species collected were new to science and apparently endemic to the deep Southern Ocean. Several groups have diversity equal to or greater than that known for tropical deep sea faunas. The continental shelf is much deeper than average, and contains a mixture of species from the deep sea and the continental slope. The polar front is a barrier for pelagic species, but benthic species can disperse freely beneath the front. The extent of endemism seems related to larval ecology.

Comment. The deep sea has traditionally been thought to be depleted in biodiversity, due to the extreme environmental conditions. Recent exploration and discovery is modifying that view.

DEVELOPMENT: DIFFERENT PATHWAYS FOR DIFFERENT BODY PLANS

Dunn EF, Moy VN, Angerer LM, Angerer RC, Morris RL, Peterson KJ. 2007. Molecular paleoecology: using gene regulatory analysis to address the origins of complex life cycles in the late Precambrian. *Evolution & Development* 9:10–24.

Summary. Both protostome and deuterostome bilaterians produce free-living planktonic larvae with a specific arrangement of cilia on their surface which allow them to swim and feed as plankton. Protostome trochophore larvae and deuterostome dipleurula larvae from the red abalone *Haliotis*

*Other annotations are available on our website: www.grisda.org

rufescens and purple sea urchin *Strongylocentrotus purpuratus* respectively, both have an apical tuft which Dunn *et al*. show to be the product of different developmental pathways. Based on this, they suggest that, despite morphological similarity in their larvae, protostomes and deuterostomes independently evolved planktotrophic (plankton-feeding) larvae from dipleurula (yolk-feeding) larvae.

Comment. The results of molecular studies seem regularly to require more complex evolutionary pathways to accommodate the data. This study illustrates this phenomenon as it eliminates the simpler possibility of a planktotrophic stage evolving in an ancestor that then evolved into both protostomes and deuterostomes. Instead convergent evolution has to be invoked to account for both the similar morphology and survival strategy of the larvae in these two profoundly different groups. But if the larvae really are constructed using different gene regulatory pathways, it is not clear why common ancestry and not polyphyly would be inferred in the first place.

GEOLOGY: A BRITISH MEGAFLOOD

Gupta S, Collier JS, Palmer-Felgate A, Potter G. 2007. Catastrophic flooding origin of shelf valley systems in the English Channel. Nature 448:342-345.

Summary. Detailed mapping of the floor of the English Channel reveals landforms that indicate formation by a very large flood. Scouring of the seafloor formed islands that are elongated in the direction of flow of the flood current. Additional longitudinal scours are parallel to the direction of flow. These features resemble similar features seen in the Channeled Scablands and attributed to the great Missoula Flood. Further evidence of flood erosion is seen in crescent-like scours that meet upstream in V-shaped headcuts. Evidence for a second megaflood is seen in a bedrock bench at the valley margin. There, the seafloor has been rapidly eroded, forming a "hanging tributary" where a paleo-river flowed into the valley. The source of the water is believed to have been a large glacial lake formed when advancing ice sheets created a dam in the North Sea between Scandinavia and Britain. This dam trapped water between the ice sheet, the European continent, and the Weald-Artois Anticline connecting Britain and Europe at Dover. As the resulting lake filled with water, it eventually breached the rock dam at Dover, and eroded the dam. The result was permanent separation of Britain from the rest of Europe. The Channel megafloods were among the largest of several known glacial megafloods.

Comment. The role of catastrophe is increasingly recognized in earth history. Large-scale flooding can rapidly accomplish geological changes that would otherwise take long periods of time, or more likely, not occur at all. The size and scope of such floods serve as illustrations of the possible effects of a global flood.

GEOLOGY: SNOWBALL EARTH IN DOUBT

Eyles N, Januszczak N. 2007. Syntectonic subaqueous mass flows of the Neoproterozoic Otavi Group, Namibia: where is the evidence of global glaciation? Basin Research 19:179-198.

Summary. Sediments of the Otavi Group are located along the southern margin of the Congo Craton in Namibia. The Otavi Platform is a shallow-water carbonate shelf that transitions southward into the deepwater Outjo Basin. The basin contains poorly sorted sediments that include breccias, conglomerates and turbidites. These sediments were deposited in deep water at the foot of steep scarps formed by faulting along the margin of the Congo Craton. These sediments have been interpreted variously as glacial deposits or as mass flows. This paper concludes the evidence does not support a glacial origin, but interprets the sediments as the result of mass flows in deep water along the margin of the craton. Interpretation of glacial origin was based on the lack of sorting of the clasts, but the lack of striation or glacial clasts does not fit with this interpretation. Poorly sorted sediments may also be produced by mass flows, and this interpretation is favored. The presence of turbidites indicates subaqueous deposition, while the similar lithologies of the clasts, largely carbonate, indicate a common source. The angular nature of the breccias indicates a nearby source for the sediments, which are mixed with more rounded clasts from higher on the slope. The depositional setting includes steep slopes leading to deep water along a cratonic margin, where mass flows would be expected. This combination of features points to a mass flow regime, not a glacial origin. The non-glacial origin of these sediments removes the basis for proposals of a "Snowball Earth" in the Proterozoic.

Comment. Some authors have proposed a "Snowball Earth" scenario during Neoproterozoic (Upper Precambrian) sedimentation, in which most or all of the earth was covered by glaciers. This idea has grown in acceptance and has been widely publicized in the media. However, many geologists have remained skeptical because it is not well supported and because it fails to explain some of the data. The "Snowball Earth" hypothesis was largely based on the presence of unsorted sediments in areas that paleogeographic reconstructions place at tropical latitudes, and grew out

of earlier interpretations of the Otavi Group in Nambia. This interpretation is no longer viable, since the Otavi Group sediments are not glacial, but mass flows, similar to those found commonly throughout Phanerozoic rocks.

MOLECULAR PALEONTOLOGY: COLLAGEN FROM FOSSILS

Asara JM, Schweitzer MH, Freimark LM, Phillips M, Cantley LC. 2007. Protein sequences from *Mastodon* and *Tyrannosaurus rex* revealed by mass spectrometry. Science 316:280-285.

Summary. Fragments of the protein collagen have been recovered from bones of a fossil mastodon and a fossil dinosaur and sequenced by mass spectrometry. Collagen was abundant in the mastodon bone, putatively 160,000 to 600,000 years old. About one-third of the alpha-1-t-1 collagen strand was sequenced in the mastodon, and at least four short sequences were found to be unique to that species. Collagen was much more difficult to recover from the dinosaur bone, but seven sequences could be aligned with amino acid sequences of collagen from other vertebrates. This study shows that mass spectrometry can be used to determine amino acid sequences from very tiny amounts of protein.

Comment. Collagen is an important and very common protein that has been reported from numerous other fossils. Preservation of soft tissue was reported for the same dinosaur specimen, so the identification and sequencing of collagen seems well established. It is less clear how such material could survive intact for millions of years. This report seems less surprising to those who favor a short chronology for the presence of life on Earth.

PALEONTOLOGY: EVIDENCE OF PROBABLE ASPHYXIATION IN FOSSILS

Faux CM, Padian K. 2007. The opisthotonic posture of vertebrate skeletons: postmortem contraction or death throes? Paleobiology 33:201-226.

Summary. The condition of a fossil may provide information about the environment in which the organism lived and died. Vertebrate fossils in which the bones are still articulated indicate rapid burial and preservation. Many articulated dinosaurs and certain other vertebrates are preserved with the head drawn back over the spine and the legs extended – a condition known as opisthotonus. Several explanations have been offered for the opisthotonic condition, the most commonly accepted one being that it

reflects changes that occurred to the skeleton after death. However, this explanation has not been substantiated experimentally, and seems at odds with the necessity for rapid burial to preserve skeletal articulation. Several experiments were done to test various hypotheses proposed to explain opisthotonus. The experiments showed that opisthotonus is not induced post-mortem, but is the result of death throes involving injury to the central nervous system. Probable causes include asphyxiation, poisoning, trauma, disease or nutritional deficiencies. Opisthotonus appears to be restricted to birds, dinosaurs, pterosaurs and placental mammals. Death from asphyxiation caused by volcanic ash or drowning, followed by rapid burial, seems particularly likely to explain many of these fossil specimens. This change in understanding will impact the interpretation of many paleo-environments in which opisthotonic specimens have been found.

Comment. The proffered explanation has been available for many years in the clinical literature, as noted in the article. Nevertheless, poorly supported explanations of opisthotonus have been uncritically accepted for decades. This should give us all cause to think critically, even about the "scientific consensus." The new understanding is congenial to a flood scenario, as drowning is a major cause of asphyxiation. However, it should not be taken as proving a flood; asphyxiation from volcanic ash is thought to be responsible for at least some of the opisthotonic specimens. Of course, volcanic ash is not unexpected in a global flood catastrophe, and widespread death by asphyxiation would be expected in such a catastrophe.

PALEONTOLOGY: SWIMMING DINOSAURS?

Ezquerra R, Doublet S, Costeur L, Galton PM, Perez-Lorente F. 2007. Were non-avian theropod dinosaurs able to swim? Supportive evidence from an Early Cretaceous trackway, Cameros Basin (La Rioja, Spain). Geology 35:507-510.

Summary. A dinosaur trackway with twelve consecutive scratch-like footprints has been discovered in Lower Cretaceous lacustrine sediments in northern Spain. The footprints have characteristics of theropod dinosaurs. Tracks left by the left foot are oriented in parallel with the direction of the trackway, while tracks produced by the right foot are oriented at a 40 degree angle with the trackway. This is interpreted as indicating that the animal was swimming across a current flowing from left to right. Although other possible evidence of dinosaur swimming have been proposed, this is the first definitive evidence that dinosaurs could, in fact, swim.

Comment. The evidence offered here indicates that a dinosaur left marks in the bottom of a lake while trying to cross a current in a body of water. However, it may not indicate anything about the normal habitat of the dinosaur. Theropods seem unlikely inhabitants of aquatic habitats, and this individual may have accidentally slipped into the water, or perhaps was caught in a storm. Interestingly, there are numerous examples of dinosaurs, mostly hadrosaurs, buried in marine sediments.[1] Whether this represents the natural habitat of these dinosaurs is somewhat doubtful, although perhaps some species inhabited coastal regions. Fossil preservation is often an exceptional event and does not necessarily reflect the normal habitat of these animals.

ENDNOTES

1. (a) Coombs WP, Deméré TA. 1996. A Late Cretaceous nodosaurid ankylosaur (Dinosauria: Ornithischia) from marine sediments of coastal California. Journal of Paleontology 70:311-326; (b) Fiorillo AR. 1990. The first occurrence of hadrosaur (Dinosauria) remains from the marine Claggett Formation, Late Cretaceous of South-central Montana. Journal of Vertebrate Paleontology 10:515-517; (c) Horner JR. 1979. Upper Cretaceous dinosaurs from the Bearpaw Shale (marine) of South-central Montana with a checklist of Upper Cretaceous dinosaur remains from marine sediments in North America. Journal of Paleontology 53:566-577.

SPECIATION: PARALLEL SPECIATION IN SONGBIRDS

Ryan PG, Bloomer P, Moloney CL, Grant TJ, Delport W. 2007. Ecological speciation in South Atlantic island finches. *Science* 315:1420-1423.

Summary. Small songbirds on two islands in the South Atlantic Ocean appear to provide an example of ecological speciation in parallel. Two species of buntings in the genus *Nesospiza* are found on both Nightingale and Inaccessible Islands in the Tristan da Cunha group. Each island has an abundant species with a small beak and an uncommon species with a large beak. The two forms are reproductively isolated on Nightingale, and partially so on Inaccessible. However, molecular evidence reported in this study suggests that the forms on each of the islands are more closely related to each other than to the similar form on the other island. Assuming the ancestral form had a small beak, forms with large beaks must have evolved independently. This appears to be an example of ecological selection, where speciation was driven by differences in size of seeds used as food.

Comment. It is conceivable that speciation in response to habitat and food differences could also occur on a continental scale. This would promote rapid diversification of a lineage. Molecular phylogenies with

closely bunched branches and inconsistent tree structure might be explained as the result of rapid radiation following an immigration event. Beak size is easily changeable; see annotation in newsletter 7 (2006) at http://grisda.org/newsletter/07.pdf.

SPECIATION: SIZE DIFFERENCES IN DOGS

Sutter NB, Bustamante CD, Chase K, Gray MM, Zhao K, Zhu L, Padhukasahasram B, Karlins E, Davis S, Jones PG, Quignon P, Johnson GS, Parker HG, Fretwell N, Mosher DS, Lawler DF, Satyaraj E, Nordborg M, Lark KG, Wayne RK, Ostrander EA. 2007. A single IGF1 allele is a major determinant of small size in dogs. Science 316:112-115.

Summary. Dogs are noted for diversity in size. Variation in the gene for insulin-like growth factor 1 (IGF1), gene is located on chromosome 15, shows a strong correlation with size differences. Nearly all of 463 Portuguese water dogs studied had only two sequence types for this gene. Dogs homozygous for sequence type "B" are smaller than those with sequence type "I," and have lower serum levels of IGF1 protein. Comparison with other breeds confirmed that all 14 sampled small dog breeds have the "B" sequence. Rottweilers, a large breed, also has the "B" sequence, showing that other genetic factors are involved. Nonetheless, it appears that the "B" sequence type is a major determinant of size among dogs.

Comment. This study is a reminder that small genetic differences can sometimes account for large morphological differences. Species with genetic systems such as this may be able to diversify into many morphological forms in a relatively short time period, as appears to be the case with domestic dogs and their wild relatives.

LITERATURE REVIEWS

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MAKING IT ALL UNCOMFORTABLY CLEAR

The Politically Incorrect Guide to Darwinism and Intelligent Design. Jonathan Wells. 2006. Washington, DC: Regnery Publishing. 273 p. Paper $19.95.

Reviewed by Timothy G. Standish, Geoscience Research Institute

Jonathan Wells is widely known for writing *Icons of Evolution*,[1] a book that some consider the most useful book yet produced by proponents of Intelligent Design (ID). In *The Politically Incorrect Guide to Darwinism and Intelligent Design* (*PIGDID*) Wells continues his skewering of Darwinism and, unsurprisingly, this new book has received the same scorching reception that *Icons* did. Darwinist P. Z. Meyers was so upset by Well's critique of Darwinism that he lashed out in his blog with the all-purpose standby *ad hominem* accusation of misquoting experts, adding a frenetic "Literally. He is actually that dishonest"[2] just to ensure readers get the point. As is common with sneering accusations against opponents of Darwinism, the facts support the accusation no better than they support Darwinism itself.[3]

Wells writes with just the kind of clarity that lays bare Darwinism's wizened underpinnings. This is wonderful for those who seek to understand what is going on in the frequently complex and obscure arguments that surround Darwinism and ID. For those who wish to continue using hot air instead of actual data and logic to support Darwinism, this has to be a very uncomfortable and public stripping down. Why new arguments are not forthcoming to replace those that have been refuted is mysterious. Maybe contentions like, "[Gill] slits are found in the embryos of all vertebrates because they share a common ancestor: fish in which these structures first evolved."[4] really are the best that Darwinism has to offer. Charles Darwin himself seemed to think so: "Embryology rises greatly in interest, when we look at the embryo as a picture, more or less obscured, of the

progenitor, either in its adult or larval state, of all the members of the same great class."[5] Why this is nonsense requires reading the book.

In fairness to Wells' most vocal critics, he leaves them little option other than to attack his honesty, religion and competence. Clearly he has them trumped when it comes to logic and data, so *ad hominem* attacks are all that are left to respond with. Opponents of ID are not about to admit defeat on the basis of logic and data when, in the first place, their arguments frequently operate independent of both.

One criticism that may have some validity is that *PIGDID* is merely a rehash of *Icons of Evolution*. In some ways that is true, but *PIGDID* is much broader in scope and clearly targeted to a different audience than *Icons*. The language is simpler and less knowledge of science and scientific thinking is assumed. This makes it an easy read for anyone with a high school education. In addition Wells' first book concentrated on ten incoherent arguments or factually untrue claims used to indoctrinate students into Darwinism. *PIGDID* addresses much of the dust that has been kicked up around ID including the court cases, constant attempts to entangle it with religion and the tiresome claim that the ID is not discussed in peer reviewed literature. It addition, it explains the positive arguments for ID including such things as information encoded in DNA and molecular machines inside cells.

Most readers will appreciate the concise and clear way that Wells covers a broad range of topics related to ID. Some may find the politically conservative slant found in all *Politically Incorrect Guides* somewhat off-putting. Clearly this is a book written with conservatives in mind and as a result it includes a chapter entitled "Darwinism and Conservatives." On the one hand such a chapter is probably useful when discussing the political climate surrounding ID, but it is less useful to those who simply want to know the arguments and are not concerned about political considerations which seem to have no correlation with the truth of an idea. At the same time, it would have been interesting to see a chapter dealing with "Darwinism and Liberals." An analysis is needed of why the liberal tradition of open mindedness and a free market of ideas has not resulted in a more tolerant and free-ranging discussion of ID in the academy.

The Politically Incorrect Guide to Darwinism and Intelligent Design is the most comprehensive and easily understood guide to ID and Darwinism published to date. It covers a huge amount of territory in remarkably few pages and does so in an engaging style that is both readable and still manages to convey important nuances in the questions it addresses.

It is probably the fastest way to get up to speed on what ID is and why Darwinists react so negatively to it. But reading this book should not be the end of one's study of ID. Other books, for example Denyse O'Leary's *By Design or By Chance*, explain the religious struggles surrounding ID in richer detail and with more historical perspective. The problem for readers today is not, what is a good book to read to get up to speed with ID? Rather, the problem is which great book about ID one should start with. Jonathan Wells' *Politically Incorrect Guide* certainly makes an excellent choice for novices and also for those who wish to understand ID in its broader scientific and sociological perspective.

ENDNOTES

1. Wells J. 2000. *Icons of Evolution: Science or Myth?* Washington, DC: Regnery Publishing, Inc.
2. See http://www.pandasthumb.org/archives/2006/08/the_politically_3.html.
3. P. Z. Myers' obscure accusation is that Wells uses a quote talking about one stage of development as if it applied to a different stage. Unfortunately, Myers appears to have only read a sidebar quote on p 35 and failed to note the longer version of the same quote earlier on p 30 and 31 of *PIGDID*. In neither case does Wells relate the quote to the stage Myers says he does and in the full quote Wells includes the stage Meyers accuses him of being "that dishonest" about; an obscure misrepresentation that might slip by the ignorant.
4. Ayala FJ. 2006. *Darwin and Intelligent Design.* Minneapolis, MN: Fortress Press, p 35.
5. Darwin CR. 1872. *Origin Of Species By Means Of Natural Selection, Or The Preservation Of Favoured Races In The Struggle for Life,* 6th Edition. London: John Murray, p 396.

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THE GODFATHER OF INTELLIGENT DESIGN

Darwin's Nemesis: Phillip Johnson and the Intelligent Design Movement. William A. Dembski, editor. 2006. Downers Grove, IL: IVP Academic. 357 p. Paper, $25.00.

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It was Clarence Darrow, the silver-tongued court-room lawyer, who guided the evolutionary forces during the Scopes "Monkey" trial early in the 20th century. Although technically he lost the case, many believe that he scored a victory in the court of public opinion for freedom of inquiry and scientific thought. At the end of the 20th century another lawyer, Phillip Johnson, sought to do for the anti-evolutionary theory of intelligent design what Darrow did for evolution — to give it a hearing in public discussion. To this end, he not only wrote extensively, but collaborated with a group of like-minded scientific thinkers to launch the Intelligent Design (ID) movement. This project has provided arguably the most intellectually credible challenges to anti-materialist scientific thought in over a century.

Just how did a Berkeley criminal law professor become the intellectual godfather of a late 20th century scientific revolution? It says a great deal about the philosophical and rhetorical basis of evolutionary theory that it took someone trained in logical reasoning and rhetoric, rather than in the sciences, to spearhead such a high profile assault. *Darwin's Nemesis* explores Johnson's story and examines the impact he has had on scientists and educators.

Original pagination was p 44-47.

The book is a festschrift, or celebration volume of essays, presented to Johnson by friends. The authors are scientists and philosophers of science who knew and benefited from Johnson's work and analysis. Not all essays are by those who agree with him. Such was his credibility and magnanimity that even a number of his ideological foes became friends, desirous of honoring him. The essays range from personal remembrances and anecdotes of Johnson, to descriptions of the influence of his thought on scientific careers, to at least one full length scientific research paper on intelligent design theory.

The book is at its liveliest when personal stories are told. Such is Steve Meyer's recollection of his first meeting with Johnson at a Greek restaurant, where Johnson details his pilgrimage from materialism to evolutionary skeptic. It began with a trip to the British Natural History Museum, where a controversy over an evolutionary exhibit launched him into an examination of the creation/evolution literature in the late 1980s. His skeptical legal antennae were aroused by the often heated rhetoric employed by evolutionary apologists. He began to suspect that argument and rhetoric were being used to fill basic evidentiary gaps. By 1988, Johnson fleshed out these suspicions into a manuscript that served as the basis for *Darwin on Trial*.

Michael Behe then picks up the story. A microbiologist and committed Catholic, Behe had encountered meaningful scientific critiques of evolution early in his career, but did not know what to do with them. He was, as he describes it, reduced to "muttering rude things about evolution to innocent passersby." But then he encountered *Darwin on Trial*. Suddenly Behe had a larger framework in which to place the various scientific critiques and evidentiary shortcomings of evolution. Formerly he was haphazardly picking at genetic loose ends and fingering disparate evolutionary gaps. But now he had an affirmative, coherent critique of the materialistic philosophy of evolution which unified his criticisms.

But perhaps more impressive than Johnson's unifying influence on previously isolated anti-evolutionist thought was his ability to persuade evolutionary fundamentalists of the errors of their dogma — or perhaps more accurately, of the fact of their dogma. The typical conversion story consists of theistic evolutionists realizing, with Johnson's help, that materialist evolution was based far more on philosophical presuppositions — dogma — rather than observed facts. Such is the story described by Jay Richards who, despite being a seminary student, was a theistic evolutionist until he read Johnson's work.

The stories of personal inspiration and change are fascinating. But the feature that makes Johnson's work so spectacular, or notorious, depending on one's view, is its implications for science education and funding. If evolution and intelligent design are basically equal mixtures of "facts" and "philosophy," why should the full force of our tax dollars be used to champion one — materialistic evolution — and be forbidden from investigating the other? William Dembski and Francis Beckwith explore the increasingly heated public debate over intelligent design and education. Timothy Standish contributes a provocative chapter on the implications of Johnson's work for Christian schools. Standish argues that believers in creation should also give students the tools and ability to discriminate among a wide range of ideas, and avoid merely indoctrinating them into received orthodoxies.

There is much more, including chapters on scientific analysis and critiques of intelligent design, a delightful duo of short stories by David Berlinski that tweak both evolution and intelligent design, discussions of intelligent design and natural law, and a comparison of young-earth creationism with intelligent design. (The short description of this latter issue would seem to be that intelligent design is a large umbrella which neither mandates nor excludes a wide range of creationist positions, including young-earth creation.)

The kind and elegant short forward by U. S. Senator Rick Santorum is important for the reminder of the political implications of Johnson's work. One must be exceedingly cautious when dealing with the line between church and state. But the enforced orthodoxy of materialistic evolution for the last several decades is arguably the most widespread, ongoing, violation of the Establishment Clause in our country today. Rather than violating the United States Constitution, allowing the intelligent design critique of evolution to be discussed in public schools would actually reduce the existing constitutional problems inherent in enforcing a philosophical, materialistic orthodoxy.

Clarence Darrow, if he were alive, might not like this result. But if he were honest about it, he would have to admit that the freedom of inquiry he sought for evolution logically includes critiques of that theory. In that sense, he might find himself joining Johnson as a nemesis of Darwin — or at least of the current establishment of Darwinian orthodoxy.

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A RESPONSE TO IRREDUCIBLE COMPLEXITY

Compositional Evolution: The Impact of Sex, Symbiosis, and Modularity on the Gradualist Framework of Evolution. Richard A. Watson. 2006. Cambridge, MA: The MIT Press. 324 p. Hardcover, $50.00.

Reviewed by H. Thomas Goodwin
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Berrien Springs, Michigan

A gradualist Darwinian framework pervades public discourse about evolution. Critics of evolution urge the impossibility of evolving complex, interdependent biological systems in a gradual, step-by-step manner because the intermediate steps would be non- or maladaptive and thus would not be preserved by natural selection (e.g., Behe 1996). Evolutionary apologists counter by arguing for the feasibility or even inevitability of such gradual, cumulative evolutionary pathways (e.g., Dawkins 1996).

Which argument is correct? Perhaps neither is — or so claims Richard Watson in *Compositional Evolution*. Watson, a University of Southampton lecturer in computer science, primarily supports this claim by formal analysis of models in evolutionary computing, a discipline inspired by biological variation and natural selection that seeks to develop problem-solving strategies. Fortunately, Watson is also well informed on biological theory, and his analysis is explicitly shaped by (and brought to bear on) concepts of biological evolution.

Watson develops two interrelated arguments. First, he contends that the gradualist framework of evolution is wedded to a particular class of evolutionary algorithm (random-mutation hill-climbing procedures) that focuses procedurally on step-by-step accumulation of favorable mutations *within* a single evolving lineage. This approach works well when the indivi-

dual attributes of the evolving species may be optimized more or less independently, but fails otherwise. Second, he claims that certain "compositional" processes of evolution (more on this below) are not tied to this gradualist framework, represent a distinct algorithmic class of evolution (so-called divide-and-conquer procedures), and can readily find optimized solutions to complex evolutionary problems that stump gradualism. Thus, he offers a broader framework for understanding evolutionary capability.

Compositional evolution denotes "evolutionary processes involving the combination of systems or subsystems of semi-independently pre-adapted genetic material" (p 3) — processes such as sexual recombination, hybridization, lateral gene transfer, and symbiotic encapsulation (that is, capture of one organism within another to form an integrated whole). In the ecosystem populated by evolutionary computing models, such processes readily solve certain irreducibly complex problems that baffle gradualism — if the attributes of the evolving "lineage" display modular structure in their degree of independence. (In these theoretical organisms, attributes are grouped *within* a module if they show relatively great interdependence — you can't change one without significantly affecting the others — whereas attributes are placed in *separate* modules if they vary independently.) Given this structure, the various modules (attribute sets) can be semi-independently "optimized" in a diverse array of evolving lineages. This diverse set of locally fit "specialist" modules can then be swapped around by compositional processes to find more globally fit "generalist" combinations.

Fortunately for mere mortals such as me, the first 3 chapters provide an excellent, intuitive overview of his argument and access to the relevant theory in biology and evolutionary computing. The final chapter (Ch 10) is similarly accessible, and explores the impact of his argument on the way we view evolution. The core of his argument — complete with dense, formal model articulation and computer simulation — is offered in Chapters 4–9. Watson formally develops a modular test problem (Ch 4), shows that it cannot be solved by gradually accumulating favorable variations within a lineage (Ch 5), and demonstrates that the problem is readily solved by evolutionary computing simulations based on sexual recombination (under certain circumstances — Ch 6) or symbiotic encapsulation (under all circumstances — Ch 7). Watson then formalizes the claim that complex evolutionary problems involving strongly interdependent attributes are essentially unsolvable by gradualistic mechanisms in rational time frames (Ch 8), and shows that compositional mechanisms can exploit variation expressed at various levels of complexity (Ch 9).

For readers of *Origins*, the most important question is whether Watson successfully offers a viable natural mechanism to evolve the complex, interdependent systems so characteristic of life (e.g., Behe 1996). That depends, of course, on the degree to which his computer models mimic salient features of life. For example, compositional evolution only works when a complex problem displays modular structure in attribute interdependency (see preceding discussion). If attributes of a lineage display strong but arbitrary interdependencies (that is, some attributes are strongly interdependent — change of one strongly affects the other — but these interdependencies are not ordered into a modular structure), both gradual and compositional evolution fail. Which of these conditions is characteristic of real-life problems, such as evolving a bacterial flagellum, cellular postal system, or immune system (Behe 1996)? More work is in order.

All Watson's modeling requires a computer — a very complex, designed machine that mimics, with carefully designed programming, aspects of heredity, self-replication of instructions, variation, and selection. Similarly, evolutionary mechanisms, whatever their potential and limits, are only plausible with the biological equivalent: a remarkably complex "machine" capable of heredity, self-replication (of instructions *and* of the machine itself), variation, and responding to selection. Can computational evolution craft the computer? I doubt it.

Compositional Evolution offers important arguments about evolution, which should stimulate further work in evolutionary computing and evolutionary biology as well as discussion among evolution's critics. The excellent introductory and concluding chapters, along with periodic summaries in other chapters, flow well and allow the careful reader with a general knowledge of genetics and evolution to grasp the core arguments, at least conceptually. However, readers who lack significant computer science background will have difficulty assessing the validity of his formal argumentation.

On a final note, I appreciated the professional, civil tone of Watson's work. In particular, Watson repeatedly and directly addressed Michael Behe's critique of evolution (Behe is listed 8 times in the index) without resorting to design-bashing. He disagreed with Behe, but seemed to take his arguments seriously. I wish all participants in the debate — both apologists for and critics of evolution — would follow his example.

LITERATURE CITED

Behe MJ. 1996. *Darwin's Black Box: The Biochemical Challenge to Evolution.* NY: Free Press. 307 p.

Dawkins R. 1996. *Climbing Mount Improbable.* NY: W. W. Norton. 340 p.

LITERATURE REVIEWS

Readers are invited to submit reviews of current literature relating to origins. Mailing address: ORIGINS, Geoscience Research Institute, 11060 Campus St., Loma Linda, California 92350 USA. The Institute does not distribute the publications reviewed; please contact the publisher directly.

SEEING THE FOREST AND THE TREES

A Meaningful World: How the Arts and Sciences Reveal the Genius of Nature. Benjamin Wiker and Jonathan Witt. 2006. Downers Grove, IL: IVP Academic. 257 p. Paper $ 18.00.

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If you were a fortunate child, your mother read you Lamb's *Tales from Shakespeare*.[1] At other times she took out a big book with prints of celebrated paintings and page-long descriptions explaining the greatness of each one. Sometimes she may have allowed you to skip school to visit art galleries, and your father may have taken you around the world so that you could experience the art and history of the Old and New Worlds. Then your high school would have taken you to Saturday night orchestral performances that moved your soul, and your English teacher would have encouraged your interest in Shakespeare, T. S. Eliot and the sonnets and sermons of John Donne.

Perhaps Charles Darwin experienced a childhood something like this, but he somehow lost his love for beautiful literature. As he put it: "later in life I wholly lost, to my great regret, all pleasure from poetry of any kind, including Shakespeare."[2] Darwin's experience is not unique; in fact there are probably many scientists who somehow ceased to thrive on the wonders of art and literature. In *A Meaningful World*, Benjamin Wiker and Jonathan Witt make plain why this is and provide connections that rekindle joy and wonderment at the product of both human and Divine creativity.

Darwinian reductionism dissolves appreciation of the genius behind masterpieces. The human body is merely an arrangement of parts; behavior merely chemical reactions in the brain, paintings only pigments on canvas, sonnets arrangements of words on paper. The words are made from letters and the letters are ink and the ink is chemicals, everything is atoms and

the atoms themselves are electrons, neutrons and protons and the protons are quarks and gluons and ultimately everything is just energy slowly dissipating in a gigantic universe that grinds toward equilibrium and nothingness.

In the Darwinian world, Bach's *Jauchzet Gott in allen Landen!*[3] is the product of sexual selection because fertile women freely mate with musically talented men. The soprano sings not to "Praise God in all lands" but to increase the number of offspring she produces. She and the offspring are collections of atoms that have arranged themselves via chance changes and natural selection into the likes of Montserrat Caballe. How exactly sexual selection would work with the castratos of Bach's time is unclear, but at least we can be sure that they were made of atoms like everyone else.

For the hollow victims of Darwinian reductionism, the orchestra disintegrates into violins, oboes, trumpets and tympani drums, each of which merely moves the atoms which in turn move atoms in our ears resulting in chemical reactions and the feeling of wonder is simply a shadow which may in some way have caused our ancestors to produce more babies. Knowledge is the fragmented product of what natural selection has caused humans to believe and — while the likes of Richard Dawkins may rant about the God delusion[4] that evolution has saddled us with — belief must have been adaptive before humans evolved to the exalted state of Dawkins himself.

Given the empty fading-star world Darwinian reductionism presents, traditional Christianity offers a vivid reality, rich with texture and glowing in the light of a unity of knowledge cemented together by one ultimate Truth, one faith and one God. This symphony of knowledge has been discussed in recent books like Nancy Pearcey's brilliant *Total Truth*,[5] but Wiker and Witt visit this understanding of reality with a clarity and accessibility that is breathtaking. For once readers do not have to be trained scientists or philosophers to understand the hallmarks of genius in nature and human creativity. Rather than having a Biblical and philosophical emphasis like Pearcey's book, *A Meaningful World* is focused on the world of art and nature, making this is a book for those who love art, beauty and elegance, but not just the artistic — the scientists, engineers and mathematicians as well.

A Meaningful World unbuckles the mental straitjacket that scientists get themselves trained into. The heavens part, the rolling forest of knowledge with all its rich interacting and interdependent components is illuminated. This is heady medicine for those who can't see the forest for

the trees. Whether those who insist the forest is only trees and the trees are only atoms will take the medicine and feel the earth tremble, hear the harmony and grasp the vision remains an open question. Those who do so will experience once again the beauty of knowledge, the meaningfulness of words and understand that the joy they experienced from art and prose as a child is not extinguished by a knowledge of nature. In the real world, science and the arts each enrich and complement understanding of the other; both, at their best, are part of and point to the same Truth.

ENDNOTES

1. Lamb C, Lamb M. 1878. *Tales from Shakespeare.* NY: Thomas Y. Crowell.
2. Darwin CR. 1958. *The Autobiography of Charles Darwin 1809–1882 (With original omissions restored; Edited with appendix and notes by his grand-daughter Nora Barlow).* St James's Place, London: Collins, p 44.
3. JS Bach Cantata 51 *Jauchzet Gott in allen Landen!* (Praise God in All Lands!).
4. This is the title of Richard Dawkins recent book: Dawkins R. 2006. *The God Delusion*. NY: Haughton Mifflin.
5. Pearcey NR. 2004. *Total Truth: Liberating Christianity from Its Cultural Captivity.* Wheaton, IL: Crossway Books.