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Articles

- Deposits Remaining from the Genesis Flood:
Rim Gravels in Arizona 1
Michael J. Oard and Peter Klevberg
- The Evolution of Teeth: A Major Problem
for NeoDarwinism 20
Jerry Bergman
- Photographic Essay: Red Rock Canyon
and the Valley of Fire 31
Douglas B. Sharp
- The Geology of the Timbered Hills Group
in Oklahoma 39
John K. Reed

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Departments

Book Reviews

- The Man Who Found the Missing Link*
by Pat Shipman 17
- Refuting Compromise* by Jonathan Sarfati 19
- Understanding the Pattern of Life* by
Todd Charles Wood and Megan J. Murray 28
- Dragons* by Karl Shuker 36
- The Great Turning Point*
by Terry Mortenson 67, 68
- The Secret of Ararat* by Tim LaHaye
and Bob Phillips 69
- The Camellia Lover's Guide to the Galaxy*
by James K. G. Waterhouse 72
- Bones of Contention* by Marvin L. Lubenow 79
- Origins of Existence* by Fred Adams 80

Conference Notes

- On Eugenie Scott's Address to the American
Astronomical Society, Winter 2005 70

Notes from the Panorama of Science

- Geology Beyond Plate Tectonics 73
David J. Tyler
- A Look at Sheldrake's Strange Hypothesis
of Formative Causation 76
Colin Brown

Letters to the Editor 77

Instructions to Authors 81

Membership/Subscription Application and Renewal Form 83

Order Blank for Past Issues 84

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

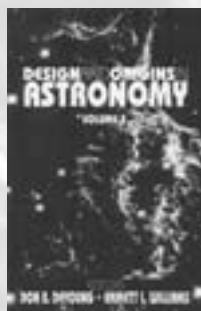
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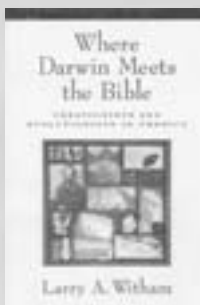
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Deposits Remaining from the Genesis Flood: Rim Gravels in Arizona

Michael J. Oard and Peter Klevberg*

Abstract

Well-rounded coarse gravel provides clues to the depositional process. The coarse gravel of the Mogollon Rim in central and northern Arizona, called Rim Gravel, was examined at two widely separated and representative locations. Further characteristics of the coarse gravel was obtained from the literature. The coarse gravel occupies the highest terrain in the region and is very coarse in east-central Arizona. It is deduced that this coarse gravel was deposited as a sheet and eroded into remnants during the Recessional Stage of the Genesis Flood. We conclude that the Rim Gravel provides evidence that the Flood/post-Flood (D/P) boundary corresponds to the stratigraphic location of rocks termed “late Cenozoic” in the uniformitarian geological column in this part of the western United States. This interpretation is relevant to theories for the formation of many notable geomorphic features, including the Grand Canyon of the Colorado River.

Introduction

Gravel, cobbles, and boulders contain information on the depositional process. They are lumped together and called coarse gravel. Sometimes paleocurrent indicators are present, such as clast imbrication and cross-beds. The degree of rounding of the coarse gravel determines the amount of action by water. Well-rounded coarse gravel is an indicator of significant transport by water during some time in its history. The larger the clasts in the deposit usually the stronger the current needed to transport the coarse gravel. If the coarse gravel is lithified within a matrix, it is called a conglomerate. There are clast-supported and matrix-supported coarse gravels. In the former, the rocks are touching each other with the matrix filling the voids, while in the latter the rocks are almost entirely surrounded by matrix.

Many (if not most) deposits probably have complex

histories, and this is likely the case for the Rim Gravel. For example, material when first eroded may be transported via mass wasting (a debris flow, landslide, slump, etc.). As transport continued, and with the addition of water, the material could have been carried in traction at the bottom of the flowing water. The rounding of coarse gravel would more likely occur during this process rather than from mass wasting. It is also possible that the material was eroded by water, rounded, and then mixed in with fine-grained sediment to become matrix supported at deposition. The fine-grained sediment between clasts could have resulted from the breaking up of subjacent material *in situ* or the erosion of finer-grained upstream substrate during the transport process. Regardless, rounded coarse gravel is an indicator of the action of water.

Uniformitarian scientists would normally interpret rounded rocks as the result of a river or beach process. When they observe rounded rocks, they have a tendency to interpret them as fluvial (Miall, 1996). Generally, one does not encounter littoral (along beaches) environmental interpretations of rounded coarse gravels. Creationist geologists also expect much rounding of rock during the Deluge.

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So, the latter need to carefully examine the characteristics of the coarse gravel to be able to distinguish between a Flood-laid coarse gravel and one laid down in the postdiluvian (post-Flood) period.

One of the distinguishing processes between river deposits and diluvial deposits could be the locations of the coarse gravel deposits. The most intriguing locations are the well-rounded coarse gravels found atop plateaus and mountain

ranges, especially in situations where the lithologies do not outcrop in the landform. Uniformitarian geologists would simply conclude that the coarse gravel was the remnant of an ancient river, but they rarely analyze their deduction in depth. This is where the diluvialist should examine other properties of the coarse gravel, such as its lithology, areal extent, geomorphology, and texture, to see if the deposit matches products of modern fluvial processes.

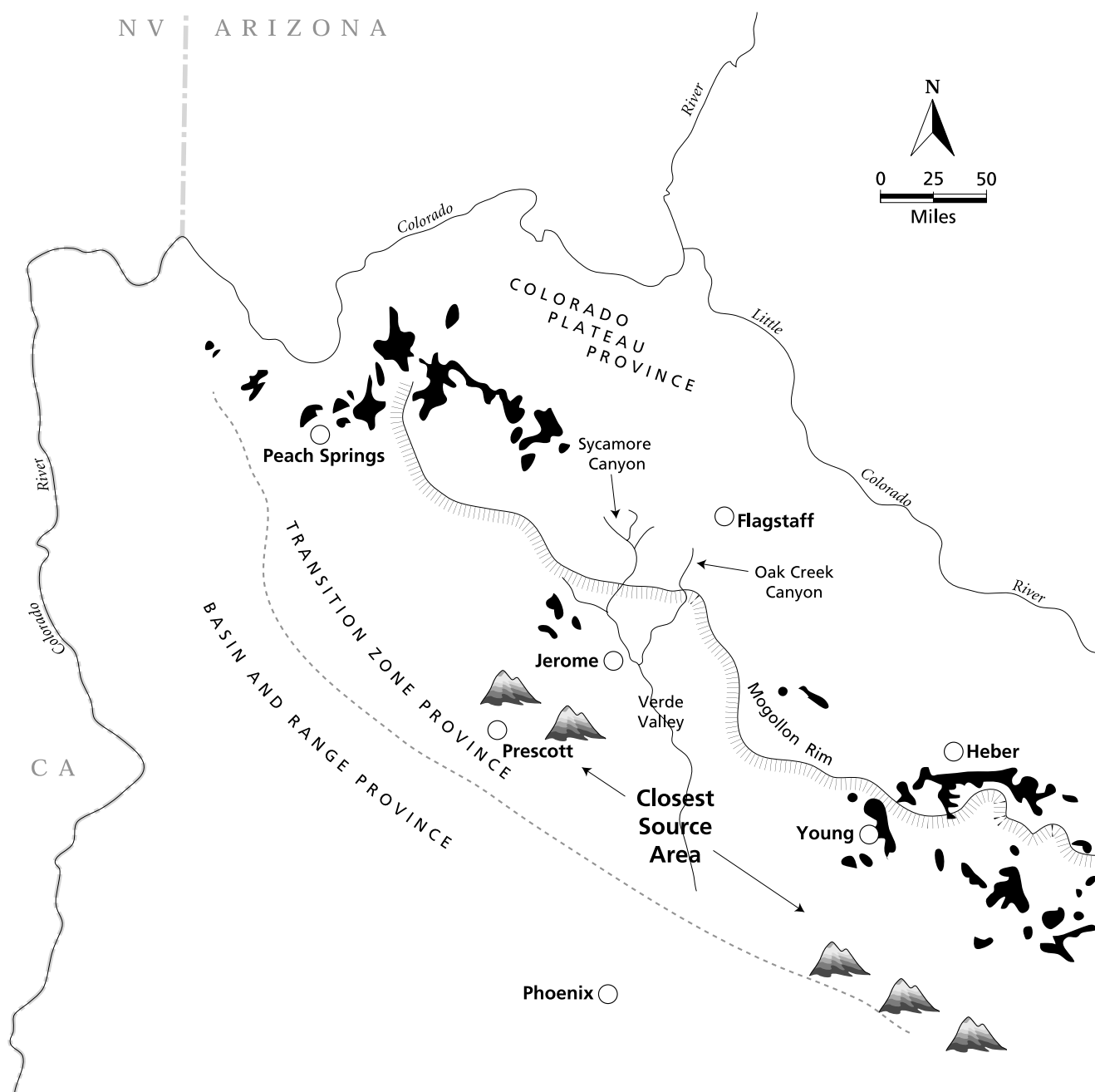


Figure 1. Location of Rim Gravel in Arizona in black (redrawn by Mark Wolfe after Elston and Young, 1991, Figure 1). Physiographic zones of Arizona are also shown. Nearest sources for the Rim Gravel along the northwest and east-central location Mogollon Rim pointed out, but this does not necessarily mean the gravels originated from these locations, since there are many sources to the south and west.

This paper reports on coarse gravel from the southwest rim of the Colorado Plateau in Arizona. This rim is called the Mogollon Rim (McKee, 1951; Young and McKee, 1978) and represents the boundary between the Colorado Plateau and the Transition Zone of mountains and valleys to the southwest. Figure 1 shows the three physiographic zones of Arizona. This rim is a general northwest-southeast escarpment that extends from northwest Arizona into east-central Arizona (Figure 2). It is the edge of a broad plateau-like feature to the northeast. The coarse gravels on and near the Rim are called Rim Gravels (Peirce et al., 1979). This article represents a literature search and a reconnaissance field description from two locations suitably representative but far apart in northwest and east-central Arizona.

Observations of Rim Gravel

Rim Gravel was observed at two widely spaced locations along and near the Mogollon Rim. These locations represent the largest deposits of Rim Gravel. The first location described is in northwest Arizona northeast of Peach Springs on the eastern Hualapai Indian Reservation. The second location is in east-central Arizona southwest of the town of Heber (see Figure 1 for locations). The appendix provides a description of the coarse gravel at these two locations.

Characteristics of Rim Gravel

Uniformitarian scientists have known about the Rim Gravel for at least 80 years (Koons, 1948a). Since this time, there have been many observations and reports on the Rim Gravel. However, there are conflicting interpretations on the ages and origins of the deposits (Holm, 2001). We examined as many data as were available to us from the literature and the field study in this section.



Figure 2. Mogollon Rim in background east northeast across the Verde Valley from the Black Hills west of the old mining town of Jerome, northeast of Prescott.

Geomorphologic Setting

The Rim Gravels in northern and central Arizona occupy a unique location on and near the surface of the Earth. They are often found on the highest terrain of the Mogollon Rim, generally on ridge crests at elevations of 2,100 to 2,400 meters (6,900 to 7,900 feet) (Scarborough, 1989). A number of geologists have noted that the Rim Gravels lie on top of an erosion surface that usually truncates the "Paleozoic" rocks of the Mogollon Rim area (Peirce et al., 1979; Young, 1979; Elston and Young, 1991). The erosion surface has beveled both hard and soft rocks the same, at least in the Sycamore Canyon area (Price, 1950).

This erosion surface has been later dissected in spots to form canyons and valleys. The Rim Gravel likely was reworked from the Mogollon Rim and now occupies the valleys and canyons as well as pediments and lava-capped mesas on the Colorado Plateau (Holm, 2001). Some Rim Gravels have been covered by lava flows that are common in the region (McKee and McKee, 1972). For example, basalt covers an outcrop of gravel in Oak Creek Canyon (Figure 3), a deep canyon perpendicular to the Mogollon Rim (Figure 1) where the city of Sedona is located (Holm and Cloud, 1990). These other gravels have been given a bewildering number of names. There is a question of whether they should be considered true Rim Gravels (Peirce et al., 1979). For the sake of simplicity, we focus mainly on the coarse gravel at and near the top of the Mogollon Rim.

Lithologies

The lithologies of the rocks vary considerably. There is a significant proportion of exotic quartzite in the coarse gravels from the Mogollon Rim. Exotic clasts do not outcrop in the vicinity but are transported from long distance. There is also a large percentage of local "Paleozoic" rocks, especially



Figure 3. Oak Creek Canyon just south of the Mogollon Rim (view south). The east side of canyon covered by a basalt flow with coarse gravel below. West side has been faulted upward over 100 meters (330 feet).

sandstone. It is claimed that there are no local basalt boulders in the Rim Gravels, but only exotic basalts of K-Ar ages older than the gravels (Elston and Young, 1991), which may depend upon the exact definition of Rim Gravel. It is also a suspect conclusion unless geochemical data of statistically adequate number and not just “ages” disprove a connection with basalt flows in the region. Basalt boulders were not observed in the two field areas included in this study. Basalt boulders are present in Sycamore and Oak Creek Canyons cut on the southwest edge of the Mogollon Rim (McKee and McKee, 1972) (see Figure 1 for locations). However, these canyon gravels should probably be excluded from the definition of Rim Gravels. A lack of basalt boulders in the Rim Gravels on top of the Mogollon Rim would imply that the agency that spread the coarse gravel occurred before the widespread volcanism and surficial basalt flows of the region. Inclusion of a few such clasts in the Rim Gravel would imply the contemporaneity of the extrusion and deposition of lava, since the gravel preceded extensive extrusion, yet the extrusion occurred in an environment where boulders could be ripped off and rounded and incorporated into the gravels before the basalt had a chance to flow over and cap them. Further research would be necessary to determine which inference is likely correct. The volcanism is attributed to uplift of the Colorado Plateau and Basin and Range extension in southwest Arizona by uniformitarian geologists (Young and McKee, 1978).

Extent

The coarse gravel is present in many places in northern and central Arizona, especially along and near the Mogollon Rim (Figure 1). In some areas of northwest and east central Arizona the coarse gravel is considered widespread (Koons, 1948b; Lucchitta, 1979; 1989; Peirce et al., 1979; Elston and Young, 1991). There are even locations north of the Grand Canyon (Lucchitta, 1989; Elston and Young, 1991), indicating that the Rim Gravels were deposited before the Grand Canyon was eroded. Koons (1964) estimated that the coarse gravel was up to 76 meters (249 feet) within the extensive surficial outcrops east of the Hualapai Indian Reservation. The coarse gravels are up to 62 meters (203 feet) thick in other locations (Peirce et al., 1979). Based on all these occurrences, it is believed that the Rim Gravels were much thicker and more continuous at one time and have been much eroded since deposition, mainly during “Cenozoic” uplift. Elston and Young (1991) state:

To obtain the existing stratigraphic and topographic distribution of Rim gravels across the Colorado Plateau and adjacent Transition Zone, the gravels must have once formed a thick, virtually continuous regional blanket that buried much, if not all, of the Mogollon Rim, the irregular

erosion surface south of the rim, and the relatively smooth erosion surface developed on resistant strata north of the rim. (p. 12,396)

Thus the outcrops represent erosional remnants after a great amount of erosion (Elston and Young, 1991).

Paleocurrent Indicators

One of the most amazing characteristics of the Rim Gravels is that paleocurrent indicators show directions from the topographically lower south or west (Peirce et al., 1979; Elston and Young, 1991). These paleocurrent directions are especially based on the location of probable source areas, cross-beds, clast imbrication, and orientation of some of the canyons and valleys (McKee and McKee, 1972). Paleocurrent directions in some of the canyon and valley gravels line up with the northeast orientation of some canyons or valleys (Young, 1966; Young and Brennan, 1974).

Source Areas

Some geologists once believed the quartzites were eroded from the Shinurump Conglomerate, at least for the coarse gravels in Sycamore Canyon (Price, 1950). However, the clast size in the Shinurump Conglomerate is too small, and the lithologies do not match (Cooley, 1962). The closest source for quartzite and other igneous and metamorphic exotic rocks of the Rim Gravel in the northwest Mogollon Rim is around the Prescott area, about 80 kilometers (50 miles) to the south (Koons, 1948a; 1964). The closest source for the east central Rim Gravel is not too distant to the south. However, the source of the rocks could be from a number of locations to the south and west where the exotic lithologies outcrop extensively (Conway and Silver, 1989; Anderson, 1989; Wrucke, 1989; Williams et al., 1992; 1999). A very minor amount of rotten granitoids may indicate that the source was not too far away, if they were weathered prior to transport. If weathering occurred after transport, they may have actually been very distant or a small portion of the initial sediment supply.

It is interesting that the altitude of the land south and west of the Mogollon Rim is much lower, and apparently, this difference is not due to significant faulting near the Mogollon Rim, since the rim is considered erosional (Holm, 2001; Williams et al., 1999). While faults with minor vertical offsets are present in the Verde Valley area, Elston and Young (1991) state:

The northern margin of the Transition Zone in central Arizona is an essentially unfaulted, south facing erosional escarpment known as the Mogollon Rim Faulting is not responsible for most of this escarpment. (p. 12,393)

Such low elevations south and west of the Mogollon Rim, where the coarse gravel likely originated, indicate

Table I. Characteristics of Rim Gravel

Characteristic	Observations
Geomorphologic setting	Covers Mogollon Rim erosion surface
Lithologies	Large percentage of exotic clasts; most clasts quartzite and other hard rock types, but Rim Gravel also includes clasts from subjacent strata
Probable source areas	Some clasts correspond with outcrops south and west of Mogollon Rim
Extent	Appears to have been originally continuous from northwest to east-central Arizona
Paleocurrent indicators	Predominant paleocurrent directions reportedly from south and west

that the land used to be higher and that tremendous erosion occurred south of the Rim during the uniformitarian “Cenozoic” Era (Dumitru et al., 1994). This postulated higher terrain south of the Mogollon Rim has resulted in the concept of the Mogollon Highlands that are now eroded to mountains and valleys (Cooley and Davidson, 1963; Scarborough, 1989).

Characteristics of the Rim Gravel are summarized in Table I.

Paleohydrologic Analysis

Paleohydrology is the application of fluid mechanics principles to questions of past fluid motion, including sediment transport. Hydraulic engineering principles are used to determine parameters pertinent to the depositional environment. It is therefore limited to providing minima (occasionally maxima) that may be used to test various historical scenarios that geologists may devise. If a particular story posits flow depths and current speeds too small to transport observed clasts (but not clasts formed *in situ*) over a given paleoslope, then the story does not hold water. Methods used in estimating minimum depths and current speeds have been described elsewhere (Klevberg, 1998; Klevberg and Oard, 1998).

Paleoslope Estimates

Based on paleocurrent directions and the configuration of erosion surfaces, paleoslope can be estimated. It is quite variable in the study area, being least northwest of Sycamore Canyon and steeper in the southeast near the towns of Young and Heber (Figure 1). The gradient was estimated from topographic maps beginning at the current edge of

the Mogollon Rim. Clast size follows this same trend, being least on the gentler slopes of the western Colorado Plateau Province and steeper back of the Mogollon Rim on the southern edge of the plateau, where the paleoslope is a reasonably steep 0.015 (1½ percent).

Bedload Transport Hypothesis

The rounding of clasts observed in the Rim Gravel is consonant with bedload transport. For the estimated paleoslope and observed clast sizes, bedload transport could occur at modest flow depths, low Reynolds numbers, and high Froude numbers. Low Reynolds numbers—in this case less than about 500—indicate laminar flow, though laminar flow can occur in the transition zone above 2,000 (Roberson and Crowe, 1985). A Froude number greater than 1.0 indicates hypercritical or “rapid” flow. A rushing mountain stream will have a Froude number greater than 1.0, while a river with a smooth surface will have a Froude number less than 1.0. These values are based on integrated average current speeds, which typically coincides with the current speed at an elevation approximately 60 percent of the flow depth measured from the stream bottom.

Calculations were performed using the Keulegan and Chezy equations (Klevberg and Oard, 1998). These were checked by using Manning’s equation to determine the n value for the stream bottom to achieve the velocities calculated using the Chezy equation. The resulting Manning n values are approximately 0.025, which is about average for earth canals and slightly lower than for an “average” gravel riverbed (Giles, 1962). If sheet flow rather than channelized (e.g. braided stream) flow occurred, the value of n would be somewhat less than average due to fewer bank and bar related obstacles.

Table II. Rim Gravel Paleohydraulic Estimates

Clast Diameter (mm)	1,500	500	1,500
Slope*	0.014915	0.007458	0.007458
Minimum Shear Stress (N/m ²)	725	240	725
Minimum Depth (m)	4.96	3.28	9.91
Minimum Current Speed (m/s)	21.5	11.5	20.0
Minimum Unit Flow (m ³ /s per m width)	106	37.8	198
Froude Number	3.08	2.03	2.03
Reynolds Number	2.15E03	7.64E02	4.01E03

*First column represents maximum observed paleoslope; second and third column values are based on arbitrarily halved value for slope, which is still in excess of minimum slope in northwest part of study area and assumes sinuosity = 1 (i.e. conservative assumptions).

Estimates of minimum current properties are shown in Table II. The first column is a straightforward calculation based on the largest observed clast size and steepest paleoslope. Since these clasts show evidence of transport, it is the maximum clast size, not the average, that determines the minimum bed shear stress (Flores and Alvarez, 1997; Klevberg, 1998; Klevberg and Oard, 1998). This column represents sandstone eroded from the subjacent strata. The second column is based on the largest exotic clast observed. The second and third columns are based on an assumed paleoslope half as steep as the steepest observed paleoslope to achieve a more “average” paleocurrent estimate (accounting for lesser slopes elsewhere and potential sinuosity) for the entire study area. The second column results may more accurately reflect the minimum current required to transport the Rim Gravel. These calculations provide values for several parameters that are important in testing genetic inferences for the Rim Gravel.

- Estimated minimum depths range from 3.3 meters (11 feet) to 9.9 meters (32.5 feet). Actual depths may have been greater.
- Estimated minimum current speeds range from 11.5 m/s (26 mph) to 21.5 m/s (48 mph). Actual peak current speeds may have been greater. These are far in excess of the recommended maximum allowable current speed for channels excavated in hard rock, which is 3 to 4.5 m/s (6.7 to 10 mph) (Julien, 1995), indicating that very rapid erosion would have taken place. Peak current speeds in excess of 30 m/s (67 mph) may result in cavitation and extremely rapid destruction of rock masses (Holroyd, 1990a,b).
- Estimated discharge per meter width range from

38 to 198 m³/s per meter width (410 to 2,130 ft³/s per foot width). Actual peak unit discharge may have been greater. The estimated unit flows exceed historic peak flood unit flows for the Colorado River at Bright Angel. Unit discharge estimates indicate a very different environment of deposition for the Rim Gravels from current environments.

- Paleocurrents were supercritical ($Fr > 1.0$). To reduce the Froude number to 1.0 (critical flow) would require a flow depth of 4.6 kilometers (2.86 miles)! Flow, therefore, was almost certainly rapid, not tranquil.
- Estimated minimum Reynolds numbers are near the boundary between laminar and transitional flow. If actual peak depths and current speeds exceed the minimums estimated here, Reynolds numbers would have been higher, and flow would have been turbulent.

Minimum paleocurrents would have been very energetic, capable of eroding hard rock, planing off obstructions, rounding clasts, and transporting large amounts of sediment.

Significance of Percussion Marks

Percussion marks were observed on many quartzite cobbles and boulders in the Rim Gravel. Percussion marks are not observed forming on clasts in modern channels where bed-load occurs as described above. Even extremely energetic stream rapids seldom produce percussion marks, though a small percentage can be produced by waterfalls or hurricanes under the right conditions (Berthault, 2004, personal communication). The formation of percussion marks under static loading has been disputed (Klein, 1963). Percussion

marks appear limited to relatively smooth clasts of hard and vitreous, cryptocrystalline or microcrystalline lithologies (i.e. hard, brittle, strong, homogeneous materials) that collide at relative velocities of at least several meters per second (Berthault, 2004, personal communication). Transport in suspension, in which clasts are briefly carried upward in extremely energetic streams, is required in a fluvial environment for the clasts to interact violently enough to produce percussion marks (Klevberg and Oard, 1998).

The presence of percussion marks in the Rim Gravels indicates that clasts transported from upstream of extant outcrops experienced currents in excess of those required for bedload transport. Subsequent bedload transport (assuming mere bedload transport occurred) was insufficient to physically weather percussion marks off clast surfaces. Data are insufficient to determine whether currents could be expected to have exceeded 30 m/s (67 mph). Cavitation is also hindered by a rough gravel bed and entrainment of air (Holroyd, 1990b). Percussion marks alone are sufficient to indicate a highly energetic and erosive environment.

Channel Width

No evidence for distinct channels was evident in the Rim Gravel. Dissected channel deposits, lag bars, bank collapse structures, or other indicators of paleochannels were not observed. The typical uniformitarian approach to this problem is to invoke braided streams, which is a possibility diluvialists need to investigate. Braided streams are observed today in glacial and desert environments where a sudden decrease in stream gradient occurs, reducing sediment carrying capacity and resulting in deposition of sediment. Braided streams, obviously, have channels that divide and reconnect repeatedly, forming a wide and shallow stream filled with bars. Bars may migrate, and sediment is constantly sorted, with coarse material deposited first and fine sediment on the lee sides where current speeds are less. This structure can be seen if one excavates through the deposits. With no evidence for channels observed in the Rim Gravels, we have avoided this problem by estimating unit flows.

Preliminary estimates of unit flow (m^3/s flow per meter width) for the Colorado River at Bright Angel based on U.S. Geological Survey data and channel dimension estimates provide a maximum historic flood unit flow rate of approximately $40 \text{ m}^3/\text{s}$ ($1,410 \text{ ft}^3/\text{s}$ per foot width), which is comparable to the *minimum* value shown in Table II. So the braided stream idea is feasible, right? No! We see no such channel evidence, and the immense area of the Colorado drainage basin is funneled through the narrow inner gorge of Grand Canyon at Bright Angel. The conditions necessary for formation of the Rim Gravel do not compare favorably with present processes.

Uniformitarian Age

Uniformitarian geoscientists, while sometimes struggling with the physical implications of the scientific data, often do not hesitate to assign ages to coarse, tabular, surficial gravel deposits. (Such deposits, which often cover planation surfaces, have no accepted scientific name or “shorthand” term as yet.) Because the uniformitarian geologic column is not a scientific construct but a speculative natural history paradigm (Froede, 1995; Klevberg, 1999; 2000a,b; Reed, 1998; 2000; 2001; Reed et al., 1996; Woodmorappe, 1999c) which was formulated largely prior to widespread field work (Taylor, 1992; Woodmorappe, 1996), it comes as no surprise that efforts to work within the confines of the geological column often result in disagreement not only between scientists, but also between theories and data (Froede, 1998; Froede and Reed, 1999; Klevberg, 2000b; Reed and Froede, 2000; 2003; Woodmorappe, 1999a). The Rim Gravel is no exception.

Rim gravels have been assigned various uniformitarian ages, as well as divergent interpretations and variable geological settings within the uniformitarian system (Young, 1979). Studies present conflicting interpretations about the ages and origins of the deposits (Holm, 2001). One early author dated the Rim Gravels in the Sycamore Canyon as “Triassic,” which was later changed to “Miocene” or “Pliocene,” late “Cenozoic,” in the mid 20th century (Price, 1950). Some authors similarly dated the coarse gravels as late “Cenozoic” (McKee, 1951; McKee and McKee, 1972).

Recent reports, however, have mostly relegated the dates of deposition of the Rim Gravel to the “early Cenozoic,” or even the “late Cretaceous” (Young, 1979; Scarborough, 1989; Elston and Young, 1991; Holm, 2001). The U.S. Geological Survey (Condit et al., 1993) classifies the Rim Gravel as “Oligocene,” from the “Tertiary Period” of the “Cenozoic Era,” which would make it mid “Cenozoic.” Valley erosion with subsequent deposition of coarse gravel is believed to have occurred mainly in the mid to late “Cenozoic” with the gravels reworked from higher terrain (Holm, 2001). Thus, the older gravels are on top of the higher terrain, and the younger gravels lie in the valleys and canyons (Young, 1979).

Diluvial Interpretation—Rim Gravel from Recessional Stage of Flood?

The paleohydrologic constraints that the Rim Gravels provide us are very significant to natural history studies of the American Southwest, both for those who hold to uniformitarian doctrine and catastrophists (including creationists). Uniformitarian and catastrophist interpretations are contrasted in Table III.

Table III. Contrasting Interpretations of Rim Gravel Characteristics

Characteristic	Uniformitarian Explanation	Catastrophist Explanation
Thickness	Channelized deposition	Sheet deposition
Coarse particle size	Episodic fluvial transport	Torrential velocities
Clast support	Bar development and sorting	High competence or current winnowing
Matrix support	Debris flows or episodically low current speeds	Characteristic of source or capacity limited
Exotic clasts	Slope retreat or episodic fluvial transport	Energetic, long-distance transport
Local clasts	Local erosion and deposition	Energetic currents resulted in local erosion
Few or no basalt clasts	Gravels before eruptions	Gravels right before eruptions
Geomorphologic setting	A large east-west valley bottom	A large erosion surface
Subjacent erosion surface	Channelized erosion by water (peneplanation)	Sheet erosion by water (catastrophic planation)
Unusual lithologies	Fluvial transport and reworking over time	Energetic, long-distance transport
Probable source areas	South and west	South and west
Lateral extent	Once continuous	Once continuous
Paleocurrent indicators	South and west	South and west, very energetic

Uniformitarian Issues

It is difficult to fit the Rim Gravels into the uniformitarian framework for the following reasons:

- Deposition of the coarse, tabular, surficial gravel was clearly regional and catastrophic.
- An enormous amount of earth material has apparently been removed, especially south of the Mogollon Rim, since deposition of the Rim Gravel, resulting in a relative reversal of topography.
- Much volcanism occurred which was at least partly contemporary to the deposition of Rim Gravel. Evidence for even one hiatus between these rapid processes has not been observed.
- The catastrophic deposition of coarse gravel and large-scale regional volcanism appear related to Basin and Range tectonism, constraining the chronology of those events.

First, the size and location of the exotic coarse gravels on the highest terrain, which represents remnants of an erosion surface, implies powerful currents sweeping downhill from the south and west. The concept of the Mogollon Highlands

seems sound. The relatively common percussion marks indicate that currents, not *in situ* or mass wasting processes, transported the rocks at around a few tens of meters per second (40 mph or more) during some stage in the clasts' history (Klevberg and Oard, 1998). It is predominantly the more resistant rocks that ended up as a boulder lag on the current Mogollon Rim, while the softer lithologies were either swept away or contributed to the matrix surrounding the boulders (both clast supported and matrix supported gravels are observed in the Rim Gravel). The likelihood that the Rim Gravel was first deposited as a sheet during an erosional event, after a great amount of deposition of other sediments, implies deposition during the Abative or Sheet Flow Phase during the Recessional Stage of the Deluge (Walker, 1994) (Figure 4).

Second, tremendous erosion occurred during and subsequent to the deposition of the Rim Gravels (Billingsley et al., 2000). The "Mogollon Highlands" were eroded a few thousand meters (6,000 feet or more) and lowered *below* what is now the Mogollon Rim. Little subsequent lowering of the Rim likely occurred during this phase, but the

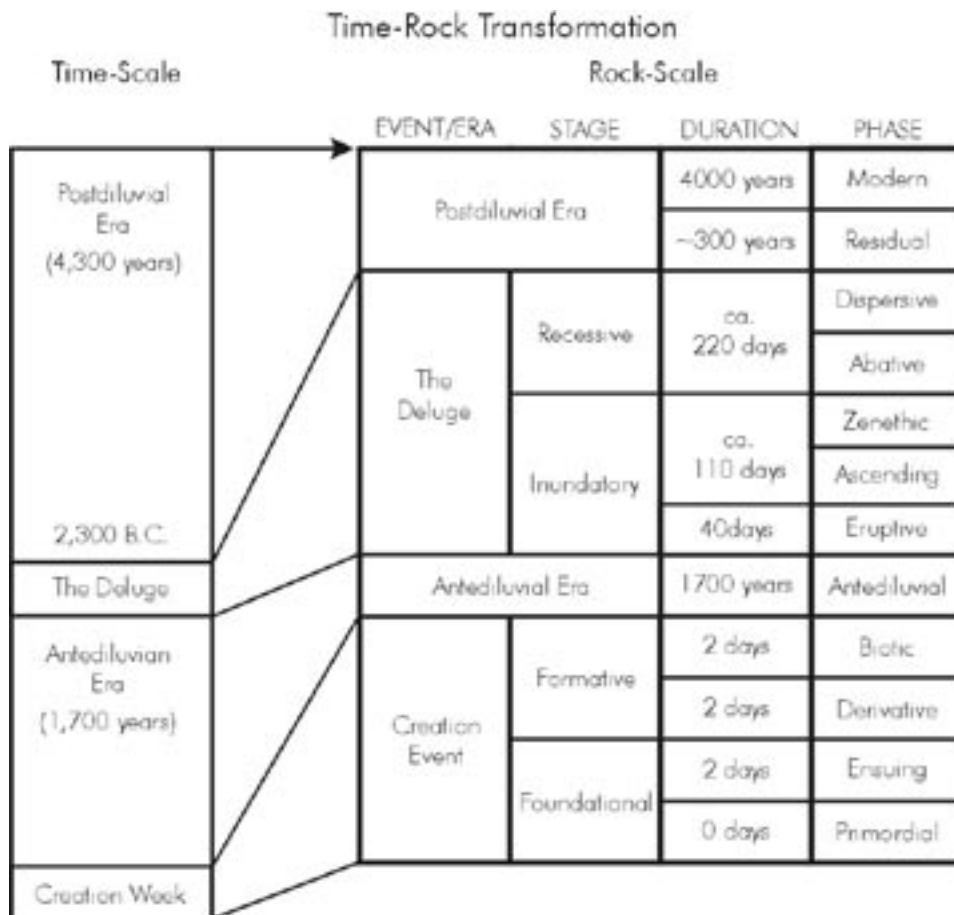


Figure 4. Walker's geological timescale and classification system for the Noahic Flood (after Walker, 1994).

coarse gravel was eroded away, leaving remnants. So, we essentially go along with the uniformitarian deduction of the erosion of the "Mogollon Highlands." The currents that deposited the Rim Gravel were from the south and west, but they became more from the north and east with time as the Mogollon Rim generally became the highest terrain, and base level became the Pacific Ocean. Therefore, there was a reversal of drainage. During this time in the biblical Flood, the water would have become more channelized, resulting in much greater erosion south of the Mogollon Rim. The channelized flow spreading off the highest land as the water level of the Deluge dropped would cut canyons and valleys, rework some of the Rim Gravel into the valleys and onto pediments, and mix the coarse gravel with local lithologies. This is the Dispersive or Channelized Phase in Walker's (1994) classification, the last event of the Flood (Figure 4).

Third, much volcanism occurred, sometimes extruding basalt on top of the Rim gravels. Some of this volcanism occurred during the Sheet Flow Phase, capping the Rim

Gravels near the top of the Mogollon Rim, after practically all of the coarse gravel was laid on and near the Mogollon Rim. Volcanism must have continued into the Channelized Phase of the Deluge, covering up those gravels reworked into valleys and canyons, such as at Sycamore and Oak Creek Canyons. Volcanism probably continued into the immediate postdiluvian period.

Fourth, all this activity must have occurred during tremendous tectonic activity while the region was still submerged below the Floodwater and while the area was emerging from the Floodwater (Oard, 2001a,b; Psalm 104:5-9). This implies rapid vertical uplift of the southwestern United States, probably accompanied by the falling Pacific Ocean bottom. The Floodwater, at first moving as a sheet during the Abative Phase, would become more channelized as more and more terrain became exposed. The volcanism

occurred during the uplift of the Colorado Plateau and the extension of the Basin and Range, as uniformitarian scientists surmise.

The coarse, tabular, surficial gravel capping an erosion surface is difficult to accommodate in a uniformitarian scenario because the once continuous cover over a wide area is not a stable feature or one seen forming in modern environments. Yet many remnants cover large areas to this day. In the east-central part of the Mogollon Rim, the coarse gravel often forms a flat surface on the highest terrain over a large area. It is difficult for uniformitarian scientists to appeal to terrain reversal due to the armoring of the coarse gravel because some of the gravel is matrix supported. In the hypothetical concept of terrain reversal, it seems that the gravel should end up as a lag and be clast supported. Lag deposits should provide a rough outline of paleochannels, yet this does not appear to be the case. So, the coarse gravels give every indication of being caused by a great catastrophe. But was this catastrophe the Genesis Flood or events in postdiluvian time?

Issues for Catastrophists

Catastrophists come in very different forms: evolutionists, diluvialists, and neocuvierists.¹ Catastrophists may acknowledge the evidence for catastrophic deposition of the Rim Gravels while completely disagreeing on the natural history in which the catastrophe or catastrophes occurred. While the Rim Gravels do not appear to be braided stream deposits, neither are they readily explained by the catastrophic emptying of pluvial lakes *a la* the dam breach theory for the formation of the Grand Canyon. This is evident from the unit flow estimates and the high elevation of the coarse gravels. Not only would such a reservoir have to fill and empty many times to create such a vast gravel deposit (and where are the channel boundaries?), but the paleocurrent directions are wrong. A postdiluvial interpretation of the Rim Gravels strains credulity. While the popular dam breach theory for Grand Canyon faces great technical difficulties (Oard, 2001b), these do not hold a candle to the difficulties facing anyone attempting to explain the Rim Gravel as a postdiluvial phenomenon. It is inconceivable that such deposition of Rim Gravel, tremendous erosion, huge tectonic uplift, and great volcanism could occur after the Deluge. What kind of postdiluvial catastrophic scenario would account for all this activity? Just the rounding of so much quartzite implies the action of large volumes of water, indicating the whole region was under water in the early “Cenozoic”—assuming there is any validity to the sequence of the uniformitarian geological column. We believe that the gravel represents a diluvial deposit from the Recessional Stage of the Flood, according to Walker’s (1994) biblical geological timescale (Figure 4).

Preliminary Stratigraphic Interpretation

No thorough diluvial analysis of regional stratigraphy has been conducted as yet, and studies to date have been at the reconnaissance level. Uniformitarian scientists have described some of the relative dating relationships (mix-

ing them, of course, with dubious radiometric “data”—see Woodmorappe, 1999b). In general, they identify the Rim Gravel as a relatively early deposit for the Mogollon Rim area, contemporary with lower Paulden, Cherry, and Beavertail Formations. These conglomerate units are interpreted as slope base or valley fill sediments (Holm, 2001); the presence of basalt clasts indicates no significant hiatus before emplacement of the Hickey and House Mountain Basalts. A similar situation exists with the stratigraphically higher Perkinsville and Verde Formations, and the overlying “Rim Basalts.” The presence of Rim Basalts over Rim Gravel in some locales provides an obvious means of relative dating, as do flows that ran over the Mogollon Rim, but relative dating of the various flows must still be worked out. Present published information is largely a confusion of scientific data with speculations and inferences derived from uniformitarian presuppositions.

Froede et al. (1998) interpreted the Hickey Basalt and subsequent volcanics as postdiluvial (“Ice Age Time Frame” and “Upper Ice Age/Lower Present Age Division,” respectively). These interpretations were described by the authors as tentative, and they may be subject to reconsideration based on new evidence (Froede, 2000), in which case a diluvial interpretation may be preferable. In either case, the preliminary stratigraphic interpretation agrees with the diluvial interpretation of the Rim Gravel provided here. We believe the paleohydrologic constraints of the Rim Gravel make it an excellent chronostratigraphic marker for earth history studies by diluvialists.

Implications

The Rim Gravel is considered one key to understanding the persistent uniformitarian problems of the Colorado Plateau, including the erosional history of the Colorado Plateau, the origin of the Grand Canyon, and the origin of the Mogollon Rim (Elston and Young, 1991; Holm, 2001). We believe deposition of the Rim Gravel is key to interpretation of the diluvial history of the area.

The lead author, who thinks the uniformitarian stratigraphic column represents a *general* geologic sequence, believes the Rim Gravel provides a means of locating the end of the Genesis Flood in the rock record. The deposition of the Rim Gravel is mostly dated as early “Cenozoic” in the uniformitarian geological timescale. The subsequent erosion of the area would occur more towards the middle “Cenozoic.” So, the Floodwater must have still covered much of the area clear into the mid “Cenozoic,” leaving the late “Cenozoic” to finish the more channelized erosion. Thus it appears that if a creationist assumes the validity of the stratigraphic sequence of the uniformitarian geological

¹While some may consider *neocuvierist* a pejorative term, this is not necessarily the case, and not our intention here. There is no better term we are aware of for the view espousing multiple global (or at least continental or regional) catastrophes, only one of which was the biblical Flood. While Georges Cuvier thought the Deluge was the last of these, many *neocuvierists* differ from him in positing postdiluvial catastrophes. Diluvialists, in contrast, consider such catastrophes as orders of magnitude less important than the Deluge.

time scale, the diluvian/postdiluvian (Flood/post-Flood or D/P) boundary is in the late “Cenozoic” in this region. (It is important to recognize that “Cenozoic” is used by evolutionists to designate rocks nearer the Earth’s surface or up section and are therefore more likely than many other rocks, e.g. “Devonian” or “Pre-Cambrian,” to coincide with the D/P boundary.) Diluvialists who (like the other authors) are column agnostics or doubtful of such universal claims may still recognize in the Rim Gravel a significant relative dating mechanism for the D/P boundary. Any post Rim Gravel feature, such as the Grand Canyon, cannot therefore be earlier than this point in earth history.

While the Rim Gravel has great significance to historical geology, it is not an isolated example. We, along with John Hergenrather, have been studying exotic, well-rounded cobbles and boulders, mostly of well-rounded quartzite, across the Pacific Northwest, Montana, Wyoming, southern Alberta, and southern Saskatchewan (Oard, 1996; 2000; 2001a; Klevberg and Oard, 1998; Oard and Klevberg, 1998). We observe these far-traveled rocks many hundreds of kilometers from their nearest source. They are not only found in valleys and on plains, but also are located on mountaintops, such as the Wallowa Mountains of northeast Oregon, the Gravelly Range of southwest Montana, the northern Teton Mountains, and the mountains of central Oregon. We have managed to deduce that these gravels represent objective and powerful evidence for rapid currents of wide and deep extent flowing both east and west off the Rocky Mountains (Klevberg and Oard, 1998). We are aware of other exotic gravels in Utah and southwest Wyoming (Schmitt, 1985; DeCelles, 1988; Elston and Young, 1991; DeCelles and Cavazza, 1999). So, it appears that the Rim Gravels of Arizona are part of the same diluvial events that occurred over the whole western United States.

All these coarse gravels are dated from the “late Cretaceous” and “Cenozoic” within the uniformitarian system. The quartzite also lies upon late “Cenozoic” lavas of the Columbia River Basalts (Oard, 1996). Thus, if one follows the sequence of the uniformitarian geologic column, the pattern based on exotic quartzite and other coarse gravels indicating the Flood/post-Flood boundary is consistent over the western United States. Alternatively, most of the coarse gravels near the D/P boundary have been lumped into the “late Cretaceous” and “Cenozoic” categories by uniformitarian scientists. It may be worthwhile to study the reasons why uniformitarian scientists have classified these deposits thus in their system (cf. Klevberg, 1999; 2000a,b; Reed and Froede 2003; Woodmorappe, 1999c). From either vantage, the significance of these coarse gravel deposits for historical geology is great.

Summary

Coarse gravel on top of the Mogollon Rim in central and northern Arizona, called the Rim Gravel, has great significance for questions of historical geology in the American Southwest. We examined two widely separated and representative locations near the northwest Rim and along the east-central Rim. The coarse gravel occupies an erosion surface on the highest terrain in the region and is believed to have once been continuous all along the Rim. A large percentage of the coarse gravel is exotic quartzites, sometimes with percussion marks. Based on literature sources, paleocurrent data indicate the coarse gravel was transported from the south and west, which currently is at a much lower elevation than the Mogollon Rim. Based on paleohydrological analysis, we calculate that the coarse gravel was transported by sheet flow moving at velocities of at least a few tens of meters per second (40 mph or greater).

Although the uniformitarian age of the gravel is generally believed to have been early “Cenozoic,” it can be surmised that the gravel and the “Mogollon Highlands” to the south were eroded probably in the mid “Cenozoic.” The more channelized erosion of the area probably would be assigned to the late “Cenozoic.” This is premised, of course, on the assumption that these uniformitarian classifications have any real meaning at all.

We infer that this coarse gravel was deposited as a sheet during the early Recessional Stage of the Genesis Flood. The area then underwent erosion of the deposited gravel and substrate during uplift of the area, generally during the Channelized Phase of the Deluge. We conclude that the Rim Gravel provides evidence that the Flood/post-Flood (D/P) boundary largely corresponds to the stratigraphic location of rocks termed “late Cenozoic” in the uniformitarian geological column in this part of the western United States. Since the Grand Canyon of the Colorado River cuts through the Rim Gravel, this feature must post-date the deposition of the Rim Gravel at least slightly.

Appendix

The first location examined during field reconnaissance was in northwest Arizona along Arizona Highway 18 in the eastern Hualapai Indian Reservation, northeast of Peach Springs (Figure 1). Valley gravels are common along Arizona Highway 18 (Figure 5). These gravels would be considered the Robbers Roost gravel of Koons (1948b). The coarse gravel is mostly sandstone from local “Paleozoic” deposits. The gravel deposits observed were mostly clast supported, generally cemented, and poorly sorted with small sand or sandstone interbeds or lenses. True Rim Gravel was found covering the highest point along Highway 18



Figure 5. Robbers Roost gravel along Arizona Highway 18 about 12 kilometers (8 miles) northeast of U. S. Highway 66. Rock hammer in center of picture provides scale.



Figure 6. Rim Gravel on Arizona Highway 18 from the eastern Hualapai Indian Reservation about 50 kilometers (31 miles) northeast of Peach Springs, Arizona.



Figure 7. Well-rounded quartzite clast with percussion marks from Rim Gravel shown in Figure 4.

about 50 kilometers (31 miles) northeast of Peach Springs (Figure 6). This gravel represents an extensive deposit on the Coconino Plateau in the eastern Hualapai Indian Reservation and farther eastward. The unlithified coarse gravel observed by the lead author contained about 30 to 40% exotic well-rounded quartzite. The largest clast was about 30 centimeters (12 inches) in diameter. Some of the boulders possessed percussion marks (Figure 7) indicative of a very energetic depositional environment (Klevberg and Oard, 1998).

The coarse gravel on the east-central Mogollon Rim is most impressive. The gravel is thick and very coarse (Elston and Young, 1991). On ridges near the Mogollon Rim, the coarse gravel forms a flat surface (Figure 8). The deposit extends southward down the valley leading to the town of Young (see Figure 1 for location). The deposit exhibits clast-supported fabric in some places, and matrix support in others (Figure 9). Observed clasts were around 50 to 70% exotic quartzite, 15 to 25% local sandstones, less than 2% granitoids (Figure 10) with rare conglomerate, quartz, chert, gneiss and other igneous and metamorphic lithologies. Some of the granitoids and gneisses were well weathered and rotten. The quartzites observed were well rounded, large, and contained percussion marks (Figure 11). The largest quartzite observed had an A-axis of about 60 centimeters (24 inches) and a B-axis of around 50 centimeters (20 inches) with abundant percussion marks (Figure 12). The A-axis is the long axis while the B-axis is the intermediate axis of the clast. The sandstone boulders were even larger, mostly up to 1 meter (3.3 feet) A-axis. One subrounded sandstone boulder lay on top of the very coarse gravel (Figure 13) with a 2 meter (6.6 feet) A-axis (Figure 14). (It is possible this large clast was deposited at this location when the road was built, taken very likely when the road cut was excavated.) The size of the clasts decreased from



Figure 8. Coarse gravel on a ridge just north of Mogollon Rim forming a flat surface. Picture taken about 4 kilometers (2.5 miles) southwest of Arizona Highway 260, southwest of Heber, Arizona.



Figure 9. Matrix-supported Rim Gravel at the top of the Mogollon Rim at the junction of forest roads 512 and 291, southwest of Heber, Arizona.



Figure 10. Granitoid clast with an A-axis of 45 centimeters from just south of the Mogollon Rim, 7 kilometers (4.5 miles) south of Arizona Highway 260 on Forest Service Road 512, southwest of Heber, Arizona.

the top of the Mogollon Rim south down the valley toward Young. One reason the clasts are so large in the east-central Mogollon Rim compared with the northwest Rim could be

due to the closer source for the former.

Several gravel samples collected during this investigation contained rocks exhibiting mineralization or evidence



Figure 11. Quartzite with abundant percussion marks from just south of the Mogollon Rim, 7 kilometers (4.5 miles) south of Arizona Highway 260 on Forest Service Road 512, southwest of Heber, Arizona.

of hydrothermal alteration. Particularly prominent were hematite, limonite, malachite and lesser amounts of other copper minerals. Significant mineralization is present in the vicinity of Jerome, Arizona (Figure 1). While no active mining is underway in Jerome, local historical postings state that large-scale mining of the copper deposits occurred from 1876 to 1953. Based on the lithologies from the Rim Gravel, mineralized outcrops were exposed long before 1876.

Glossary

Braided stream: a stream form characterized by anastomosing channels separated by bars and generally found where a sudden decrease in gradient occurs.



Figure 12. Well-rounded quartzite with abundant percussion marks and an A-axis of about 60 centimeters (24 inches) and a B-axis of about 50 centimeters (20 inches) from about 1 kilometer (0.6 miles) south of the junction of forest roads 512 and 291, southwest of Heber, Arizona.



Figure 13. Outcrop of very coarse, clast-supported gravel with very large sandstone boulders up to 2 meters (6 feet) A-axis on top (shown in Figure 14). Location is 7 kilometers (4.5 miles) south of Arizona Highway 260 on forest road 512, southwest of Heber, Arizona.

Clast: an individual pebble, cobble, or boulder.

Coarse gravel: gravel containing significant amounts of cobbles and boulders.

Cross-beds: fabric patterns in detrital sedimentary rocks or unconsolidated sediments formed by laminations at an angle to the bedding direction, often observed forming today as advancing (prograding) delta fronts.

Exotic: of a lithology not found subjacent to the deposit, implying transport from a distant source.

Froude number: the square root of the inertial-gravity force



Figure 14. Close-up view of 2 meters (6 feet) A-axis boulder from Figure 11. Boulder is subrounded and composed of local sandstone.

ratio; critical flow occurs at a Froude number of one, representing the minimum energy but an unstable condition, Froude numbers greater than one are rapid, and Froude numbers less than one are tranquil.

Granitoids: Any quartzofeldspathic phaneritic plutonic rock, including granite, diorite, quartz monzonite, and tonalite.

Imbrication: stacking of somewhat flattened shapes in a shingle fashion; relatively flat (nonequant) rocks in streambeds are usually imbricated dipping upstream.

Matrix: the material surrounding clasts and occupying the void spaces between them.

Percussion marks: crescentic fractures in the surface of a microcrystalline or cryptocrystalline rock, somewhat cone-shaped in section.

Quartzite: a rock composed primarily or completely of silica (SiO_2) in which fracturing occurs across grains (if grains are evident) rather than between them.

Reynolds number: the ratio of inertial to viscous forces; low Reynolds numbers indicate laminar flow, high Reynolds numbers turbulent flow.

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Book Review

The Man Who Found the Missing Link: Eugene Dubois and His Lifelong Quest to Prove Darwin Right by Pat Shipman

Simon & Schuster, New York, 2001, 514 pp., \$28.00.

Author Pat Shipman writes a very human portrait of the discoverer of Java Man. In plodding, almost novel-like

fashion, Shipman goes into considerable detail delving into the motivations and personal life of this complicated man. The book is filled with reconstructed conversations, detailed descriptions of the Dubois family homes and psychological descriptions of Dubois, his wife and friends. It even has a villain or two. The most prominent was the stubborn old German pathologist Rudolf Virchow who seemed bent on and thwarting Dubois at every turn.

In some ways the portrait author Shipman paints is one of the prototypical late 19th and early 20th century scientist who was as much driven by scientific dogma as any priest or missionary is by religious concerns. Yet, we also see a man who is capable of being a good friend and responsible family man. While the central event of this book is Dubois' discovery and life-long defense of the so-called *Pithecanthropus erectus* (composed of a skull cap, femur and several teeth) there are many other important aspects to consider.

One of the most interesting parts of this book tells how Eugene Dubois became obsessed with evolution and finding the missing link between animals and humans. When

he was ten years old (1868) a prominent German biologist gave a lecture in Dubois' Dutch hometown. While his father did not allow Dubois to attend, the highly intelligent boy secured a newspaper that gave an account of Dr. Vogt's lecture which extolled the virtues of Darwinian evolution. It is then that "Dubois longs to be a man of science, a man to whom everyone listens, a man with great ideas who will discover the truth" (p. 15).

Later Dubois is sent to the technical high school in Roermond. His school master introduces the young teen to the works of Charles Darwin, Thomas Huxley, and Ernest Haeckel. Huxley and Haeckel especially exert a profound influence on the young Dubois. "Reading Haeckel's words is for Dubois like emerging from the dark confines of the chrysalis. He can feel his creeping wormlike self first exposed and then transformed by the light of knowledge. Religion is finished for Dubois now. [The Dubois family were practicing Roman Catholics] Haeckel's words have burst the wooly cocoon of confused, everyday thought, revealing a theory of descent with modification that shines with truth... He becomes an evolutionist, as indelibly as one who takes holy orders becomes a priest" (pp. 20–21).

Significantly the sister he is closest to, Marie, becomes a nun, which deeply disappoints Dubois. He believes "religion is false, is unproven, unprovable" (p. 24). However none of his arguments can dissuade her. "She will be devoted to the Church, and he is bound over to Truth and Science" (p. 25). Many years later in Java after the tragic still-birth of one of Dubois' daughters, mysterious, haunting cries erupt from the surrounding jungle. These "moan and wails" continue night after night. Finally a local dukan (shaman) performs an occult ceremony (pp. 213–215). Dubois dismisses it as "rankest mumbo-jumbo." "Still, he has been here long enough to know that more than distance and culture separate Java from the Netherlands. A strange, indefinable quality flavors the very air in Java; forces are at work here that cannot be grasped or understood. In this place, even this tough-minded scientist, who denies that which cannot be measured, must acknowledge the possibility of spirits and magic. He does not know how this can be so. Something about Java defies logic" (p. 215). After the dunkun's visit the night cries cease.

In 1930 Dubois displays a spiritual struggle that will continue until his death ten years later. While organizing a massive collection of fossil he collected years earlier in Java he confides in his assistant, a Jesuit priest named J.J.A. Bernsen, "I believe that I, in leaving the Catholic Church, have done more for the Catholics, and in general for the Christian cause, than many advocates in the Catholic Church... I have surely demonstrated the untenableness of Darwinian ideas of gradual evolution and survival of

the fittest. My researches have clashed directly with social Darwinism, too. And I am convinced that Marx would never have written his book had Darwinism not preceded it" (p. 391). Later Dubois complains, "I get the impression sometimes that the others here at the museum regard my work as the making of my last will and testament. It is highly unpleasant for me, that they always look at me to see if I am dead yet." Bernsen considers, "death...is when you will confront your Maker and his judgment on your life. Is that what really haunts you, the final accounting yet to come... he recognizes the anguish of the lapsed Catholic in his colleague" (p. 392).

Less than a year before his death, in 1940, Dubois writes to his daughter Eugenie, "I have explained to them that my researches have delivered certain evidence for the animal descent and definite monkeylike descent of humans, not by gradual transformation (as according to Darwin) but by two leaps, leaps that have taken place everywhere in the animal kingdom—which the religious believers can and will consider creation. My opponents do not understand that, or rather refuse to understand it, and ascribe to me other motives than the search after the objective truth" (p. 447).

Dubois eventually forsook the explanatory barrenness of Darwinian gradualism for evolution by saltum, "by leaps." He proposed "that evolution proceeds by cellular process" (p. 379). The "phylogenetic progress in the brain, in terms of the size of the cerebrum and the complexity of its function—what Dubois calls the psychoencephalon—is determined by internal, autonomous factors, not external natural selection as Darwin has proposed" (p. 380). Dubois wrote, "Here is a law of evolution came forth out of the nature of the living being itself, not imposed by the surroundings...It appears that there actually does exist...a law of phylogenesis [law operation] with progression, with perfecting" (p. 380). How such a law originated in living creatures is not discussed.

Certainly here is an irony. The sub-title of the book is "Eugene Dubois and His Life Long Quest to Prove Darwin Right." Dubois actually abandons Darwin's explanation for evolution. Another irony reveals itself in the first major criticism of Dubois' Java Man in an 1893 newspaper article (pp 176–180). The article writer signs his name as Homo Erectus, the very category in which late 20th century paleo-anthropologists consigned Dubois' most famous discovery. While this book deals satisfactorily with the scientific issues it is as much a psychological portrait of a "paranoid, brilliant and stubborn man [who] cast his own fate" (p. 453).

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Book Review

Refuting Compromise by Jonathan Sarfati

Master Books, Green Forest, AR, 2004, 411 pages. \$14.00.

I have never watched a chess grand master play a game against a novice. However, after reading Jonathan Sarfati's latest book, *Refuting*

Compromise, I have a sense of what

such a match would be like. This third "Refuting" book is written to specifically address the old earth compromise teachings of Hugh Ross and other progressive creationists. Sarfati's rebuttal is so well documented and exhaustive that one almost begins to feel sympathy for progressive creationists—the sympathy one has for the novice chess player who has lost all his pieces and the king is now in checkmate!

Sarfati begins with an emphasis on the authority of the Word of God. From the outset, he frames the discussion from the supremacy of the Scriptures. Thus, he claims that the main difference between young and old earth creationists is how they view the authority of Scripture. He discusses the magisterial vs. the ministerial use of science and why nature does not count as a 67th book of the Bible.

From there, Sarfati embarks on a strong defense that the "days" of Genesis are normal 24-hour days. Along with the common arguments, he includes many that are rare. He discusses the appropriate semantic range of the Hebrew word "yom." He examines and rebuts typical objections to the 24 hour day including Hosea 6:2, Genesis 2:17 and the issue of days and nights before the sun. Following this is a chapter on the history of the interpretation of Genesis 1 which covers both ancient and recent theologians and scholars.

The chapter on the "Big Bang" clearly explains this theory even for the non-expert. He first presents the evidence commonly used to support the theory and then presents the scientific problems including quantized red-shifts, a rotating cosmos and the horizon problem. He wraps up by

addressing galaxy formation and the nebular hypothesis.

The book has chapters on the created kinds/speciation, the flood of Noah and the origin of death. This includes scientific and Biblical evidence for a global Flood that go far beyond simply addressing the size and capacity of the ark. He effectively refutes the notion of any type of local flood. Sarfati emphasizes the fact that death and suffering is the result of the Fall and the curse. He discusses the typical objections including predation, plant death, cellular death and pathogens.

Sarfati includes a chapter on the history of mankind in which he discusses the various source texts for the Old Testament and compares the genealogical dates and records among them. He addresses the alleged gaps in the genealogies. He also discusses the timing of the Fall which is a rare and under-appreciated component in defense of a young earth. He touches on the longevity of the patriarchs, the human fossil record and mtDNA evidence.

Refuting Compromise represents the best, most comprehensive, presuppositional defense of young earth creation currently available. It is well referenced with extensive footnotes and current citations—even from the 2003 International Conference on Creationism. The book is not simply a rehash of older material but includes many new arguments. Sarfati has compiled and distilled into one place a book that will be a key resource for years to come. The magnitude, quantity and sophistication of some of the arguments may be overwhelming to those who are new to the creation issue. Nonetheless, this book is definitely a must-have for those who want to defend creation and refute compromise.

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The Evolution of Teeth: A Major Problem for NeoDarwinism

Jerry Bergman*

Abstract

Teeth are one of the most common vertebrate fossils found, partly because they preserve far better than any other body part. If any evidence exists for NeoDarwinism, it would most likely be found in fossil teeth. The results of a literature research on the origin of teeth show no empirical support for their evolution. A review of the fossil record shows no evidence of transitional forms that bridge teeth to their theorized precursors, such as bone. Nor has any clear evidence been found to support the evolutionary origin of various types of teeth, such as molars or tusks. The complexity of teeth, and the complex inter-connections between teeth and bone, also conflict with a NeoDarwinian origin of teeth.

Introduction

Evidence for evolution of vertebrates “is derived largely from the fossil record, and much of it is provided by teeth” (Butler, 2002, p. 201). As Jernvall et al. (2000) noted, “the study of mammalian evolution often relies on detailed analysis of dental morphology” (p. 14444). The same is true for most other vertebrates. Many evolutionary conclusions, such as elephant evolution, are based largely on comparative dental morphology (Maglio and Ricca, 1977). The importance of teeth in human evolution is so great that “were it not for teeth, anthropology would be a different subject” (Jernvall and Jung, 2000, p. 172). Fossil teeth are ideal objects to study evolution because they preserve extremely well in the fossil record, much better than even bone (Teaford et al., 2000; Smith and Tchernov, 1992; Zhu, 1935; Wilson, 1943). As a result of their abundance, teeth play a major role in helping to distinguish between different extinct species (Johanson and Shreeve, 1989). In Gould’s (1989) words:

An old paleontological joke proclaims that mammalian evolution is a tale told by teeth mating to produce slightly altered descendant teeth. Since *enamel is far more durable*

than ordinary bone, teeth may prevail when all else has succumbed to the whips and scorns of geological time. *The majority of fossil mammals are known only by their teeth* [emphasis added] (p. 60).

Deterioration of fossils is caused by water, weather, and temperature. Bone mineral crystals tend to be long and narrow and, as a result, the needle-shaped splinters that form from water trapped in the pore spaces that exist in all bone causes these pores to widen. As they widen, even more water is allowed to enter, forming yet larger crystals (Calcagno, 1989). Within a few weeks to a year in moist environments, the bone is rapidly damaged. The major causes of deterioration of animal body parts (including bone) are:

1. drying and wetting (very important in all semi-arid, arid, and temperate areas, or in humid areas with monsoonal climates),
2. formation of salt crystals during drying (and the analogous formation of ice crystals during freezing), and
3. freezing and thawing (an important process, especially at high altitudes or for short periods of time).

In contrast to bone, tooth enamel is far better preserved because enamel is extremely dense, with virtually no space between the crystals, and very few pores (Patterson, 1956; Teaford et al., 2000). Therefore, it requires about 10 to 100 times longer for the same deterioration effects to occur in

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tooth enamel as it does in bone. Even dentine takes longer to break down—usually 2 to 10 times longer on average—than bone. Conversely, cementum tends to be easily destroyed and, consequently, is rarely found preserved on teeth in the fossil record. Because the anchoring bone for teeth decays more rapidly than the teeth themselves, loose teeth are very common in the fossil record. Often, when a fossil is discovered, the teeth are among the best-preserved parts of the animal. Consequently, much of our understanding of animal history is a result of the study of teeth, and many animals are known *only* by their teeth (McCollum and Sharpe, 2001).

Over 50 basic types of teeth have been classified and teeth have so much variety that they often can be used to identify a mammal's taxonomic order (Miles, 1972; Forstén, 1973; Denison, 1974; Cocke, 2002; Matthew et al., 1924; Patterson, 1956; Raschko and Hillam, 1973; Scott, 1892). Teeth are a major means by which to differentiate humans from other primates. Often an attempt is made to identify an animal solely on the basis of its teeth. This is sometimes very difficult, of course, as the classic case of the *Hesperopithecus* has shown—peccary teeth are very similar to human teeth and, as a result, are mistaken for human teeth (Bergman, 1993).

Mammals are heterodonts, which means that their teeth vary even within one animal. In fish and reptiles, however, the teeth are all close to identical, except for size (homodonts). Even closely related mammals can have very different tooth morphology, depending on their diet and food-chewing needs. Those who believe in the Darwinian origin of teeth assume that the evolutionary status of an animal's teeth is an excellent index of its body evolution. The stage of evolution of an animal's teeth, though, is not always directly related to the stage of the supposed evolution of its entire body (Frayer, 1977; Oxnard, 1987).

The Structure of Teeth

Although seemingly simple organs, teeth are actually very complex, well-designed, living structures that require proper care to keep healthy, especially in humans. As Stokstad (2003) noted, “in whatever form they take, teeth are a marvelous invention, enabling us to rip into drumsticks or chew a caramel with abandon” (p. 1164). Although many animals can effectively chew a wide variety of materials, their teeth are often designed to fit the normal diet of the animal (Lucas, 1982).

The exposed part of the tooth is called the crown; the tooth part in the jaw is the root (see Figures 1 and 2). The outer part of the tooth, the enamel, is the hardest structure in the body. Enamel is composed of numerous microscopic

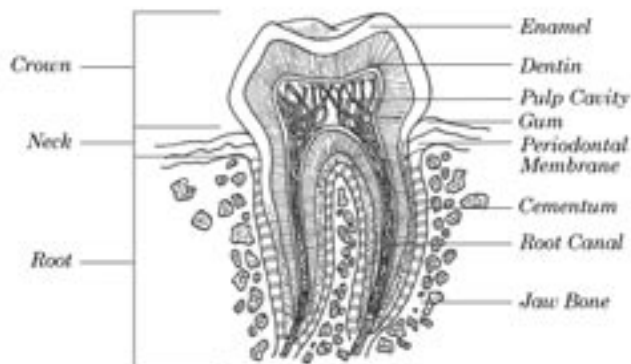


Figure 1. A modern incisor tooth showing its internal structure.

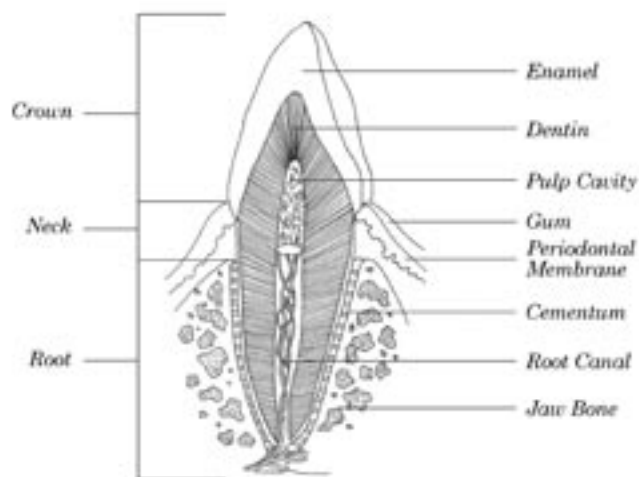


Figure 2. A modern molar tooth showing its internal structure.

crystalline structures that resemble soda straws set parallel to each other (Moeller, 2003, p. 119).

Below the enamel is the dentine, a substance that resembles bone, except that it is much harder (Shier et al., 2004). Dentine is living cellular tissue that requires adequate blood circulation, which is provided by the veins and arteries located in the root canal. The root is enclosed by a thin layer of material similar to bone called cementum, which helps to bond the tooth firmly in the bone socket. The tooth is firmly attached to the bone by thick bundles of collagenous fibers called periodontal ligaments. The ligaments contain nerves that keep the animal from applying excess pressure to the teeth.

Although mammalian teeth are more complicated and more efficient than those of other vertebrates, “all teeth are basically similar, formed in essentially the same way from enamel” (Butler, 2002, p. 208). Most vertebrates have teeth, but some totally lack them. In all toothed vertebrates except mammals (fish, reptiles, a few extinct birds such as *Archaeopteryx*, and amphibians) the teeth develop to fill the jaw space that was designed to hold them. In sharks, some amphibians, and even some other animals, no matter how many teeth are lost, new ones normally develop just like a cut always heals in a healthy animal. In these vertebrates the animal either has an endless supply of teeth or does not have any teeth.

The complex development of teeth is not well understood (Zhao et al., 2000). Teeth are merely the final product of a cascade that produces a complex structure which appears to have been designed to develop at a specific location in the body. Tooth evolution cannot be understood apart from the development of the entire dento-maxillary system. The periodontal ligament co-development, the root growth development, the condylar growth, the jaw basal bone, the enamel microcrystal structure, and the simultaneous development of the opposing arch are all part of this complex pattern of co-development (Moeller, 2003). Moeller (2003) concluded that, “You cannot prove or disprove either evolution or Creation ... outside of the system approach. This is evolution’s gross failure” (p. 1).

Mammals that have teeth are also unique because two sets of teeth form during their development—the first set, called primary teeth or milk teeth, erupt at regular intervals between about six months to two or three years of age. These teeth are then later replaced with a larger secondary or permanent teeth. Some mammals develop primary teeth but do not produce permanent dentition replacements. The monotreme *Ornithorhynchus*, duck-billed platypus, has “two pairs of upper teeth and three pairs of lower molariform teeth, but these are shed before maturation and are functionally replaced by a leathery beak” (Carroll, 1988, p. 420).

In humans, the primary teeth are both fewer in number (20) and smaller than the secondary teeth (32). The 32 secondary teeth are arranged as follows: *molars* (for grinding) are in the back; *premolars* on the side; *cuspid*s (or canines) for tearing or stabbing are located on the side towards the front; and *incisors* (for cutting and biting off chunks of food) are located in the direct front of the mouth.

The complexity of teeth indicates that the number of genes involved in their formation is “undoubtedly large” (Butler, 2002, p. 208). All this variation is “genetically controlled to a high degree” and is little influenced by the environment (Butler, 1982, p. 44). If environmentally influenced, it would adapt to local conditions and genetic selection would be less important. Therefore, this trait is ideal for Darwinists to study and is another reason why the fossil record should show an abundant number of clear transitional forms.

The Evolution of Teeth

In the most widely held theory of tooth evolution, it is hypothesized that marginal oral skin produced small knobs (denticles) that then evolved into tooth-like condonts (McCollum and Sharpe, 2001). Figure 3 shows an artist’s rendition of one of the most commonly held concepts of tooth origin by evolution. Eventually the condonts evolved into primitive teeth and then, after many more eons, into modern teeth (Teaford et al., 2000; Miles, 1972). Many new discoveries have challenged this view. Even the theory that teeth evolved by co-option of external skin denticles at the margins of the jaws has recently come under attack by Smith and Johanson (2003) who examined the need for functional teeth to survive.

Because they preserve so well, teeth are an excellent means of evaluating neoDarwinism (Young et al., 1929; Smith and Tchernov, 1992; Kurtén, 1982; Osborn and Gregory, 1907; Butler and Joysey, 1978; Balkwill, 1893; Butler, 1982). The wide diversity of morphology (shape and size), enamel, and other microstructures of teeth among

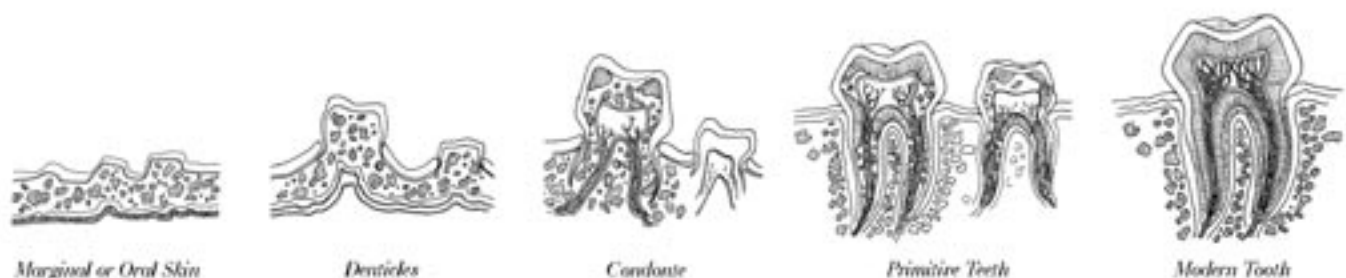


Figure 3. Artist’s rendition of a common scheme of tooth evolution. Diagram by Artist Richard Geer.

the extant and fossil animals indicates that a large number of clear transitional forms should exist to confirm the path of their evolution (Moeller, 2003).

Although size changes can be observed, the fossil record reveals no evidence of tooth evolution, either from primitive teeth or from some theorized precursors. As Stokstad (2003) noted regarding teeth instead, “These complex structures are always organized—into sturdy rows of molars, for instance ...” (p. 1164). Even accessory structures such as dentine are found in the fossil record. In the case of dentine, the fossil record extends back to the late Cambrian (Smith and Sansom, 2000). As a result of the good fossil record in the “Cambro-Ordovician vertebrates, we know that there was great diversity” of dentine tissues even in the Cambrian (Smith and Sansom, 2000, p. 79). Furthermore, recent evidence challenges the classical view of teeth evolution (Smith and Coates, 1998). An example is the finding that living and fossil animals either have fully developed teeth, or none at all, and that “complex structures with dentine and enamel have been described in the earliest jawless vertebrates, condonts” (McCollum and Sharpe, 2001, p. 153).

All living amphibians have ridges on their jaws that can function as teeth, but they lack even very primitive teeth. Such ridges are interpreted as “transitional features,” but they are, in fact, fully developed structures (Miles, 1972, p. 6). Some jawed vertebrates caught their prey with “bumpy gums or bony cutting blades and cuff-like structures made of so called semi dentine” (Stokstad, 2003, p. 1164) but these structures were not teeth, nor were they constructed out of dentine, enamel, or other modern tooth structures. They were merely bumpy gingiva, often covered by horny plates, and nothing more. Nonetheless, these horny plates were well developed systems, and not transitional forms; they functioned very effectively for grasping and slicing (Miles, 1972). Modern examples include turtles and tortoises.

Another major problem facing the theory that teeth evolved from bone is that there are at least two different types of proteins in teeth that are not found in bone. Furthermore, most all of the internal structures of teeth are considerably different from those of bones (Shier et al., 2004).

Did Teeth Evolve Once or Many Times?

The complexity of teeth and the small likelihood they would have evolved even once in history have caused many researchers to “assume that teeth evolved just once, in the common ancestor of jawed vertebrates” (Stokstad, 2003, p. 1164). A recent reevaluation of teeth, however, has now caused many researchers to question this assumption of monophylogeny. The extended jawed fish called placoderms,

for example, have teeth that differ greatly from other fish teeth. The difficulty in fitting these teeth into a single, viable evolutionary scenario has posed such serious difficulties that the researchers involved argue that teeth must have evolved more than once (Smith and Johanson, 2003). This poses no small challenge to Darwinism, however, and has caused some researchers to question the position of “a significant portion” of animals on the current vertebrate family tree. In Stokstad’s (2003) words, “scientists may need to shake up a significant portion of the vertebrate family tree” (p. 1164) as a result of these and other findings, by which he meant that the order and phyletic relationships of many groups on the tree may have to be changed.

Some researchers agree with tooth evolution expert Jukka Jernvall that “multiple origin of all the things that have something to do with teeth seem to be an emerging theme in evolutionary biology” (as quoted in Stokstad, 2003, p. 1164). This polyphyletic view renders tooth evolution less plausible because it was long considered to be so unlikely, forcing the conclusion that teeth must have evolved only once. To conclude now that they evolved *many* times indicates that something very unlikely must have happened often, forcing one to question the whole scenario. Such an unlikely trend toward the multiple origins of teeth in separate taxonomic group fits well with the concept of the creation of many distinct kinds (baramin).

This newfound parallelism of teeth does not “reveal how teeth came about” and, consequently, does not help to solve the evolutionary conundrum but only complicates it (Smith and Johanson as quoted in Stokstad, 2003, p. 1164). Generally, teeth of living and extinct animals are lined up according to criteria that appear to be based largely on size and complexity. The teeth are then assumed to have evolved largely along this pattern. A major problem with this approach, however, is the large amount of intraspecific variation in dental features found in some animals (Metz-Muller, 1995).

Another evolutionary theory for the origin of teeth is the belief that they did not arise as chewing structures, but for other purposes, such as a superior method to capture prey (Smith, 2003). This event is theorized to have occurred in a primitive animal that then gave rise to all of the other groups of jawed vertebrates, including sharks, osteichthyes (bony fishes), and certain extinct animals. Placoderms are considered the most basal group of jawed vertebrates, and for this reason their study is critical in researching the evolutionary origins of teeth (Smith and Johanson, 2003). Fortunately, well-preserved examples of early placoderms with teeth are available for study. These various placoderm teeth have now been studied carefully, and it was found that the animals with teeth all had true teeth, not primitive

less-evolved teeth as had been expected. Once again, an evolutionary prediction was falsified.

Smith and Johanson in their study of well-preserved placoderm specimens concluded that the same tooth pattern in placoderms they studied is also found in modern lung fish. The placoderm teeth were not primitive bony projections but rather conical structures arranged in defined rows (Smith and Johanson, 2003). Smith sliced through a few teeth, showing that they were fully developed teeth made of “regular dentine, not semi dentine” (Stokstad, 2003, p. 1164). Some placoderms, though, totally lacked teeth. So far no evidence of transitional tooth forms between the no-tooth condition and completely developed teeth has been discovered.

A Computer Literature Search on the Evolution of Teeth

In my review of the literature, all articles having both the keywords “teeth” and “evolution” (some overlapping exists in these databases, and Biological Abstracts contains many journals devoted totally to evolution) were located and reviewed (see Table I). Most of the articles located fell into these categories: discussions of the growth and development of teeth in infants and children, theoretical/speculative discussions, studies of individual teeth, review articles, or discussions of new fossil finds. None provided clear evidence for the evolution of teeth but, at most, involved discussions of minor changes in the size and shape of fully developed teeth from different animals. But even here, much controversy existed (for example see Frayer, 1977). Many studies compared the teeth of animals in hypothetical evolutionary lineages, showing, at best, evidence for saltation (evolutionary jumps)—evidence that would fit equally well with the creation of separate kinds.

The Use of Living Animals to Study Evolution of Teeth

In contrast to many evolutionary hypotheses, one can create a mental picture of the development of teeth from bone into teeth (see Figure 3). This picture, in turn, gives us an idea of what to look for in the fossil record. Because teeth are the hardest structure in the body, teeth evolution evidence should therefore be very apparent in the fossil record. As indicated earlier, I have found few reports of plausible fossil evidence of tooth evolution (see Table I). Hypothetical scenarios are freely postulated, but all lack empirical evidence (Miles, 1972).

Many evolution studies are based on living animals such as primates, and operate under the assumption that some living primates are “primitive,” and others are more “modern.” (The terms “primitive” and “advanced” in this context, however, have meaning only if Darwinism is true.) The teeth of living animals are then compared, and trends in evolution are deduced from these comparisons (Butler, 2002). This, though, is not proof of evolution, but can merely provide plausible “just-so stories.”

Of the hundreds of thousands of fossil teeth that have been evaluated so far, all are fully developed compared to their modern forms, and very few have even been claimed to be transitional. Although teeth vary considerably, no fossils have been proposed as clearly transitional from non-teeth to fully developed teeth. One problem, as described by Smith and Sansom (2000), is that:

Historically, many descriptions have used terminology, either based solely on these interpretations, or on comparison with bone, based on the assumption that an evolutionary series exists as a fossil record of the transformation of bone into dentine. Terms such as mesodentine, semidentine and metadentine have been used unrealistically in phylogenies with this assumption (p. 79).

Table I. The Results of a Computer Literature Search*

Data Base	Records	Number of Hits**	Hits as Percent of Records
Biological and Agricultural Index	1,080,522	0	0.0
Biological Abstracts	6,469,420	20	0.00031
Medline 1966 to present	12,402,978	3	0.00002
Anthropological Literature	507,779	59	0.0116

* Date of search: Nov. 21, 2003.

** A “hit” was a record in which the search term set was identified.

As noted above, complex structures with both dentine and enamel have been found in “the earliest jawless vertebrates” (McCollum and Sharpe, 2001, p. 153). The major difficulties in the evolution of teeth, especially the fact that traits considered both “primitive” and “modern” are found in both ancient and modern teeth, are explained by some Darwinists as resulting from “convergent evolution.” Jernvall and Jung (2000) conclude that the distolingual cusp in the upper molars (called the hypocone) has evolved “at least 20 times in mammals” and even “among primates, the hypocone has evolved multiple times” (p. 181). But, as noted earlier, such polyphyletic schemes in which teeth arise independently many times are extremely unlikely.

Morphogenesis: The Evolutionary Origin of Different Shapes and Types of Teeth

Teeth exist in a bewildering variety of shapes, seemingly every shape possible (Garcia and Miller, 1998). In fish and reptiles, all of the teeth in any one animal are very similar in shape (homodonts). In contrast, mammals are heterodonts (use many different kinds of specialized teeth). Moeller (2003) claimed that thousands of morphology variations and what can be called eruption sequence variations, together within other developmental cascades, exist. Thus, even though two teeth appear to have similar morphology, they could have major differences in development.

Some of the differences in morphology include teeth that are specially designed to scissor, stab, grind, dig, chisel (as in beavers), sieve (as in some aquatic animals), and lift (such as elephant tusks). Some “fangs” have a complex mechanism to deliver venom (Miles, 1977). The largest teeth in a living animal are elephant tusks, which are greatly enlarged incisors composed of dentine (Garcia and Miller, 1998). One documented elephant tusk was 16.5 feet (5m) long and weighed 465 lbs. (211 kg). Walrus tusks, which are teeth, can grow up to 1 meter long, and can weigh up to 12 pounds. (5.4 kg).

In addition, many other interesting teeth oddities exist, such as the Narwhale *Monodon monocerus* (order Odontoceti) that has two teeth in its upper jaw, but only one of these (normally the left one) grows out. This tooth grows long enough to serve as a tusk, while the other tooth remains small.

Other significant variables among the different kinds of animals include the dento-maxillary complex and the eruption sequence. The enamel microstructure differs widely and includes radial enamel, prismatic enamel, and synapsid columnar enamel (Moeller, 2003a). Even the periodontal attachment system varies enormously (Moeller, 2003). Moeller (2003) argued that the fossil record should

not only contain mutational improvements, but also even more mutational failures that include such obvious changes as dental crowding, hypereruption, and hypoeruption. He concluded as follows:

Considering the enormous amounts of fossil dental and jaw material available, it is statistically unrealistic to assume that no fossil evidence exists of any intermediate dental types. Just because it is possible to arrange different appearing dentitions in a phylogeny, this does not indicate support for the position that they evolved. The engine of evolution, that being genetic mutations, has great difficulty in accounting for the gradual modification of a highly complex integrated and coupled system in small increments. Genetic theory has an even greater difficulty in accounting for such changes (Moeller, 2003, p. 125).

Evidence for an evolutionary sequence among these many variations finds no support in the fossil record. Each of the many various types of teeth is believed to have evolved from the basic reptilian tooth type. This is sometimes called the “problem of tooth morphogenesis,” concerning which Salazar-Ciudad and Jernvall (2002) noted that the:

Generation of morphological diversity remains a challenge for evolutionary biologists because it is unclear how an ultimately finite number of genes involved in initial pattern formation integrates with morphogenesis (p. 8116).

“Transitional Stages” Lacking

Evolutionists would expect to find many fossil transitional teeth between the basic kinds of teeth, such as between elephant tusks and the common mammal teeth, for example. Models of morphogenesis exist, so we have some idea what to expect in the fossil record, but clear examples of linking steps have never been found in the millions of fossil teeth uncovered so far. This is a serious gap in the fossil record. Another problem is confirming the identity of a transitional tooth. Would it be a tooth that is smaller than a tooth in a modern animal? Would it be one with half the enamel, half the periodontal ligament, half the dentin, or half erupted compared to a non-transitional tooth? Or would transitional teeth be like malformed teeth as we see often in humans with genetic abnormalities?

Several groups of mammals lack teeth, including the ten species of whales in the order Mysticeti, the eight species of Pangolins family Manidae, and the three species of anteaters of the family Myrmecophagidae within the order Edentata. Modern toothless mammals and certain other animals such as birds are theorized to have lost their teeth in evolution, a conclusion that is also unsupported in the

fossil record and hard to rationalize, considering how critical teeth are for defense, for grooming, for procuring food, and for using as tools. The only exception I have been able to locate is one reptile that has evidently lost its teeth in the distant past: the Triassic turtle *Proganochelys*. It had rows of small homodont palatal teeth whereas modern turtles have none (Romer, 1974).

Irreducible Complexity

One argument against Darwinism is “irreducible complexity,” the observation that a complex organ must first exist in a fully formed condition to function, otherwise it will afford no selective advantage to its possessor. Some claim that this argument from irreducible complexity is less successful in the case of the evolution of teeth than for most other body parts because a less developed tooth may be better than no tooth at all, and small bone protuberances might be better than no bone protuberances for chewing food and self-defense. These evolutionists claim that *any* improvement would seem to be selected for, and most all transitional forms would seem to provide a survival advantage. If this were true, we would expect transitional forms to occur and they do not.

As noted earlier, teeth do not exist in a vacuum, but are part of a complex “functional system that necessarily has remained operational throughout evolutionary change” (Butler, 2002, p. 209). Irreducible complexity is therefore a valid concern because all of the basic parts of the dentomaxillary complex must exist for the system to be functional. University of California biologist Richard Goldschmidt (1982) even “challenged the adherents of the strictly Darwinian view ... to try to explain the evolution of ... teeth ... by accumulation and selection of small mutants” (p. 6–7). Importantly, no evidence exists of malocclusions in the first jawed fish, the placoderms: the first jaws articulated perfectly. To achieve perfect occlusion from day one is a large task for Darwinism (J. Cuozzo, 2004, personal communication).

In a paper published the same year as Goldschmidt’s, Butler (1982) discussed the many problems of tooth evolution, concluding that their complexity severely limits the number of ways teeth can evolve. Moeller (2003) added that the dentomaxillary system is very resistant to the effects of random mutations. Of the about 100 known human and animal mutations that affect the dentomaxillary system, almost all are loss mutations. No known genetic mechanism can selectively modify single tooth morphology, but rather typically causes a variety of damaging changes to the gingiva, the jaw, and related structures.

This research has caused Moeller (2003) to conclude

that the claimed “transitional” teeth involve various modifications that place them in hypothetical “phylogenies,” that are then retrofitted into a scheme to “demonstrate” evolution. He added that no evidence of beneficial mutational changes in the developmental cascade exists. He concluded that the claimed “tooth only” fossil record demonstrates only trivial modifications of previously created tooth forms.

What the fossil record does demonstrate is “quantum leap dental-maxillary morphologic changes” which are apparent only by considering the dento-maxillary system as a single identity. An example Moeller (2003) gave is that the elephants (proboscids) have an entirely different method of tooth eruption than ungulates. He concluded that evolutionists need to demonstrate fossil evidence for changes in tooth eruption patterns. The dento-maxillary system ought to provide untold examples of fossil intermediate malerupted teeth. The fact that there is no evidence of any such transitional modification of the dento-maxillary subsystems lends strong support for the Creation model.

Summary

Because teeth are comparatively well preserved in the fossil record, evidence for their evolution should be found if it exists. Osborn (1925) wrote that enamel is “the most enduring animal substance in the whole order of living Nature, defy[ing] all the vicissitudes of time and of subterranean burial and take first rank among Nature’s hieroglyphics of the past” (p. 40–41). Yet, in spite of a century of intensive searching, evidence for evolution of teeth still cannot be found. The claimed support for macroevolution usually amounts to nothing more than very ambiguous evidence, such as bone fragments which, in living animals, generally make up much less than 10% of the mass of the entire animal body.

As a result, it is on the basis of bones rather than fossil teeth the claims for evolutionary change are usually made. In the case of teeth, it is difficult to argue that more fossil discoveries will fill in the enormous number of missing links required to prove their evolutionary origin. Millions of fossil teeth have been discovered and not one has provided clear evidence of teeth originating by macroevolution. Conversely, the fossil record for teeth, as well as the complex structure of teeth, provide clear evidence for intelligent creation according to separate kinds.

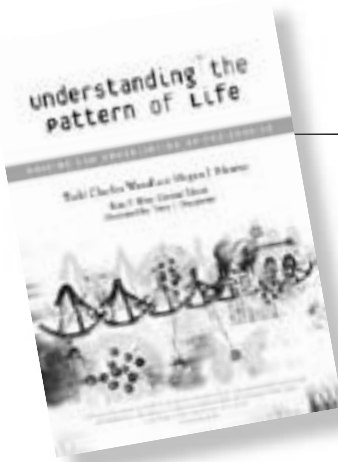
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Book Review

Understanding the Pattern of Life
by Todd Charles Wood and Megan J. Murray
Broadman & Holman Publishers, Nashville, Tennessee,
2003, 490 pages. \$25.00.

Todd Wood served as director of Bioinformatics for Clemson University Genomics Institute before becoming an assistant professor at the Center of Origins Research and Education at Bryan College. This paperback volume is composed of three general sections: Foundations, Methodology, and Application. Coauthor Megan Murray helped put the book into a popular, readable style. Each chapter ends with a summary, review questions, and suggestions for further discussion. Wood unabashedly starts with the Word of God and extensively uses scripture to illuminate his work. Indeed he demonstrates that the idea of a *baramin* (Hebrew for created kind) being fundamental to the pattern of life is derived from the biblical account.

Wood attempts to accomplish multiple things at once

with this work. On the one hand the book is designed to be a textbook, acting as an introduction to creationist systematics. In this regard it is very successful. But he also attempts to seriously advance the work of baraminology, which he defines as a creationist biosystematic method, with some novel definitions and approaches. Some of these are insightful while others are confusing. The book is also a practical handbook which offers helpful tips for practicing baraminologists.

The book begins with an excellent cursory history of the issues involving systematics. For any who will wonder how this study is relevant to creationism or why it should be undertaken in the first place, these chapters will be enlightening. The next few chapters seek to establish a

framework of terms, definitions and procedures for pursuing baraminology.

Wood builds on the discontinuity systematics initiated by Walter ReMine's book *The Biotic Message*. But the paraphrase of ReMine's definitions for holobaramin and apobaramin are incomplete. For example, an apobaramin is defined as "a group of organisms that do not share an ancestor with any other organism" (p. 23). In ReMine's book these definitions are immediately followed by a note that these only consider *known* organisms (ReMine, p. 445). By omitting this note and leaving the word "known" out of the definition, Wood produces a definition that would make identifying a holobaramin and apobaramin impossible because researchers will never have every specimen to consider.

The section on the Refined Baramin Concept introduces some new terminology and definitions. References to ancestry are replaced with the concept of holistic similarity. This is useful in practice but risks obscuring the focus of creation systematics. Baraminology is, after all, more than the study of interesting patterns and discontinuities. It is the serious business of approximating the created kinds by grouping their descendants together. At a minimum the statement should be made that continuity is demonstrated by interfertility. For example, if Wood's study of two organisms left him with the conclusion that "significant holistic difference" existed and that they should be in separate apobaramins, but subsequently someone produces a fertile hybrid; then, by definition, continuity should immediately be established. Moreover, hybridization is the objective yardstick to calibrate our concepts of significant holistic similarity. Indeed such lab and field evidence are important to answer the charges considered by Wood, "the evolutionist... finds our efforts nonsensical and arbitrary" (p. 71).

After discussing how an organism's traits can be plotted in multi-dimensional space, the author notes that "there are some combinations of characteristics that could *not* produce a real organism" (pp. 25–26). The areas of possible organisms are then defined as "Potentiality Regions." Confusion arises as to whether the space that could not produce a real organism is thus described because those organisms would not be viable (eg a mammal with no lungs) or whether they are not possible merely because of created limits on diversification that are inherent to the baramins. Perhaps the identification of another region, a "Viability Region," encompassing a broader area in which hypothetical organisms could survive (but would not be possible to code for) would help clarify the situation.

Wood then proceeds to define *baramin* as "all of the organisms that exist in a potentiality region at any point or period of history." But if one exercises the strict language

of his potentiality region, a combination of characteristics could be envisioned that would produce real organisms linking humans and apes. Therefore the two would belong in the same baramin! I believe this redefinition of a baramin is unfortunate. No doubt it is useful to define the other terms of baraminology in light of holistic continuity for methodological purposes, but the baramin should be left as a straightforward theoretical term that is understandable to lay creationists. Wise states it elegantly:

Just as theology is the study of *theos* (God) and biology is the study of *bios* (life), baraminology is the study of baramins. The ultimate end of baraminology is to identify, name, and classify baramins—God's created kinds (Wise, p. 112).

This more traditional definition avoids the confusing potentiality region and keeps the ultimate goal in this pursuit immediately before us.

The book next seeks to justify the baramin concept biblically. I concur with the author that there is no definitive revelation that the Hebrew *min* is an absolute biological classification, but the evidence for it is somewhat stronger than the book presents. In the first place, Genesis 1 repeats the phrase "after his kind" like a refrain ten times! Such scriptural repetition is significant. The Holy Spirit could merely have stated: "Let the earth bring forth some land animals." A mere four chapters later, the same inspired term is used for the divisions of creatures brought on the ark. If these bore little resemblance to the original created *min*, why employ this same term? Why not simply instruct Noah to take on board some fowl, some cattle, and some creeping animals? It seems that if the original kinds bred true for centuries up to the flood, this would be good evidence that they would persist thereafter. Some creationists also interpret Gen. 1:12 to infer reproductive limits and cite this as evidence for baraminic discontinuity. While that interpretation is disputed, it does deserve mention.

Wood notes that some scholars argue that extrabiblical usage of kind (or *min* in the original) indicates a meaning of "division" for *min*. He proceeds: "Since the precise meaning of *min* is still not clear, it is best to avoid using *min* as the foundation of baramin" (p. 27). It seems to me that scholars are fairly consistent in holding that the word means "division," or "kind." For example, the 70 Hebrew scholars that translated the Old Testament into Greek (the Septuagint) employed the word *γενος* or "genos." This is Strong's Number 1085 and the primary definition is "kin." It is used throughout the New Testament: "kind" (Mark 9:29; I Cor. 12:10, 28; 14:10), "family" (Acts 4:6), "race" (Mark 7:26; Acts 4:36; 7:13, 19; 18:2, 24; II Cor. 11:26; Gal. 1:14; Phil. 2:5; I Peter 2:9), and "offspring" (Acts 13:26, Rev. 22:16). After reviewing the word *min* in the Mishnah, Dead

Sea Scrolls, and other sources, Williams concluded: "The basic meaning of 'division' which is suggested by the etymology may support creationist views of biological taxonomy as involving major discontinuities" (Williams).

This issue is fundamental to our pursuits in baraminology. As the author states "...we believe that something like a 'discrete unit of biological creation' (to use a Marshian term) must exist..." (p. 71). If that originally created kind did not breed true, how would baraminology show this? The entire structure of baraminology assumes discontinuous kinds, so one might as well equate baramin with "created kind." If, in the end, the identification of holobaramin becomes completely untenable, then using it within creationism as a model for the baramin should be abandoned.

The authors nicely highlight the gaps in the fossil record as evidence of discontinuity. But the observations that have been formulated into the Law of Biogenesis could be noted as well. While the authors review interpretations of life's patterns, from Aristotle to Darwin to Wise, it is unfortunate that he does not reference ReMine's seminal work as well when discussing life's hierarchical pattern.

The middle of the book is primarily devoted to putting baraminology into practice. A chapter on hybridization is most instructive. At once the reader begins to appreciate that interspecies fertility is a major feature of the biosphere. Wood states, "Until recently, many non-creationist scientists have not recognized insterspecific hybridization as the extensive biological phenomenon that it is" (p. 98). In this way, Wood and Wise and their colleagues at Bryan College who are assembling this online database are making an enormous contribution, not only to creationism, but to scientific knowledge in general.

But the major advance over other attempts at baraminology (like those of Marsh and the *Wort und Wissen* group in Germany) is the procedure of holistically studying organisms and plotting their character traits to identify discontinuities. The book incorporates both Wise's query matrix and statistical baraminology. These chapters flow logically. They review the enormous strides made in recent years as Wood, Robinson, Cavanaugh and others have formalized the analysis of character diversity. The Analysis of Patterns and the discussion of biological trajectories are particularly enlightening.

Chapters nine and ten give a good overview of the concept of design in biology, suggesting a program for further development. Wood offers the insight:

"The Bible reveals a God who generously and gladly provides above and beyond anything anyone could ever need. Such a God would happily create millions of species precisely because humans do not *need* them" (p. 150).

The issue of "imperfect" designs (poor engineering, odd designs, vestigials, and carnivory) are addressed. Degeneration and the curse of Genesis 3 are detailed as important considerations. However, I felt that satisfying answers to Darwin's riddles were not presented. Why would a Designer sometimes use the same pattern for different purposes and then use different designs to accomplish the same ends? Why would an intelligent Designer use jury-rigged and odd designs?

The book ends by surveying the concepts of diversification and biogeography. Wise's popular analogy of baramins as trees in an orchard is augmented with emerging theories of rapid post-Flood diversification, followed by stasis. There is an inkling given of novel hypothetical mechanisms being developed by Wood and Wise to explain this diversification. Scheven's floating forest and Wise's pre-flood epicontinental lagoon models are nicely incorporated. Fresh and interesting insights into the rate and possible mechanisms for post-flood organism dispersal are presented in the last chapter.

In conclusion, *Understanding the Pattern of Life* is important reading for serious creationists interested in staying current with our movement. The work being performed by Wise, Wood, and the others is paramount. Indeed, it seems to me that this is some of the most fruitful, straight-forward, and most coherent model development that creationists can be doing today.

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Photographic Essay

Red Rock Canyon and the Valley of Fire

by Douglas B. Sharp*

Twenty-five miles west of Las Vegas, Nevada, the Spring Mountains rise abruptly from the desert, and the Los Madres Mountains branch east in an arc. These uplifts comprise the Red Rock Canyon National Conservation Area, run by the United States Bureau of Land Management (BLM). Red Rock Canyon is west of Las Vegas off Route 160. Driving west, one can see uplifted strata tilted to the north at nearly 40° (Figure 1).

These strata form the Los Madres Mountains, and include the uppermost Bonanza King Formation (Figure 2), a “Cambrian” limestone that overlies the “Jurassic” maroon Aztec Sandstone that forms the bulk of the Calico Hills. A sharp contact exists between the two formations. Turtlehead Mountain is part of the Los Madres Mountains. Towards Las Vegas, the tilted strata reveal “Triassic” and “Permian” sequences. The Triassic strata are the dark purple Chinle Formation and Shinarump Conglomerate, consisting of mudstone, siltstone, sandstone and conglomerate. Beneath them is the Permian Kaibab Formation, consisting of gray limestone with intervals of white gypsum.

One of the best views of the Cambrian limestone atop the Jurassic Aztec Sandstone is at Calico Basin, a turnoff

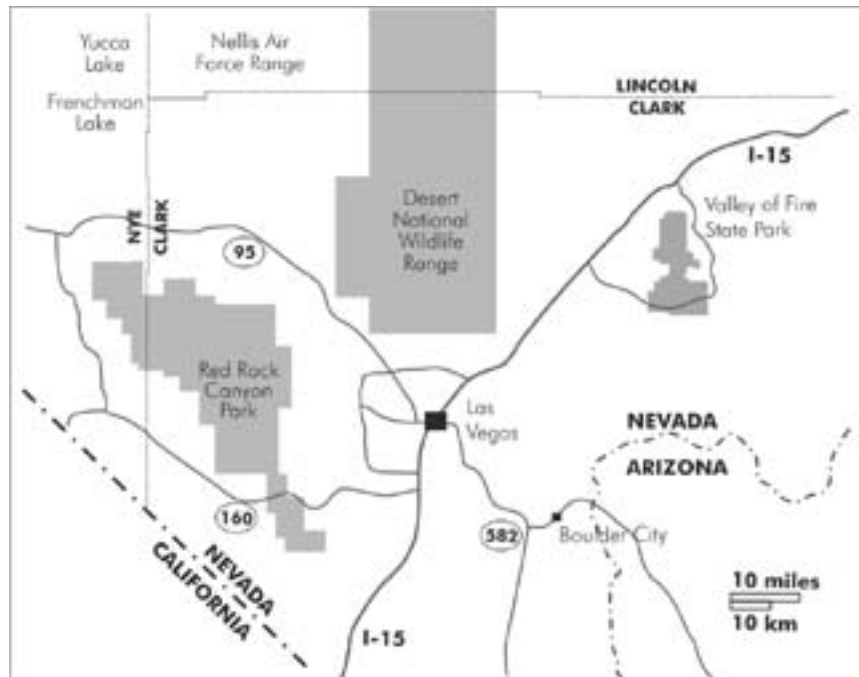


Figure 1. Location map for Red Rock Canyon National Conservation Area.



Figure 2. Bonanza King Formation as seen from Turtlehead Mountain near Calico Basin.

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Figure 3. Limestone-Sandstone sequence as seen from Calico Basin.

just before the park entrance (Figure 3). According to the geologic literature provided by the park, the out-of-order sequence is explained by the Keystone Thrust, a block of strata that was supposedly moved 60 miles from the west over the Jurassic sandstones (Madison, 1990).

The Red Rock Canyon visitors' center affords a grand view of the Calico Hills, directly beneath Turtlehead

Mountain, and the Spring Mountains to the west. The Spring Mountains contain the same out-of-order sequence as the Los Madres, with gray cap rock overlying the colorful sandstone (Figure 4). Beyond the visitor's center is a road that follows a circuit of the area. Along the route, there is a place to stop and explore the Calico Hills, a wonderland of wind and water-carved sandstone that forms a small



Figure 4. Out of order sequence at the Spring Mountains.



Figure 5. Calico Hills Canyon.



Figure 6. Alternating white and red bedding in Jurassic sandstone at Calico Hills Canyon.



Figure 8. Brecciated limestone.



Figure 7. Vertical limestone bedding on the White Rock Trail.

canyon—Calico Hills Canyon (Figure 5). Further along the route is a stop near an old sandstone quarry. The alternating white and red bedding is clearly visible at this stop (Figure 6).

The road proceeds around some switchbacks and just beyond the lookout at the highest point on the road, a turn-off takes you onto a rough gravel road to the trailhead for the White Rock Trail and Bonanza King Trail. White Rock Trail is a 10-mile circuit around a mountain, ending at Willow Creek day use area. The Bonanza King Trail branches off to the right from White Rock Trail to a limestone knoll where the contact between the limestone and sandstone can be approached from above. I walked a good distance by mistake on the White Rock Trail, thinking I was hiking to the Bonanza King Formation, but was rewarded with a marvelous view of a valley, eroded into the Red Rock Sandstone below the white Bonanza King Limestone. At this location, the limestone was almost vertical (Figure 7).

The Bonanza King Trail is shorter, only 1.1 miles long, though a bit steeper up the side of the mountain. From the White Rock parking lot, on Bonanza King Limestone, the path crosses a limestone ridge to the contact between the limestone and sandstone. At that spot, the limestone was brecciated, a sign of fault motion (Figure 8). However, the contact with the sandstone was sharp and no deformation or metamorphism was visible in the sandstone, nor was there any interbedding of the sandstone and limestone layers (Figure 9). There seemed to be a lack of physical evidence for the proposed thrusting except for the breccia, which perhaps reflects local faulting.

Without regional studies by creationists, it will be hard to determine if the Bonanza King Formation was indeed emplaced on top of younger strata. The local field evidence makes me skeptical of the uniformitarian explanation, but more investigation is needed. Whatever the geologic sequence, we understand that violent upheaval and erosion took place as the result of the Flood.

An interesting parallel to Red Rock Canyon is found 75

miles to the northeast at the Valley of Fire State Park, east on Route 159 to the Moapa Indian Reservation off Interstate 15, north of Las Vegas (Figure 1). Near the park, the Muddy Mountains tilt to the south and the bedding is easily seen. The strata there exhibit the same out-of-order sequence as Red Rock Canyon: Cambrian atop Jurassic, Triassic, and Permian. Purkey et al. (1994, p. 72) note: "This geologic similarity has let some geologists to propose that the two ranges were once part of a geologic block before Cenozoic extension pulled them apart." Two other possible explanations are that two different overthrusts produced the same out-of-order sequence 75 miles apart, or that one massive overthrust moved the Cambrian strata 150 miles. Regional



Figure 9. Contact of limestone and sandstone near the White Rock parking lot.



Figure 10. Erosion features in the sandstones at the Valley of Fire State Park.

study will be needed to evaluate the possibilities. The erosion features in the sandstone at the Valley of Fire are more complex than those of Red Rock Canyon (Figure 10).

The Muddy Mountains to the south of the park are composed of the Cambrian limestone, (Fiero, 1998) and are the first geologic features you encounter as you enter the park (Figure 11). Just after the western park boundary, the road descends down the center of a canyon, with a good view of eroded strata on both sides of the road. After the park sign, there is a view showing the contact between the limestone and sandstone. At the foot of the mountain, the red and white sandstone, carved by erosion into grotesque hoodoos, comes into view. The area is noted for this fantastic, eerie beauty and attracts many visitors (Figure 12). In this area an anticline shows Jurassic, Triassic, and Permian rocks in the center, and the older Cambrian rocks are exposed at the top, at the southern edge of the park.

Conclusion

Creationist models such as Catastrophic Plate Tectonics (Baumgardner, 2002) or the Hydroplate Model (Brown, 1995) can accommodate overthrusting. Large-scale tectonic motions are actually more believable in a catastrophic framework than a uniformitarian one. The two matching out-of-order rock sequences at Red Rock Canyon and Valley of Fire are interesting features that would be worth investigating by Flood geologists. Unconstrained by the need to keep the fossils in order, such an investigation might conclude that there was no overthrusting. Stronger physical evidence would be needed. Creationists are not limited to uniformitarian assumptions.

The 150-mile minimum distance the Cambrian strata



Figure 11. Cambrian limestones of the Muddy Mountains.



Figure 12. Hoodoos at the Valley of Fire State Park.

would have to move in the uniformitarian interpretation creates a problem with the dimensions of the thrust sheet. The proposed thrust sheet is ~15,000 feet thick. The amount of force needed to move that mass of rock should cause the rocks to buckle, instead. Reducing the force by pore pressure at the base of the thrust would be more likely in the Flood than otherwise. While the local physical evidence does not appear to support two different overthrusts, creating the same out-of-order sequence in both places, the question remains for further investigation.

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- For more information:**
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 Calico Basin/Red Springs, <http://www.sunsetcities.com/Red-Rock-Canyon/red-springs-calico-basin/calicobasin.html>
 Red Rock Canyon, <http://www.redrockcanyon.blm.gov/Resources/geology.asp>
 Red Rock Canyon National Conservation Area, <http://www.desertusa.com/redrock/>
 Nevada Division of State Parks, Valley of Fire State Park, <http://parks.nv.gov/vf.htm>



Book Review

Dragons: A Natural History by Karl Shuker

Simon & Schuster, New York, NY, 1995, 120 pages. \$22.50.

Shuker has employed his encyclopedic knowledge of zoology to try to understand data recorded by past civilizations. The first chapter is on “serpent dragons” or big snakes. Chapter two describes “semi-dragons.” These are the two-legged, wingless *lindworms* and the *wyverns* having a single pair of legs and wings. The *lindworm* may be, “based upon a real creature, but one that continues to elude formal scientific discovery.” This real creature would be the cryptid Tatzelworm (clawed worm) or Stollenwurm (hole-dwelling worm) which has been reported for centuries by people living in the Alps. According to these sightings, the Tatzelworm is, “1.2–1.5 meters long, with two visible forelegs” (p. 56). Zoologists believe it may be a large undiscovered skink or lizard or, perhaps a siren which is an eel-like amphibian (sirens are presently known only in North America). The Renaissance scientist Ulyssis Aldrovandi (1640, p. 404; see also Taylor, 1987, p. 41) had a specimen in his museum that he described and which closely resembles the Tatzelworm. However, this is topic for another paper.

The third chapter is on “classical dragons.” Among these are the English Wantley dragon (p. 62), the Australian *bunyip* (pp. 64–65), and a *dragonets* reputedly killed by Winckelreidt near its lair on Mt. Pilatus in Switzerland. According to Shuker, the “explanation ... may lie in the fact that skeletons of pterodactyls ... have been discovered in the locality of Mt. Pilatus” (pp. 74–75). Therefore it is believed that the people imagined what these fossils would have looked like and invented legends about them.

On pp. 66–69, Shuker described the *piasa*, a dragon-bird that devoured human beings, whose petroglyph Marquette observed in 1673 along the Mississippi River in Illinois. According to the Indians, the *piasa* preyed on deer, dwelt in an immense cave, ate dead bodies resulting from a battle between the Illini and an enemy tribe, and then became a people-eater. Covered with red, black, and green scales, the *piasa* was 9 m. long, 4 m. tall and it sported a pair of leathery wings with a span of 5–5.5 m. It had talons on its feet, a long serpentine tail terminating in a double fin [which sounds like a pterosaur’s tail vane], and its head had a huge pair of branched antlers like a deer. The face was

a grotesque parody of a man with teeth and a beard of stiff bristles on its chin. It was ambushed by using a person for bait who ran into the woods so that it had to fold its wings to prevent them from becoming entangled. Then other warriors shot arrows which bounced off the scales, though they wounded its wings and face. Blinded and unable to fly, the Indians killed it with tomahawks.

Chapter four is on sky dragons. The Amphiptere resembled a large snake with wings and no legs (pp. 78–79). This creature was allegedly observed on May 27–28, 1669, near Henham in Essex, England, according to a local pamphlet dating from that year entitled “The Flying Serpent.” The beast was about 3 m. long, as thick as a man’s leg, and covered in heavy scales. Its eyes were very big and encircled by broad wattled rings; its mouth contained not only a mass of sharp fangs, but also two tongues (one of which was normal, the other shaped like an arrow). It had a pair of disproportionately small wings that sprouted from its shoulders.

A painting of St. Margaret (p. 9) also represents a pterosaur-like creature with two legs, wings, two ears (or a crest?), and a long tail with a tail vane. Shuker didn’t comment on the tail vane, which is known from fossilized skin impressions of the *Rhamphorhynchus* from the Solnhofen limestone in Germany.

Neo-dragons are the subject for chapter five. Shuker wrote (pp. 96–97) that the *basilisk* (Greek for “little king”) evolved in past zoological thought to become the *cockatrice* (which term the Authorized Version used to translate the Hebrew word *tsepha* in Is. 11:8; 14:29; 59:5, and Jer. 8:17). In medieval times bird-like legs were added, a coiling tail, and eventually a pair of wings. A zoological origin for this may be a, crowing crested cobra, has for centuries been reliably reported in Central Africa by locals and western travelers alike. Partial remains of this controversial serpent have occasionally been obtained, but never formally identified with any species known to science (p. 99).

The crest, like a king’s crown, could have led to the Greek name, *basilisk*.

The Tarasque monster lived on the banks of the Rhone River near Nerluc in southern France (pp. 100–103). The people and livestock were hunted by the monster.

Larger than the biggest horse or burliest ox, the Tarasque

stood on six powerful limbs equipped with the murderous paws of a giant bear, and furiously switched its long viperine tail from side to side like living whipcord. ... Most extraordinary of all, however, was the massive carapace encrusting its back. Resembling the shell of a colossal tortoise, it bristled with an armory of mighty spikes, rendering the monster invincible to any form of attack. ... deafening roar, accompanied by a stream of fire that curled around its luckless victim and ignited his flesh like tinder.

St. Martha held two branches before the monster in the shape of the cross and led it to Nerluc where townspeople killed it in vengeance. Nerluc is now called Tarascon, in memory of that monster, and stages a Tarasque festival each Whitsun (Pentecost). The town's official seal depicts the former oppressor.

The carapace on the Tarasque's back that bristled with spikes is like the Nodosaurid dinosaurs who had "bones in the skin ... [that] tend to be fused together into great shield-like pieces of armour plating" (Norman, 1985, p. 160). Another similarity is the long tail for the fossil and the cryptid's description. However, Nodosaurids had only four legs, not six (Norman, p. 162). Paul Taylor mentioned a monster in Nerluc, though that it had long sharp pointed horns on its head (1987, p. 40). He suggested it may have been a *Triceratops*. Shuker's sources didn't mention horns on its head. It appears a Nodosaurid resembles the images

and descriptions Shuker recorded for the Tarasque monster better than a Ceratopsian.

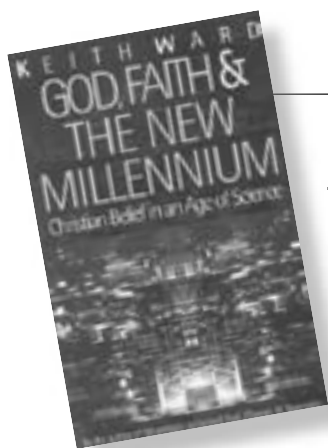
In 1505 the Renaissance sculptor Benvenuto Cellini, then five years old, observed a salamander in a fire. This creature was also reported by Aristotle and Pliny the elder. It was said to quench fires with a strange milky fluid that emitted from many star-shaped markings decorating its skin, which it could also spit like vitriolic foam from its mouth. Francis I, king of France, had an image of a salamander bathed in flames for his personal emblem. Perhaps a salamander emerging from a log in a fire explains these sightings, according to Shuker (pp. 110–113).

A bibliography, index, and many ancient representations are included. Those interested in this topic would undoubtedly benefit from Shuker's work.

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Book Review

God, Faith & The New Millennium by Keith Ward

Oneworld Publications, Rockport, MA, 2003, 220 pages. \$14.95.

Professor Ward believes in a personal, triune God who created the universe. As a Professor of Divinity at Oxford University, Ward has had many occasions to challenge the viewpoint of his colleagues Richard Dawkins and Peter Atkins that no intelligent and informed person could take a religious belief seriously. He would not, however, subscribe to the four tenants of the statement of belief of the Creation Research Society in the back of this issue. He believes that God did create all

things, but did so using evolution. His purpose for writing this book is to show that Christianity is a practical worldview that fits with modern science. In this book we can see how his acceptance of evolutionary science affects his views of God and the teachings of the Scriptures.

Professor Ward sees no contradiction between science and religion. He explains how science, rather than undermining faith, can expand our knowledge of God. If there is a vast intelligence behind the universe, it is reasonable to believe that He created the universe for a purpose that

we are capable of discovering. That purpose, he believes, is to create beings for fellowship with Him, beings that can find happiness by knowing and loving Him.

According to Professor Ward, our universe had to be fine-tuned to allow life to evolve. Science sees all things as having sprung into being by chance from nothing. But this “nothing” is a complex set of quantum fields. Ward believes that on the quantum level there are many possible states, but life is not the result of chance. Current theory holds that these quantum states all exist simultaneously until they collapse into only one state when observed. Ward sees God, not chance, choosing from the possible final states. He chooses the one that best suits His purpose for the universe. Ward’s God is not omnipotent in the popular sense of the word. Rather His choices are limited to those allowed by the laws of the universe He has chosen. He lacks a line-item veto. Where did those possible states exist before the beginning of space-time? They could only have existed in the mind of God. There was nothing else to contain them. So without God, there could have been no universe.

Modern science may see us as an insignificant flicker on an insignificant planet lost in a vast universe. What if the whole purpose of the universe was that on one tiny planet, beings could be created who were capable of sharing love? Then we would be the center of God’s purpose, even if we were not in the physical center of this vast cosmos. This God who created the universe can be a personal reality to us.

God permits much that He does not intend, Ward explains. God enjoys created things and must create them, but creation of beings capable of fellowship with Him involves trade-offs. Free will allows rejection of Him and permits suffering to enter the creation. Creation by evolution is not all-determining. Rather than creating things in their final form, God created indirectly, setting up physical laws to govern a highly organized and complex universe and then choosing from the possibilities that presented themselves. Some of the results were not to His liking, but taken as a whole, the result was good. Perfection is for the next world, not this one.

But to accept evolution, one must come to grips with the fact that a literal reading of Genesis does not allow for creation by that process. Professor Ward sees Genesis 1

and 2 as two separate tribal stories of creation. They are meant to teach spiritual, not literal truth. How does he know? He asked a Cheyenne elder who told him that his tribal stories are not literal accounts. Note the unspoken assumption here.

Professor Ward sees the soul as a goal of creation. Man’s brain is the most complex material thing in the universe, but the soul transcends the material world. At some time in evolutionary history the soul came into being, the non-physical from the physical. We are not told how.

Ward sees Christianity as unique among religions because its center, Jesus, is more than just a prophet. He is the Messiah and King; he is God. We can tolerate views of others and not believe they are stupid, but truth still is better than falsehood. Not all beliefs about God can be true, especially claims of deity. Ward sees miracles as possible interventions of God for His purposes, so he is inclined to accept the virgin birth, but Ward does not believe Jesus was God who became man. Rather, he was a man who was so “one with God” that God took him into the Godhead and even resurrected him. Thus the virgin birth is not an essential doctrine to Ward.

Ward believes that we are saved by faith, but the darkness of hell is just separation from God. Hellfire is merely our evil desires. Unbelievers stay in hell until they repent and decide to stop working against God’s purpose. They may repent at any time. Hopefully, all will repent eventually, but either way, all who oppose God will be excluded from heaven. Thus all evil will be excluded. At times Ward seems to understand that even men of great faith have sinful natures, but he does not explain how even the best of us can enter heaven without corrupting it.

Professor Ward’s book contains many beautiful insights, but it also shows how, when one tries to fit Christianity with the evolutionary worldview, one must spiritualize the scriptures until he can no longer know what God means to teach us.

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The Geology of the Timbered Hills Group in Oklahoma

John K. Reed*

Abstract

The Timbered Hills Group unconformably overlies the igneous basement in Oklahoma and consists of two formations, the lower Reagan, and the upper Honey Creek. With the exception of the highest “hills,” the Reagan Sandstone covers the eroded Carlton Rhyolite in southwestern Oklahoma and various other igneous rocks throughout the rest of the state. It grades up from nonmarine sands to marine sands, capped by a widespread glauconitic “greensand.” The Honey Creek conformably overlies the Reagan and unconformably overlies all but the highest remaining hills of the igneous substrate. It is composed of interbedded pelmatozoan grainstones and quartz sands, which grade up into the pure carbonates of the overlying Arbuckle Group. Evaluation of published field data indicates that the physical features of the two formations can be explained readily within the framework of the Genesis Flood. The Reagan contains the boundary between the freshwater and marine phases of the early Flood. The Honey Creek marks the transition from clastic deposition to the continent-scale North American carbonate platform that apparently formed early in the Flood.

Introduction

The previous paper in this series (Reed, 2004) described the igneous basement of Oklahoma: its lithology, structure, and proposed uniformitarian history. It proposed the formation of the igneous basement during the creation week, but recognized that an important tectonic feature of the southwestern part of the state, the Southern Oklahoma Aulacogen (SOA), could have formed at the beginning of the Flood. The SOA is a fault-bounded downwarp filled by bimodal igneous rocks, including rhyolites and sheet granites over mafic intrusives. Events of this period are obscured by later tectonism which splintered the SOA into several uplifts and basins (Figure 1).

Both within and without the SOA, a thick, predominantly carbonate, lower “Paleozoic” sedimentary sequence overlies the igneous basement in Oklahoma. These carbonates can be correlated across much of the North American midcontinent, but reach their greatest thickness in the SOA, the depocenter of a broad downwarp known as the Oklahoma Basin during the lower and middle “Paleozoic” (Johnson, 1988). The upper “Paleozoic” marks the tectonic breakup of the large midcontinent platform into sharply delineated, fault-bounded basins infilled predominantly by clastics.

This paper will describe the basal sediments in Oklahoma. They are classified as upper Cambrian, and the same vertical sequence occurs over most of the midcontinent in North America: (1) igneous basement, (2) an erosional surface, (3) a blanket sandstone, grading to (4) mixed carbonate and clastics, and finally to (5) relatively pure carbonate. In Oklahoma, the basal unit is the “Reagan Sandstone;” in

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Figure 1. Geologic provinces of Oklahoma modified from Northcutt and Campbell (1995).

System	Stage	Group	Formation
ORD.	495 Ma	Trempealeuan	Arbuckle
CAMBRIAN	Upper	Franconian	Fort Sill Formation
			Honey Creek Limestone
	Middle	Timbered Hills	Reagan Sandstone
			Carlton Rhyolite

Figure 2. Stratigraphy of the Timbered Hills Group modified from McElmoyl and Donovan (2000).

overlies Precambrian granite, gneiss, and rhyolite.

The Timbered Hills Group in turn is overlain by the regional carbonate sequence of the Arbuckle Group (i.e., it is correlated to the Ellenburger Dolomite in Texas and the Knox Dolomite in Tennessee). The Timbered Hills and Arbuckle groups range in thickness to more than 3,000 m (~10,000 ft) of shallow marine carbonates with a few interbedded sands and shales, deposited in a broad epicontinental marine setting that covered much of the region (Figure

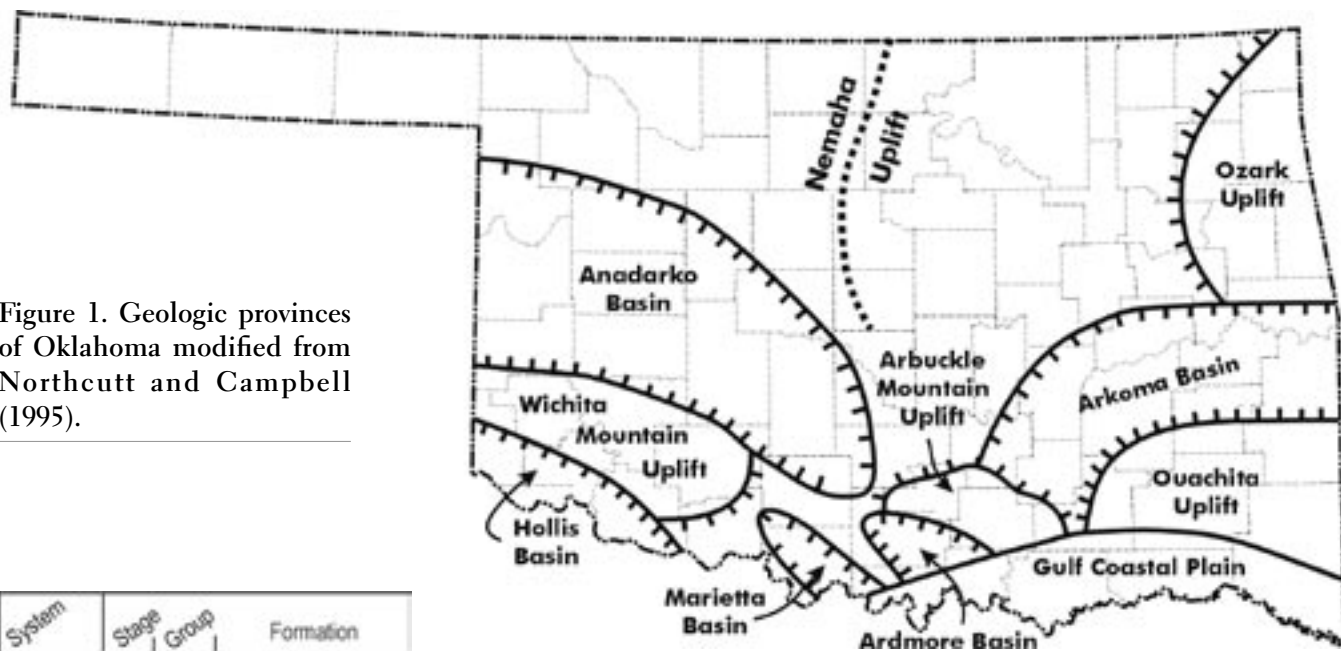
other parts of the midcontinent, it is called the “Lamotte,” the “Hickory,” or the “Mount Simon.” In Oklahoma, the Reagan grades up to the Honey Creek Limestone (Figure 2). The substrate for the Reagan in the SOA is the Carlton Rhyolite (Donovan, 1995), but outside the SOA, the sandstone unconformably

3). This study summarizes published descriptions of the strata, attempts to dissect the uniformitarian interpretation from that description, and then develops an alternate explanation consistent with biblical history. Other interpretations are certainly possible within the biblical worldview, and the additional work of other creationists to refine and correct the conclusions of this study is welcome.

The Ouachita Trough

The coastline at the time of the Cambrian transgression is thought to correspond roughly with the Ouachita Front, a regional series of “late Paleozoic” thrust faults transporting a thick clastic section, interpreted as deep water clastics, over shelf carbonates. Somewhere in southeastern Oklahoma (now obscured by the thrusting) was the boundary that is perhaps analogous to the shelf-slope transition of modern oceans. Prior to thrusting, geologists envision the Ouachita section as a deep marine trench. The Timbered Hills Group has not been encountered in outcrop or by drilling in the Ouachita province (Johnson, 1991). Because the boundary is profound, regional, and lithologic, it may well represent the shoreline at the time of the Flood (Figure 3).

Southeastern Oklahoma comprises some of the most complex geology in the world. The apparent northward transport of multiple allochthonous sheets, combined with significant structural deformation resulted in tight folding, overturned strata, imbricate thrusts, and repeated section; these various factors hinder accurate stratigraphic reconstruction of the offshore Ouachita section, despite numerous wells, seismic lines, and years of study. In addi-



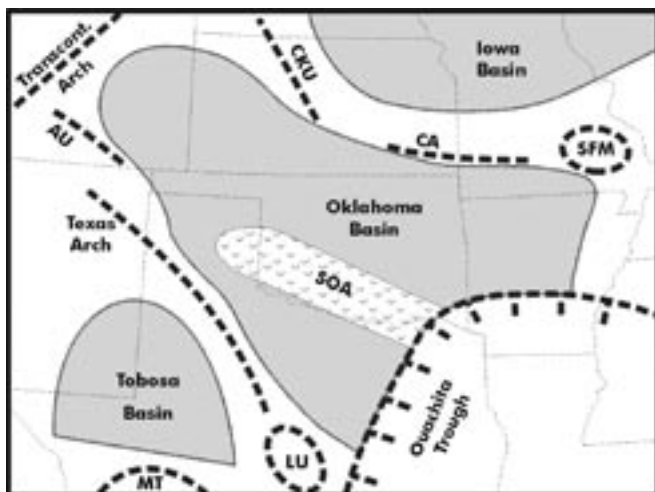


Figure 3. Extent of “lower Paleozoic” Oklahoma Basin and its relationship to the Southern Oklahoma Aulacogen modified from Johnson et al. (1988). CKU = Central Kansas Uplift, CA = Chautauqua Arch, SFM = St. Francois Mountains, LU = Llano Uplift, MT = Marathon Trough.

tion, the clastics are lithologically similar and it is difficult to correlate deepwater clastics to the predominantly shelf carbonates.

Because of these problems, it is virtually impossible to produce a composite stratigraphic section or a standard reference section of the Ordovician Ouachita facies with which to correlate. (Suhm, 1997, p. 27).

Gatewood and Fay (1991) discuss the Ouachita-Oklahoma shelf boundary and correlation between the Ouachita clastics and shelf carbonate. Further discussion of the Ouachita Front will be deferred to another paper.

Summary of Basement Surface

If the geological activities that formed the majority of the Oklahoma stratigraphic section occurred during the single year of the Genesis Flood, then a close relationship should be discernable between successive elements of the vertical sequence. If the tectonic and magmatic episode that formed the SOA occurred at the onset of the Flood, then the relationship between the basement igneous rocks and the subsequent sediments must have been much different from that envisioned by uniformitarians.

Neither age nor compositional boundaries of these Precambrian rocks appears [sic] to have had a substantial effect on Paleozoic history. (Johnson et al., 1988, p. 310).

Uniformitarians envision a long period of intense tropical weathering of the Wichita igneous complex based on its

paleogeographic location relative to the equator (McBee, 1995). There is little direct evidence of this belief other than the irregular topographic surface. The topography of the basement can be observed in outcrop in the Wichita and Arbuckle Mountains with relief up to 300 m (1,000 ft) in the Slick Hills (Donovan, 1995). The slopes of the basement hills in outcrop are gentle, but prior to sedimentation, the rhyolite was apparently tilted $\sim 5^\circ$, intruded by diabase dikes, and cut by north-south faulting before sediments were deposited. Donovan and Burchett (2000) noted a pre-Reagan dip of 22° in the Slick Hills. These data are consistent with synchronous tectonism and magmatism, followed immediately by sedimentation.

Outcrops provide direct observation of the igneous substrate in the Slick Hills.

Most exposures weather red-brown; the most common lithology is porphyritic lava; phenocrysts are either feldspar or quartz. In most of the rhyolite exposures, flow structures have been observed. (Tsegay, 1983, p. 17).

Donovan and Stephenson (1991) noted that the Carlton surface underwent rapid subsidence and saw no evidence of the rhyolite being elevated relative to the craton. Additionally, they noted that the topography was rugged outside the SOA, too; to the north are the “Tulsa Mountains,” and the map of the basement surface (Reed, 2004, Figure 3) shows irregular topography. From a regional perspective, however, the basement surface shows another face.

The surface on which the Cambrian seas transgressed was generally of low relief (about 100 m), supported by a heterogeneous suite of mostly granitic igneous rocks swept clean of any significant debris. (Johnson et al., 1988, p. 310).

Thousands of square kilometers of igneous basement were “swept clean” prior to Reagan deposition. That statement deserves much greater consideration than given by uniformitarian geologists; one does not often see vast areas of continental basement “swept clean” as a matter of course. The extent and amount of erosional energy required to do this is certainly elevated relative to processes operating today. Also, stripping the basement down to granite over most of the continent speaks to a rapid event, since even a few millennia of weathering, erosion, and redeposition would recover the clean basement surface with sediment and soils. Thus, the extent and efficacy of erosion combined with the widespread deposition of the Reagan and its correlative sands speak to the scale and rapidity of both events.

Another distinction between uniformitarian and creationist approaches to the initial sediments lies in the timing of the magmatism of the SOA. If it occurred as a result of the initiation of the Flood, heat flow would have been elevated during early sedimentation, and we would expect significant

geochemical activity due to magmatic outgassing, resulting in local, dramatic changes in pH and Eh.

Timbered Hills Group: Reagan Sandstone

General Extent and Geometry

The Reagan Sandstone covers the basement of most of Oklahoma and extends across most of the midcontinent under the various names mentioned above. It is absent only over topographic highs in the basement, such as the Tulsa Mountains (Figure 4) and highs in the Wichita and Arbuckle Mountains (Johnson, 1991). In some areas the absence may be the result of nondeposition and in others, later erosion. Often it is impossible to tell. The Reagan and its equivalents are present in a vast number of wells and are exposed in outcrops in the Arbuckle and Wichita Mountains in southern Oklahoma, in the St. Francois Mountains and Ozark Uplift in Missouri, and in the Llano Uplift in Texas (Johnson et al., 1988). The initial post-basement sediments are more complex at the Llano Uplift, where more than 300 m (1,000 ft) of marine clastics were deposited, and much of those sediments are dated earlier in the Cambrian (Dresbachian) than the Reagan. The SOA forms an abrupt northern boundary for these thicker clastics; the Reagan is commonly less than 60 m (200 ft) in thickness (McBee, 1995).

The Reagan is time transgressive to the northwest (Johnson et al., 2000). The Cambrian transgression migrated in that direction over Oklahoma from the Cambrian continental margin (probably near the Ouachita front), depositing 15–76 m (50–200 ft) of sand over most of the state (Johnson, 1991), but greater thicknesses of 23–137 m (75–450 ft) in the Arbuckle region (Ham, 1973). This remarkable uniformity of sediment thickness and composition speak to similar depositional processes across the entire area, especially in light of the irregularities in the basement surface that are in places greater than the thickness of the formation.

Even more remarkable, this relatively thin vertical sequence from the basement into the Paleozoic is similar across much of Texas, Oklahoma, Kansas and Missouri (Donovan, 2000b). The basal sand is generally feldspathic and glauconitic, consisting of reworked detritus eroded from the igneous basement, and quartz sand from the cratonic interior. Depositional conditions over the same area changed drastically immediately after the Reagan; thousands of feet of almost pure carbonate were deposited over much of North America. The transition between the siliciclastics of the Reagan and the pure carbonates of the Arbuckle Group in Oklahoma is the Honey Creek Formation, which ranges between 30 and 90 m (100–295 ft) thick.

The Timbered Hills and Arbuckle Groups are better exposed in the Slick Hills (Figure 5) than in the Wichita and Arbuckle Mountains (cf. Figure 1, Donovan, 1986), and better in the eastern Slick Hills than in the western.

Donovan (2000b, p. 48) stated: “The exposure quality is high, and facies variation can be adequately assessed.” Thus the descriptive sections in this paper are heavily weighted to the Slick Hills outcrops. The eastern Slick Hills exposes a homoclinal section that dips 20°–50° NW over almost ten miles of outcrop (Figure 6). The thickest Reagan in this area is associated with minimal relief; basement showing greater relief is overlain by thin Reagan beds (Tsegay, 1983).

Composition

Stitt (1973) describes the Reagan in the Arbuckle region as a fine to medium-grained, red-brown to white, glauconitic arkose, a composition mineralogically similar to the basement. Its lower beds are discontinuous where interrupted by the irregular topography at the onset of the transgression. In the Slick Hills

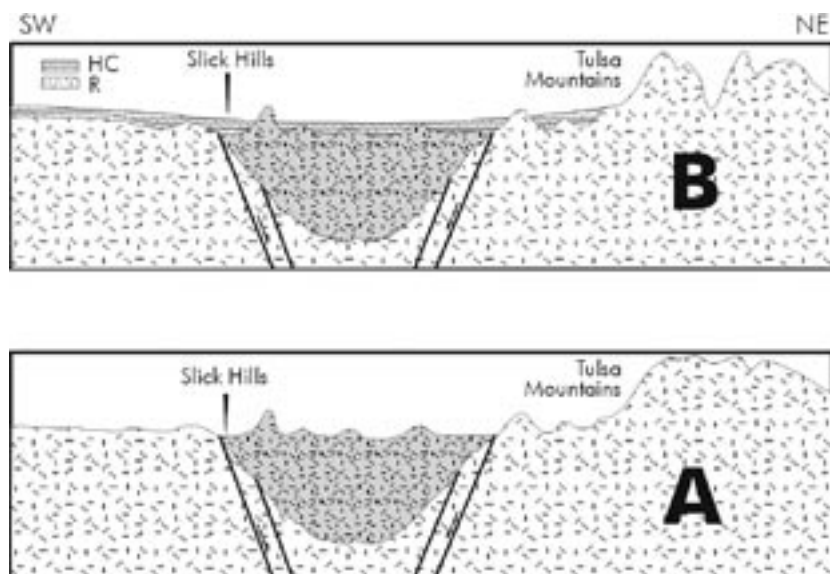


Figure 4. Cross section of the Oklahoma basement (A) before the Timbered Hills transgression, and (B) following Timbered Hills sedimentation. Igneous fill in center represents SOA. R = Reagan Formation, HC = Honey Creek Formation. From Hosey and Donovan, 2000.

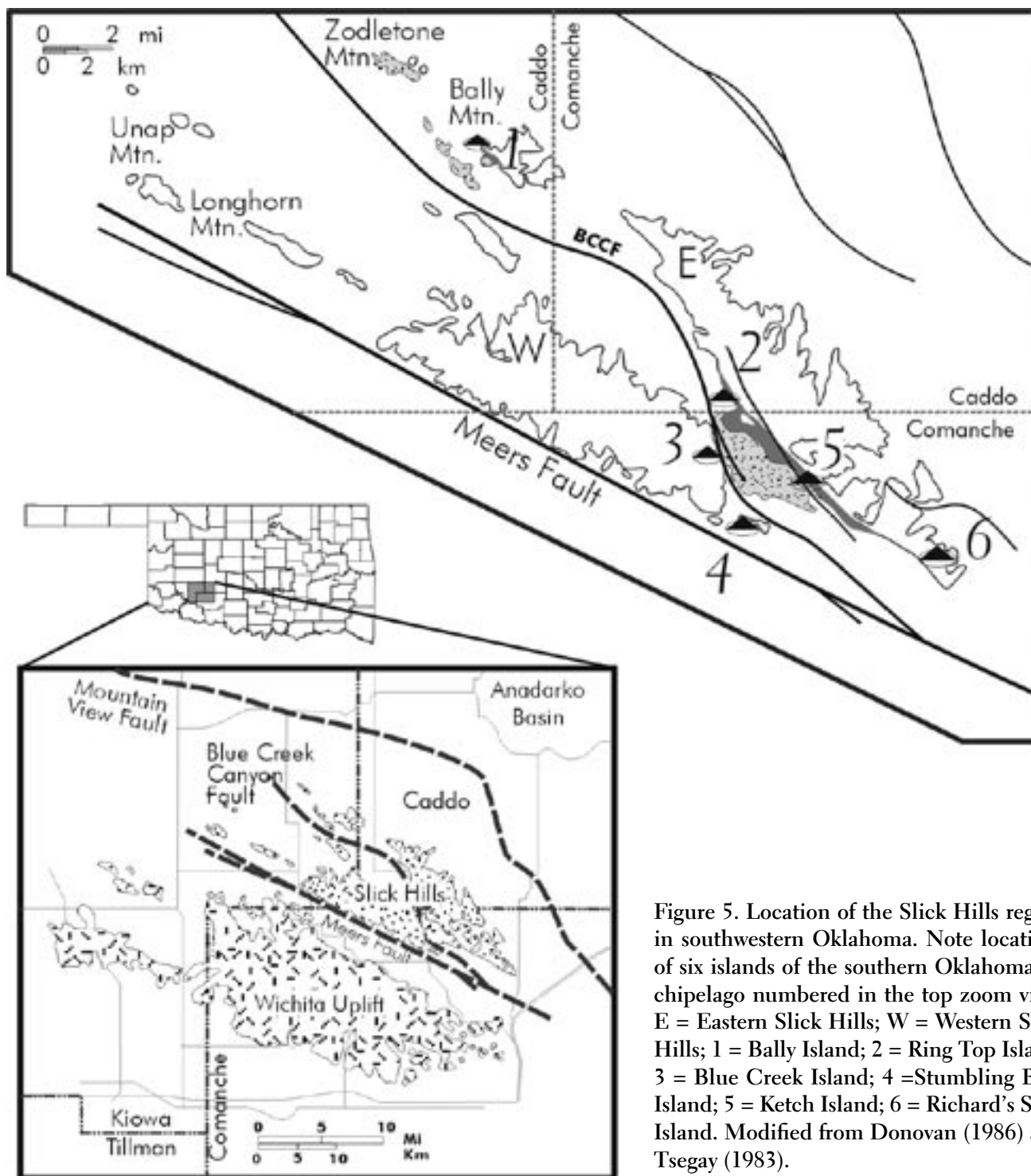


Figure 5. Location of the Slick Hills region in southwestern Oklahoma. Note locations of six islands of the southern Oklahoma archipelago numbered in the top zoom view. E = Eastern Slick Hills; W = Western Slick Hills; 1 = Bally Island; 2 = Ring Top Island; 3 = Blue Creek Island; 4 = Stumbling Bear Island; 5 = Ketch Island; 6 = Richard's Spur Island. Modified from Donovan (1986) and Tsegay (1983).

region, this surface formed islands which are known as the "southern Oklahoma archipelago." Although trilobites (mostly fragments) are present in the middle and upper parts, no body fossils are found in the basal beds.

Tsegay (1983) described seven facies of the Reagan in the Slick Hills. These included: (1) basal and fringing con-

glomerates and Breccio-conglomerates; (2) lithic sandstone; (3) red-brown orthoquartzite (sandstone composed almost entirely of quartz grains); (4) purplish-red orthoquartzite; (5) tan (buff) orthoquartzite; (6) green (glauconitic) sandstone; and (7) green shale. In more recent publications, this empirical classification has been diluted by interpretation,

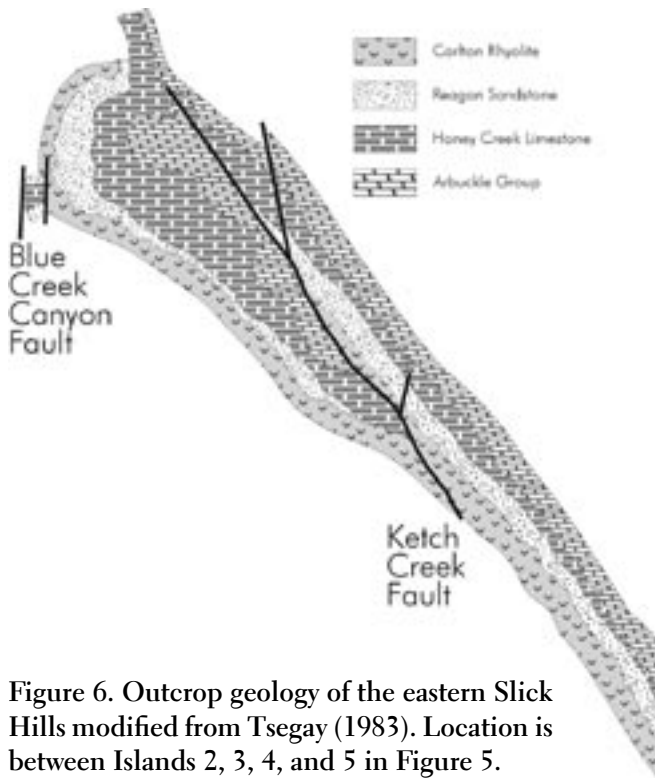


Figure 6. Outcrop geology of the eastern Slick Hills modified from Tsegay (1983). Location is between Islands 2, 3, 4, and 5 in Figure 5.

as is demonstrated by the use of interpretive terminology below. This “evolution” is an example of how descriptive work is submerged beneath interpretive and the two are seldom divorced.

The “interpretive” facies of the Reagan Sandstone fit into a general vertical sequence of lower (1 below), middle (2–4 below), and upper (5 below) parts of the formation. The facies include:

1. *Detrital Alluvial Facies.* Donovan (1986) described the basal deposits of the Reagan as red-brown, poorly sorted conglomerates and sandstones that overlie the irregular topography of the basement, and fill channels cut into the rhyolite. He interpreted this facies as alluvial talus and braided stream sediments. This facies is approximately 12 m (40 ft) thick in the Slick Hills area and is composed of sediments that have been locally eroded and redeposited. The basal conglomerates are most commonly found in valleys and channel deposits and are usually less than 2 m (6.5 ft) thick. Individual beds, which are poorly sorted and show no sedimentary structures, range up to 1 m (3 ft) thick. The matrix in the lower beds is rhyolite debris, in contrast to the glauconite, phosphatic shell debris, and mature quartz in the upper beds (Tsegay, 1983).

Rhyolite conglomerates are found fringing the hills at all levels in the Reagan, but are laterally restricted. Rhyolite pebbles and cobbles range up to 15 cm (6 in) in diameter, decrease in size up section, and are glauconitized in the beds of the upper formation (Tsegay, 1983). Red-brown orthoquartzite is restricted to one locale, with small-scale trough cross beds and horizontal laminations. Tsegay (1983) shows this facies stratigraphically beneath the shoreline facies sands. A significant component (up to 15% of the whole rock) of this facies is iron in the form of hematite cement (Cloyd et al., 1986; Tsegay, 1983). Iron is present in all facies of the Reagan in various forms including iron-rich illite, replacement ankerite, glauconite, pyrite, and siderite, as well as intraformational ferruginous ooids and glauconite peloids.

2. *Shoreline Facies.* Fine to coarse-grained, well-sorted, occasionally pebbly quartz sandstone overlies the alluvial facies. These sands are purple (hematite cement) and tan (silica cement). Up to 15% ferruginous ooids (deformed against quartz and rhyolite grains during diagenesis) are present as well as traces of plagioclase and microcline (Donovan and Burchett, 2000). The ooids are composed of alternating bands of hematite and illite. A photo from Tsegay (1983) showed a 1-mm ooid composed of a silt particle nucleus surrounded by alternating bands of hematite and illite. This ooid and many others were deformed by compaction prior to cementation. These sands are interpreted as tidally influenced shoreline sands derived from the craton (Donovan, 2000b).
3. *Lenticular Sandstone Facies.* Much of the middle Reagan is composed of lenticular bodies of quartz sandstone up to 10 m (35 ft) thick. They are composed of up to medium to large-scale cross beds (Donovan and Ragland, 1986) and show an upward decrease in both grain size and bed thickness (Tsegay, 1983). The sandstone is composed of dominantly unstrained quartz with some rhyolite clasts, glauconite peloids, ferruginous ooids, and phosphatic debris. Reactivation surfaces are common across the faces of cross beds, and vertical burrows of the *Skolithos* ichnofacies are present in small scale cross beds. Cross beds show bimodal and bipolar paleocurrents to the NW-SE, with asymmetric frequency to the SE.

On the assumption that the transgression was to the northwest... flood tides were evidently less effective than ebb tides in moving sediment. In other words,

the adjacent craton was a net contributor of large volumes of siliciclastics to the transgressing seaway. (Donovan, 2000b, p. 49).

Tsegay (1983) notes that cross beds in the purple facies show evidence of rapid deposition (steep bed angles) and variations in the strength of the current flow. Both of these observations support a Flood scenario.

4. *Heterolithic Sequence Facies.* Gray-green shale is interbedded with the middle and upper Reagan sandstones. At Bally Island, these shales are present immediately above the first middle Reagan shoreline sands. The shales are composed of olive green illite. Like the sandstone bodies, the shaly interbeds also show small-scale, bipolar lenticular bedding and horizontal burrows. No organic carbon is present.
5. *Green Sandstone Facies.* The upper part of the Reagan Formation is a distinctive widespread green, fine to coarse-grained, peloidal, quartzitic sand that receives its distinctive color from up to 60% glauconite peloids mixed with quartz sand, phosphatic nodules, rhyolite grains, and up to 10% phosphatic brachiopod parts (*Lingula* sp.). Glauconite is also present as an alternation of rhyolite clasts, and is illitic rather than smectitic in composition (Tsegay, 1983). An orange, iron-rich illite matrix is present in the lower beds of the greensands, except at Zodletone Mountain (Figure 5) where excess iron allowed the development of a glauconite matrix (Tsegay, 1983). There is a positive correlation between glauconite peloids and phosphatic fragments, interpreted as evidence for an organic origin of the glauconite from the brachiopods and other fauna (Donovan et al., 2000), but bioturbation is much less abundant in the upper sands compared to the middle sands. The absence of *Skolithos* in the upper greensands may reflect deeper, less oxygenated water. Some outcrops reveal bipolar cross bed sets up to 1.5 m (5 ft) thick. *Cruziana* ichnofacies are also present (McElmoyl and Donovan, 2000), but at Bally Island, the cross beds are only ~30 cm (12 in), indicating lower energy. Conversely, rhyolite conglomerates are more abundant at Bally Island in this facies, where six individual layers of rhyolite conglomerate with pebbles and cobbles up to 15 cm (6 in) thick are present.

The typical vertical sequence of these facies includes a basal unit of the detrital alluvial facies, a middle unit including tidally-influenced lenticular and shoreline facies, interbedded with the heterolithic sequences, and finally a

widespread upper greensand faces (Figure 2). The middle unit includes coarse-grained purple and brown, medium scale trough cross-bedded quartz with hematite and quartz cement, covered by a tan to light brown sandstone with abundant *Skolithos* with tapering and slightly sinuous burrows ranging up to 15 cm long and 1 cm across. *Arenicolites* U-shaped burrows are also present (Tsegay, 1983).

Sedimentary structures in the Reagan Sandstone are dominated by the small to medium-scale trough and planar cross bedding in sets up to 2 m (6.5 ft) thick. Paleocurrent directions from the cross beds in the purple sand facies are unimodal to the SE; those in the greensand are bimodal, dominantly to the SE and subordinately to the NW (Tsegay, 1983). The bimodal cross beds are considered strong evidence for a tidal style environment.

Understanding of diagenesis in the Reagan is complicated by the later uplift and reburial during "late Paleozoic" time. Pre-cement porosity in the Reagan is quite high, suggesting early cementation. The lower Reagan sands are cemented by particulate hematite covered by syntaxial quartz overgrowths. Hematite cements persist into the middle Reagan but silica cement is also present, both with and without hematite. In the middle sands there was sufficient time prior to cementation to compact the ferruginous oolites against the harder grains. Higher in the formation, hematite is absent and silica cement is not well developed. In the greensand facies, an iron-rich illite matrix inhibited cementation; peloids show greater compaction and the greensands weather more easily than the lower facies. A change in cement chemistry occurs just below the top of the formation, where calcite and ankerite cements are present. The introduction of carbonate cements probably resulted from infiltration of carbonate-rich fluids downwards from the Honey Creek.

The contact between the Reagan Sandstone and Honey Creek Limestone has been moved up and down the section during its history (McElmoyl and Donovan, 2000), but is presently placed at the level of the first bioclastic grainstone. The lowest Honey Creek beds include abraded and broken pelmatozoans (echinoderms) and minor shell debris, with reworked quartz, rhyolite, glauconite, and phosphate grains.

Although a few grains appear toward the top of the Reagan Sandstone, the widespread incoming of bioclastic grainstones is taken as the base of the Honey Creek Limestone. (Donovan, 1986, p. 2).

A diagenetic reaction between carbonate and glauconite formed a distinct orange ankerite layer at the boundary of the Reagan and Honey Creek (Donovan and Ragland, 1986). This phenomenon occurred when iron-silica cementation gave way to iron-silica-carbonate cementation.

(Cloyd et al., 1986). Ferrous iron was incorporated into the existing carbonate grain lattices resulting in coarse crystalline ankerite forming euhedral rhombs. This diachronous boundary (Donovan, 2000b) ranges from 0.6–4.6 m (2–15 ft) thick and persists throughout Slick Hills, an area of over 48 km² (30 mi²). The thickness variations of the ankerite zone are attributed to varying permeability of the sediments during diagenesis (Cloyd et al., 1986). Although the ankerite contact is commonly sharp, it does not always correspond to bedding. Ankerite replacement occurs both with and without the destruction of previous bedding.

Timbered Hills Group: Honey Creek Limestone

General Extent and Geometry

The Honey Creek Limestone overlies the Reagan Sandstone with no apparent erosional boundary and unconformably overlies the Carlton Rhyolite where the Reagan is missing. Examples of Honey Creek-Carlton contact are visible in the Blue Creek Canyon and Bally Mountain (c.f. Figure 5) areas of the Slick Hills (Rafalowski, 1982). The base of the Honey Creek is defined by the first marine pelmatozoan-rich grainstones (Donovan, 1986), and the Honey Creek is conformably overlain by the Fort Sill Formation of the Arbuckle Group. The introduction of carbonate is significant: “Ultimately, the area became part of the immense Late Cambrian-Early Ordovician microtidal carbonate platform that circled the Laurentian craton.” (Donovan et al., 2000, p. 40). The contact between the Honey Creek and the Fort Sill Formation is defined by the first occurrence of persistent carbonate mud. Both the upper and lower Honey Creek contacts are visible and laterally continuous in outcrop.

Like the Reagan, the Honey Creek Limestone is exposed in outcrops of the Slick Hills, the Wichitas, and the Arbuckles in Oklahoma. Rafalowski (1982) found five good exposures in outcrops in the Slick Hills. Based on lithology, fauna, and sedimentary structures, the formation is subdivided into three informal members: “upper” and “lower” members, divided by a discontinuous “red limestone” member defined by McElmoyl and Donovan (2000). In the Slick Hills, the Honey Creek Formation ranges between 37 and 91 m (122–300 ft), has an average thickness of 60 m (200 ft) and thins to the northwest (Donovan and Ragland, 1986). In the Arbuckles, the formation is only 30 m (100 ft) thick, but it thickens to ~70 m (225 ft) and is dolomitized on the craton (Ham, 1973).

Uniformitarians use biostratigraphic correlation (trilobite fauna) to equate the Honey Creek with the Davis Limestone in Missouri; various members of the Wilberns

Formation in Texas; the Franconia Formation in Wisconsin and Minnesota; the Deadwood Formation in South Dakota; and Copper Ridge Dolomite in Georgia, Alabama, and Tennessee. Rafalowski (1982) provided a concise historical summary of the stratigraphic studies in the area.

Composition

The Honey Creek Formation is “a resistant, coarsely-crystalline, glauconitic, bioclastic limestone interbedded with tan to brown, fine-grained, glauconitic, calcareous, bioclastic sandstone and green shales.” (Rafalowski, 1982, p. 47). Stitt (1973) described the formation in the Arbuckles as a gray, fossiliferous, glauconitic biosparite. Rafalowski (1982) identified three components of the Honey Creek: siliciclastics, allochems, and authigens, as well as related sedimentary features. The distribution and nature of these in the Slick Hills are shown in Table I. The grainstones are well washed and cross-bedded (Donovan and Ragland, 1986) and the beds in the formation vary from pure bioclastic grainstone to mixtures of quartz, carbonate, rhyolite, phosphatic debris, and glauconite. The siliciclastic fraction increases upward through the formation to a layer called the “quartz spike” towards the top of the formation, before decreasing dramatically (Figure 7). In contrast to the Reagan, the Honey Creek contains very little detrital clay (Donovan et al., 2000), but is well cemented with virtually no porosity (Rafalowski, 1982).

The formation contains abundant small to medium-scale, planar, trough, and herringbone cross beds with NW-SE bipolar trends (similar to the Reagan) and many reactivation surfaces (more dominant in the lower formation). However, while the cross bed sets of the Reagan range up to 2 m (6.5 ft), those of the Honey Creek seldom exceed 23 cm (9 in). The alternating laminae are both planar and wavy. Bed boundaries between the two grain populations have been altered during diagenesis by pressure solution and stylotization of the carbonate grains (Rafalowski, 1982). Faunal diversity increases upward from the Reagan to the Honey Creek, with phosphatic brachiopod shells, both vertical and horizontal trace fossils, and carbonate pelmatozoans, orthid brachiopods, and thick-shelled trilobites present (Donovan, 2000b).

Several different facies are present in the Honey Creek Limestone. In addition to the pelmatozoan grainstones, there are mixed grainstones and quartz sandstones in alternating thin beds that maintain a striking purity of the end members. In areas of mixed composition, there is distinctive wavy bedding with alternating carbonate and siliciclastic beds with small scale cross bedding in each lithology. Rafalowski (1982) described a number of facies. These are shown in Table II. In Blue Creek Canyon, the

Table I

Constituent		Description	Distribution
Siliciclastics	Quartz	grains= silt to medium sand, angular to sub-rounded; overgrowths as cement; beds= lenses with small cross beds, laminae, detritus; inverse relationship between quartz and fauna	Overall decrease upward; but increase into "quartz spike" near top of formation
	Feldspar	mostly K-spar angular to subangular silt to medium sand	similar to quartz
	Rhyolite	sand to boulders; roundness decreases up section; devitrified, altered to iron minerals	size and abundance decreases up section; clasts from Carlton Rhyolite
Allochems	Pelmatozoans	grains= medium sand to pebbles, usually single plates; early syntaxial overgrowths common; late pressure solution features	decreases up section; up to 90% of rock in lower beds
	Trilobites	most are fragmented, though thick shelled; fragments range up to 6 mm; create geopetal porosity	fragments up to 20%; most common in middle of formation
	Brachiopods	disarticulated; up to 4.25 mm; some replacement, geopetal porosity	most common at unconformity with Carlton Rhyolite
	Phosphatic brachiopods	broken fragments up to 4.75 mm; up to 5% abundance	most common in mid formation; along carbonate laminae and pressure solution bands
	Plant fossils, stromatolite, oncolites, algae	stromatolites = red-brown, columnar and bulbous growth; oncolites = alternating carbonate and hematite on fossil fragments, range up to 2 mm	only near unconformity with Carlton Rhyolite; one layer, 127 mm thick, 609 cm across
	Peloids, trace fossils	micrite peloids well sorted, 2-3 mm, up to 20% of grains; ovoid; fecal origin; glauconite peloids up to 3 mm, up to 15% of grains; many replaced by calcite; all peloids associated with fossils	micrite peloids in one layer near top of formation; glauconite peloids decrease up formation
Authigens	sparite	abundance ranges 3-56%; up to 1.5 mm; mostly syntaxial overgrowths on pelmatozoans; also blocky, equant, drusy, radial cement	generally decreases up formation
	micrite	occurs as fill of geopetal porosity, burrows, etc.	generally decreases up formation
	dolomite - ankerite	1) zoned (by iron) single rhombs <5% of rock; 2) sparry mosaics that comprise up to 70% of rock	present in lowermost part of formation
	iron minerals	glauconite = peloids; hematite = trace amounts as grain coatings, glauconite replacement, void fill; pyrite = trace amounts associated with glauconite	glauconite decreases up formation; hematite also decreases up formation
Sedimentary Features	stylolites	stylolites and pressure solution present; insolubles occur along boundaries	horizontal stylolites in all formation
	voids	formed by shell fragments	abundant throughout formation

facies are interpreted as reflecting two environments: (1) a sheltered coastal environment with mud, stromatolites, and brachiopod shell banks, and (2) an exposed rugged

rocky shoreline with rock pedestals, fissures, rounded rhyolite boulders, covered by coarse grained pelmatozoan sand bodies (Rafalowski, 1982). Donovan (2000b) noted

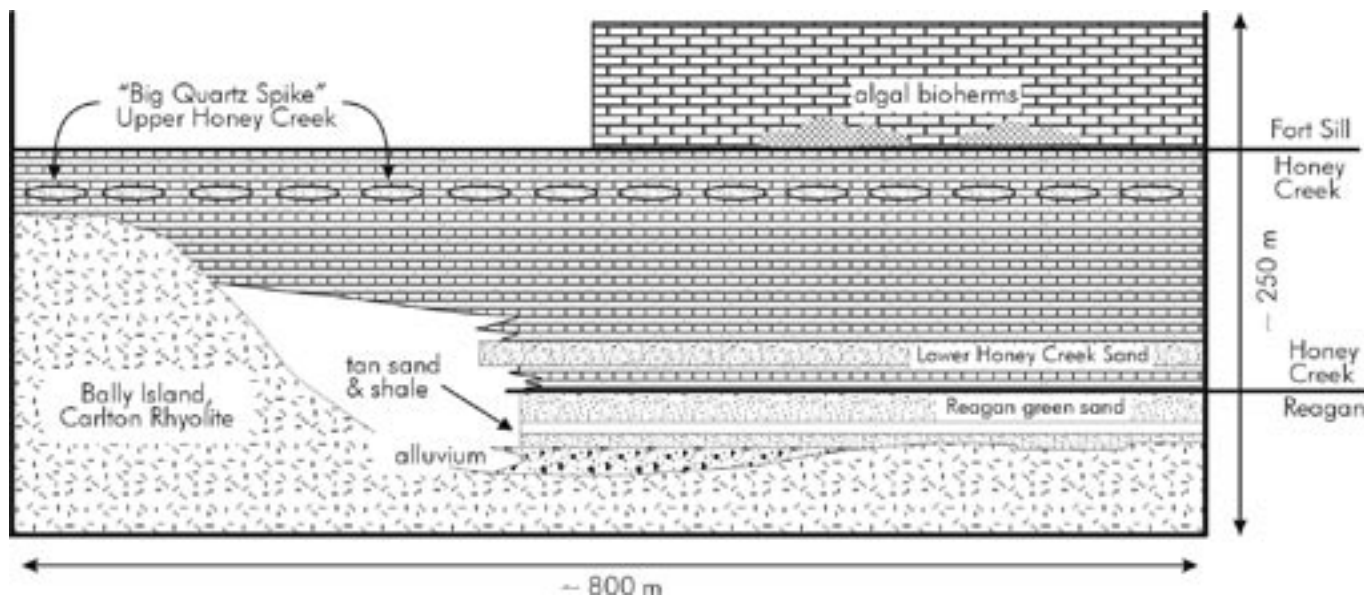


Figure 7. Cross section of the Timbered Hills Group at Bally's Island in the Slick Hills. See Figure 5 for location. Modified from Donovan and Burchett (2000).

the presence of lime mudstone, bafflestones, sponges, algae, pelmatozoan holdfasts, ferruginous stromatolites, and glauconite hardgrounds in the lee of rhyolite islands (Donovan, 2000b).

McElmoyl and Donovan (2000) identify and describe three informal members: a "lower," an "upper," and a "red limestone" member (Figure 8). The "lower" member is usually much thinner than the "upper" and is composed of light gray pelmatozoan grainstones. Significant amounts of quartz, glauconite, and angular rhyolite grains are also

present. Fossils in the "lower" member are broken and abraded. The grains are cemented by syntaxial overgrowths of calcite. Many bedding boundaries are stylolitic; during diagenesis, pressure solution dissolved carbonate against thin quartz sand beds. Cross beds are common and range between 2 and 10 cm (1–4 in) thick. The base of this member contains significant diagenetic oxidized ankerite. Donovan and McElmoyl (2000) showed that the three members could be grouped by end members of sparite, mud, and detritus. Sparite increases in the "red limestone"

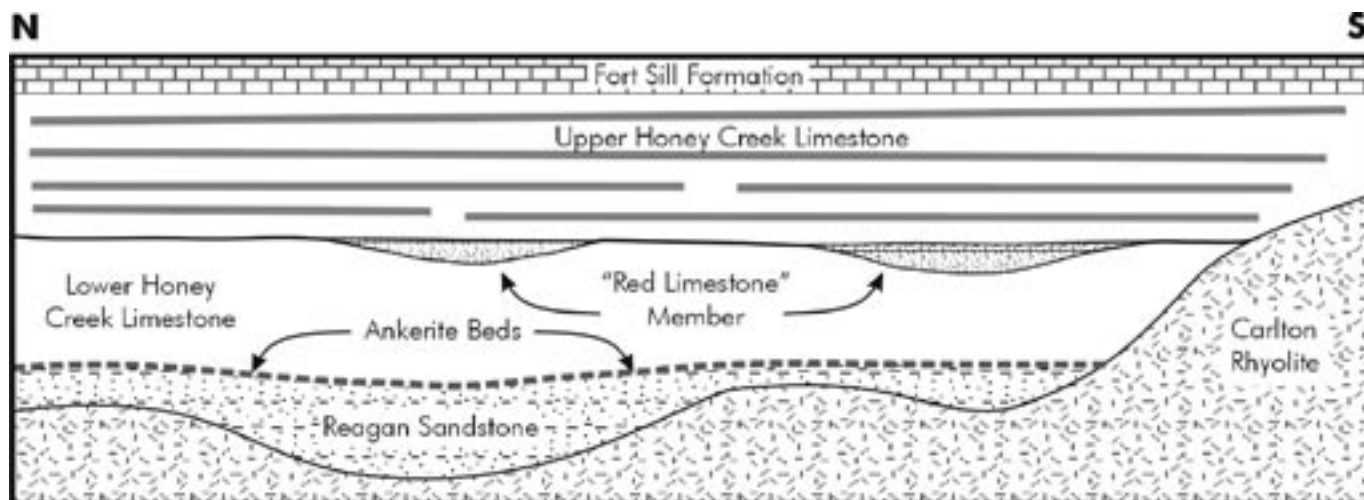


Figure 8. Cartoon cross section of the Timbered Hills Group modified from Donovan and McElmoyl (2000). The "grand cycle" unconformity lies between the "upper" and "lower" Honey Creek Limestone members and beneath the "red limestone" member.

Table II

Facies	Description	Interpretation
Facies A - basal breccia	50% angular, well sorted, devitrified rhyolite (average 3.75 mm); 28% micrite; 20% spar cement with some iron oxide	Initial transgression, erosion by wave action, rapid cementation.
Facies B1 - washed mechanical bafflestone	25% vertical disarticulated brachiopod shells; 20% micrite; 52% radialial carbonate cement	shell bank under sufficient wave energy to remove mud
Facies B2 - filled mechanical bafflestone	30% vertical brachiopod valves; 50% micrite; 10% equant spar cement; minor sand and glauconite	same as B1, but less energy, possibly from deeper water
Facies B3 - horizontally packed brachiopod packstone	32% horizontal brachiopod valves; 10% vfg angular sand; 46% micrite; 7% euhedral spar cement; minor glauconite	same as B1 & B2, but below zone of breaking waves. B1, B2, and B3 represent shell bank deposited by waves and currents in fissures of Carlton
Facies C - mudstone	30% quartz, feldspar, glauconite, rhyolite; 10% biogenic fragments; 60% lime mud with stromatolites and oncolites	shallow, quiet water conditions
Facies D - grainstone	90% pelmatozoans with overgrowths up to 1 cm; 10% quartz and feldspar grains; medium-scale cross beds	shoals migrated over lower facies as water deepened; these facies formed in sheltered coastline before covered by grainstones
Facies E - fissure fill	35% vertical brachiopods with hematite rinds; 28% quartz, feldspar, rhyolite, pelmatozoan grains (rhyolite to boulder size); 5% micrite; 6% hematite; 23% anhedral spar cement	debris filling fissures of rocky shoreline
Facies F - medium-scale cross bedded pelmatzoan grainstone	88% pelmatozoan plates with overgrowths up to 1 cm; 10% quartz; 5% micrite	migrating pelmatozoan sand shoals gradually cover rocky coast with fissures filled with rhyolite boulders and fossil debris
Bally Mountain Facies - unconformity cover	30% angular rhyolite clasts up to 4 cm; 15% cg pelmatozoan fragments; minor quartz; 40% anhedral spar cement	initial deposition over Carlton Rhyolite

and “upper” members, as does quartz. In outcrops of the Slick Hills, the “lower” Honey Creek ranges up to 10 m (33 ft) thick; the variations appear to be due to compaction against Reagan or onlap on rhyolite islands.

The upper and lower members are separated by what uniformitarians call a major disconformity, although evidence of physical erosion is not present in all outcrops. The “red limestone,” a bioclastic limestone, occurs in lenses beneath the disconformity. The breccia and the disconformity are related to a regional regression that interrupted the Franconian transgression (Donovan and Burchett, 2000). The “red limestone” member (McElmoyl and Donovan, 2000) is a pink to maroon colored, poorly-sorted, fossiliferous packstone with abundant angular rhyolite pebbles and cobbles up to 10 cm (4 in) in diameter. It erosionally overlies

the “lower” member, ranges up to 3 m (10 ft) thick, but cannot be traced throughout the outcrop area. Where the “upper” member overlies the “lower” one, “Contact with the underlying beds is sharp. We have not seen unambiguous evidence of erosion, and no basal conglomerate occurs.” (Donovan et al., 2000, p. 42). Its red color is caused by abundant disseminated hematite. The fossils are similar to those of the “lower” Honey Creek, but are less abraded and broken.

The “upper” member is a calcareous quartzarenite with alternating beds of quartz sand and bioclastic grainstone. The composition of the individual layers varies from 90% quartz and 10% bioclasts to 80% bioclasts and 20% quartz. A distinct wavy bedding results from the diagenetic alteration of interbedded sands and carbonates. The small to medium

scale cross beds range between 2 and 10 cm (<1–4 in) thick and are common. Some beds in the upper member weather to a distinctive honeycomb pattern from the dissolution of shell hash. The sands are fine-grained and composed of ~70% quartz, 15% peloidal glauconite, fresh feldspar, and minor phosphatic fossil fragments. The carbonates are pelmatozoan grainstones (up to 5 mm), with subordinate fossil fragments and glauconite peloids. These two lithologies are interlaminated down to a millimeter scale. Both have parallel laminae and small trough cross beds up to ~8 cm (3 in) high. The carbonate portion often shows no internal structure; it is masked by horizontal traces and differential compaction due to early calcite cementation of the grainstones, forming rigid plates against compaction. This bedding is interpreted as having formed in an environment with insufficient energy to mix the fine siliciclastics and coarser carbonate sands. “The coarse-grained fragments of pelmatozoans appear to have responded as a discrete grain population hydraulically partitioned from the finer siliciclastics.” (Donovan et al., 2000, p. 44).

Donovan et al. (2000) described the “upper” member of the Honey Creek at Bally Mountain (Figure 7). At this location, the formation is 45 m (146 ft) thick and overlies the “lower” member with a distinct bedding contact, but there is no basal conglomerate or evidence of erosion. The basal bed of the upper member is a tan, fine-grained, well-sorted, parallel laminated to cross-bedded quartz sandstone that forms a distinctive ledge that can be traced throughout the area. The succeeding beds include thin alternating layers of quartz and bioclastic sandstone. The percentage of carbonate gradually increases up the first two thirds of the member, then a persistent 1.2 m (4 ft)-thick, tan quartz sandstone with bimodal cross beds, parallel laminations, and abundant angular rhyolite pebbles interrupts the trend. Between that bed and almost the top of the member, the percentages of quartz and carbonate are about equal; then near the top, the percentage of carbonate increases to about 85%. Within this section, there is a 4 m (13 ft) section with a dramatic increase in quartz grains up to granule size called the “Big Quartz Spike.” The spike includes quartz, feldspar, and granophyre in a bimodal grain distribution, and it is interpreted by uniformitarians as erosion from the Wichita granites from tectonic rejuvenation. At Bally Island, the top of the Honey Creek is marked by a very visible, one inch thick, purple lime mud hardground, present all over the area and associated with disseminated hematite, glauconite, and phosphate. It forms a growth platform for algae and pelmatozoans.

Diagenesis, or processes affecting the Honey Creek after its deposition, can be deduced by identifying secondary minerals and post-depositional physical features. Radial

fibrous cement and syntaxial overgrowths on pelmatozoan parts occurred early, even syndepositional. The overgrowths are thought to represent a freshwater environment saturated with calcium carbonate (Rafalowski, 1982). Cathodoluminescence patterns show rapid alteration of cement patterns, suggesting rapidly varying water chemistry, as would be predicted in the Flood model. Ankerite, reflecting the continued presence of iron in the sediments, occurs as both a replacement mineral and cement. It is both coarse grained and xenotopic. “In general, the abundance of ankerite must reflect the widespread availability of iron in the diagenetic environment.” (Donovan et al., 2000, p. 43) Hematite grain coatings and pore fills occur and are also thought to be early. Sparite formed later, infilling remaining voids. Not unexpectedly, the spar tends to be iron-rich. Silica overgrowths on quartz grains occur in the siliciclastic layers. Glauconite occurs as pellets and pore filling cement.

Pore filling glauconite is thought to be syndepositional in the Honey Creek Formation as evidenced by later syntaxial overgrowths on pelmatozoan grains with pores filled with glauconite. (Rafalowski, 1982, p. 71).

During diagenesis, grain replacement was also common. Rhyolite devitrification formed silica, hematite, and clay. Calcite replaced quartz, feldspar, and glauconite throughout the formation. Dolomite formed as scattered rhombs and as mosaics of baroque, ferroan dolomite; both found near the Reagan contact, and both late forming. Silica replacement occurred only at the Honey Creek – Carlton contact, where carbonate stromatolite laminae were replaced, resulting in alternating laminae of silica and hematite. Pressure solution after burial led to the formation of stylolites, especially along the contacts of carbonate and quartz beds.

The upper boundary of the Honey Creek Formation (with the Fort Sill Formation of the Arbuckle Group) is defined lithologically as the first limestone with a large mud component. The basal Fort Sill appears as light gray beds of the “tombstone” lithology that is characteristic of Arbuckle Group

The choice of boundary would seem to be somewhat arbitrary, as the change from “typical” Honey Creek to “typical” Fort Sill takes place over a thickness of 25 m. In practice, the choice can be surprisingly exact. For example, a 2-cm-thick hardground chosen as the boundary during the course of logging a single section on Bally Mountain can be traced along the entire width of outcrop—about 800 m. (Donovan, 2000b, p. 51).

The Southern Oklahoma Archipelago

Interpretation of the deposition of the Timbered Hills Group must include the role of island-forming basement

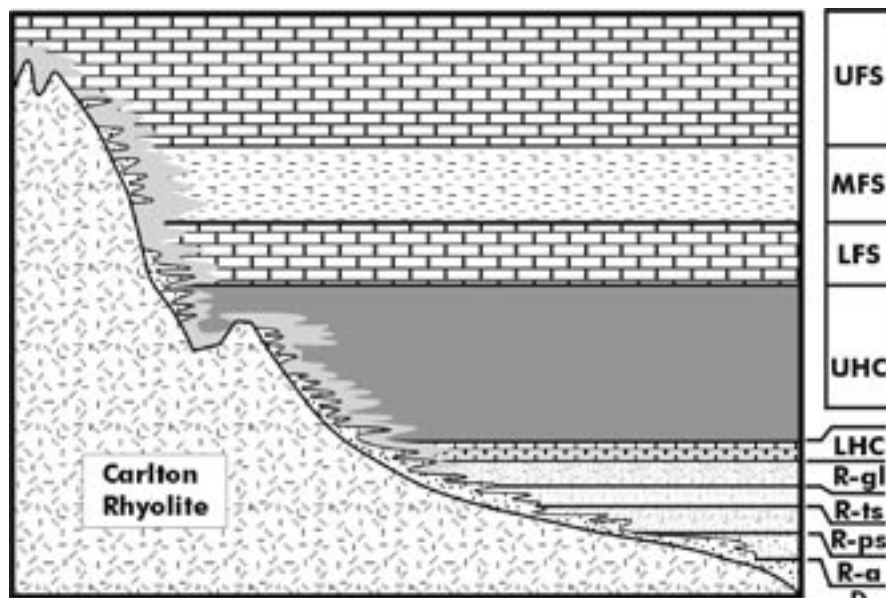


Figure 9. Cartoon cross section of the stratigraphic section onlapping a rhyolite island. Note conglomerate/breccia facies adjacent to the island. Gray shaded areas indicate facies associated with islands. D = basement debris, Ra = Reagan alluvium, Rps = purple Reagan sandstone, Rts = tan Reagan sandstone, Rgl = Reagan greensand, LHC = Lower Honey Creek, UHC = Upper Honey Creek, LFS = Lower Fort Sill Formation, MFS = Middle Fort Sill Formation, UFS = Upper Fort Sill Formation. Modified from Donovan and Burchett (2000).

topography during the inundation of Oklahoma. North of the SOA, rugged topography with relief up to 200 m (650 ft) known as the “Tulsa Mountains” remained uncovered until covered by Arbuckle Group sediments (Figure 4), but these are not preserved in outcrop. Six islands are exposed, however, in the Slick Hills in Kiowa, Caddo, and Comanche Counties, on the northeast side of the SOA (c.f. Figure 5) along a linear trend of some 24 km (15 mi). Both the Carlton Rhyolite and the overlying sediments are exposed on the islands that have been called the “southern Oklahoma archipelago” (Donovan and Stephenson, 1991). The maximum relief along that unconformity is 300 m (1000 ft). Bally Island is located the farthest inland, to the northwest, and while Richard’s Spur Island is located the closest to the ancient shoreline, it was the last covered. Most of the islands had slopes of 10° or less and remained exposed until covered by the Fort Sill Formation of the Arbuckle Group (Figure 9). At Bally Mountain, the Carlton dips 74° NE, while the overlying sediments dip 50°, suggesting a pre-Reagan dip. The two northernmost islands are Bally Island and Ring Top Island, covered by Cambrian sediments, then Permian conglomerates.

The islands influenced facies distribution in both the Reagan and the Honey Creek. Facies distinctively associated with the lee sides of islands include carbonate mud accumulations with fossiliferous mud banks, brachiopod buildups, and ferruginous stromatolites. Outcrops demonstrate that the windward sides of islands had shorelines of coarse grainstone deposits (Donovan and Stephenson, 1991). They described distinct facies at Richard’s Spur Island. The island facies are restricted in outcrop and their exposure is limited. Richards’s Spur Island extends upward into the Fort Sill Formation. The island shoreline facies is characterized by rich, diverse fossil contents, thin beds (usually < 1 in), hardgrounds, and evidence of reworking. Facies include:

- (1) rhyolite breccia with broken shells and clasts, cemented by drusy sparite, and found adjacent to the basement (interpreted as a beach gravel);
- (2) pelmatozoan-rich (>80%) grainstone with fragments of trilobites, brachiopods, lime mud intraclasts, quartz silt and glauconite peloids, all cemented by syntaxial overgrowths of calcite (interpreted as wave-washed sand shoals);
- (3) poorly-sorted pelmatozoan rich packstones and wackestones (interpreted as below wave base);
- (4) poorly-sorted fossiliferous mudstones, with whole brachiopods, sponges, trilobites, pelmatozoans, and algae, intraclasts of lime mud, numerous glauconite-coated hardgrounds (interpreted as protected environment facies);
- (5) bafflestones formed by the vertical stacking of brachiopod valves which trapped mud and silt and formed a substrate for pelmatozoans (interpreted as shell banks produced by moderate energy waves); and
- (6) ferruginous stromatolites, colored a vivid red by fine grained hematite, forming mats on hardgrounds only 4 cm (1.5 in) thick (interpreted as forming in a protected environment).

Facies associated with these islands demonstrate an upward transition from clastics to carbonates, an upward

decrease in size and power of tidal currents, and an upward decrease of basement contribution. Facies distribution was apparently influenced by: (1) sand distribution controlled by island geometry, (2) variability in paleocurrents, and (3) distinct leeward and windward facies, and (4) small contribution of rhyolite fragments to carbonates (Donovan, 2000a).

Donovan et al. (2000) noted that rhyolite conglomerate beds up to 1 m (3 ft) thick with pebbles up to 15 cm (6 in) in diameter are present throughout the Timbered Hills Group. Rhyolite grains in the Reagan are more rounded; grains in the overlying carbonate are angular to subangular, perhaps from carbonate cushioning that minimized abrasion. These were derived from the erosion of the rhyolite basement early on, then from the exposed islands following deposition of the Reagan Formation.

Approximately 275 m (900 ft) in a lateral section of sediments are exposed at Bally Island (Figure 7), where sediments strike N30°W and dip 50° NE. Bally Island was exposed until covered by late Honey Creek beds. The Reagan at Bally Island is thin, but typical in sequence. Its basal unit consists of red beds, including lithic sandstones, conglomerates, and shales composed of poorly sorted rhyolitic debris. These red beds range up to 3 m (10 ft) thick and they appear to be restricted to valleys incised into the rhyolite. Above the redbeds is a tan, pebbly, quartz-rich, well-sorted, coarse-grained sandstone with rhyolite grains and ferruginous ooids. This sand is parallel laminated, laterally continuous, and up to 1 m (3 ft) thick. Ferruginous ooids (up to 15% of the sandstone) are thought to have formed in quiet waters and been transported inshore. Above this sandstone is olive green illitic shale with cross-bedded, tan, medium to coarse grained sand lenses with *Skolithos* ichnofacies. Horizontal ichnofossils occur in the shale. Overlying this unit is a sandstone composed of up to 60% glauconite as abraded, fine to medium grained peloids. This greensand is 4.5–6 m (15–20 ft) thick and persists across the exposure. The sand also contains quartz, phosphatic brachiopods, rhyolite and feldspar. Bipolar cross beds occur in sets up to 1.2 m (4 ft) thick, with the SE ebb flow dominant. The upper green sandstone contains six beds of pebble conglomerate with rhyolite clasts up to 6 inches in diameter. Conglomerate beds persist upward into the Honey Creek (Donovan and Burchett, 2000).

At Ring Top Island, the relief on the basement rhyolite is only 7.5 m (25 ft), and only the Reagan is exposed. Rhyolite lithics are rare except in lower beds of basal breccia and sandy conglomerate. About 7.5 m (25 ft) of gray and green-gray fine to medium-grained sandstones lap onto Ring Top towards the northeast. The sands appear to pinch out at the island, indicating that it controlled sediment distribution.

Glauconite content increases in the fine-grained sands. Sandstones are banked against the island, which appears to have provided little sediment. However, on the southwest side of Ring Top, the situation is quite different. The basal bed is breccia, with boulders of rhyolite up to 80 cm (31.5 in) in a matrix of intensely bioturbated, gray green, fine to medium grained sandstone that rests directly on the basement unconformity. Glauconite is rare in this basal bed, but 1 m up section, it increases to 50% of the sand. Phosphatic brachiopods are also present.

The impression gained from the section is of rapid inundation of the island by a sea-level rise that led to the development of anoxic conditions, because trace fossils are generally absent in the green sandstones. The only soft-bodied organisms that appear to have survived the flooding event are distinctive crawlers that produced long tracks that were 0.5 in. (1.3 cm) wide. These traces are found on only two surfaces of purple mudstone that were probably clay drapes formed during periods of temporary sediment stability. (Donovan and Burchett, 2000, p. 35).

About 140 m (450 ft) west of this outcrop, a two-foot-thick tan sandy conglomerate rests directly on the unconformity, showing the rapid lateral facies change away from the island. It consists of rounded rhyolite pebbles up to almost 8 cm (3 in) in a well-sorted quartz matrix with minor rhyolite and glauconite, and is cemented by syntaxial quartz. The basal red beds and ferruginous ooids found at Bally Island are not present at Ring Top (Donovan and Burchett, 2000).

Uniformitarian Interpretation of Timbered Hills Group

Reagan Sandstone

Uniformitarian explanations of sedimentation emphasize the role of climate over many years. The paleoclimatic setting for the Timbered Hills Group is considered to have been quite different from that of present-day Oklahoma due to purported plate motions. The Cambrian setting for the SOA is placed on the western edge of Laurentia just to the south of the paleoequator with a 70° counterclockwise rotation of from its present orientation (McElmoyl and Donovan, 2000). Therefore, the 20,000,000 years between the Carlton Rhyolite extrusion (ca. 525 Ma) and the initiation of deposition of the Reagan would have been marked by intense weathering of the rhyolite surface (McBee, 1995), as well as erosion and tectonism. It is unclear why this lengthy hiatus failed to produce sedimentary facies prior to the Reagan. The basal Reagan beds are interpreted as alluvial talus and braided stream fill (Donovan, 1986).

Deposited prior to the marine transgression, these sands are found both in channels cut into the rhyolite and atop the basement surface.

Following these changes to the Carlton surface, a late Cambrian (Franconian) transgression began (Figure 2), which signaled a great change in depositional conditions across North America.

The transgression that began in the Franconian was a world-wide event during which sea levels rose to an unprecedented height by the end of early Ordovician time. (Donovan, 2000b, p. 48.)

The marine transgression progressed slowly inland from the opening Iapetus Ocean to the southeast. Simultaneously, rivers were bringing quartz sand from the craton to the northwest which mixed with locally eroded rhyolite detritus and gradually overwhelmed it, forming the tan to purple, lenticular, cross bedded sandstones interpreted as nearshore and shoreline sands. These were burrowed, forming the *Skolithos* ichnofacies, while horizontal traces formed in shales interbedded with the sands. Paleocurrents in the larger sand bodies are unimodal to the southeast, showing that they formed dominantly from ebb flow off the craton. Thinner beds have bimodal, bipolar, and even herringbone cross bedding, strongly suggesting tidal action. The middle Reagan sands is supposed to reflect current action, showing an increasing percentage of cratonic sand as the Carlton Rhyolite was covered by lower Reagan beds.

The uppermost beds of the Reagan are composed of a spectacular greensand, formed by quartz sand mixed with abundant glauconite peloids. Most workers believe that the shoreline moved northwest, diminishing the terrestrial quartz sand input, giving time for the peloids to form and be evenly distributed. This is supported by glauconite forming at the unconformity between the Honey Creek and rhyolite at islands in the archipelago.

Several lines of evidence are cited in support of slow deposition over several million years (Table III). The presence of pebble conglomerates composed of phosphatic nodules, rhyolite pebbles, and glauconitized rhyolite pebbles, appear to record substantial reworking and slow-acting chemical processes. The presence of glauconite peloids in the upper Reagan is taken as evidence of the same thing, since the accepted model has glauconite forming from the alteration of fecal pellets. The presence of reactivation surfaces on cross beds is urged as an evidence of slow development. Finally, there is an inverse relationship between *Skolithos* assemblages and glauconite sands taken to mean that some greensand bodies formed in less agitated water. Donovan (2000b) presented other environmental indicators of both the Reagan and Honey Creek formations (Table III).

However, data that are commonly considered diagnostic of time and environment are not necessarily so. For example reactivation surfaces only indicate changes in the physical parameters of dune migration; parameters that obviously are not time dependent.

Thus, reactivation surfaces seem to be related to fluctuations or changes in the flow mechanism or direction and may not be diagnostic of any environment. (Reineck and Singh, 1980, p. 100).

In computer simulations, Rubin (1987a) formed this type of bounding surface by changes in dune migration direction, dune asymmetry, dune migration speed such that a period of advance is punctuated by a period of erosion, and dune height such that the dune grows by scour of the underlying sediment. (Kocurek, 1996, p. 134).

The presence of pebble conglomerates demonstrates reworking, but reworking can occur without respect to long periods of time. Altered rhyolite pebbles and grains can reflect either a diagenetic change or the preexisting condition, not necessarily a long process. Finally, Froede and Cowart (1994) discussed the failure of trace fossil assemblages to serve as time/environmental indicators.

Honey Creek Limestone

With no erosional boundary between the Reagan and the Honey Creek, the uniformitarian interpretation of the Honey Creek depositional environment must share similarities with that of the Reagan. The lower Honey Creek cross beds show the same bipolar northwest-southeast paleocurrent directions. It also shows a decrease in cratonic clastics and iron and an increasing carbonate influence. The Honey Creek has a simple faunal assemblage of shallow water invertebrates, primarily sessile pelmatozoans that supposedly grew around the rhyolite islands, though not in the deep channels between them. These pelmatozoans were reworked and distributed all over the area by wave action over long ages (Donovan, 1986). The resulting carbonate sands are not lenticular, but appear to have formed from the migration of very small dunes, less than 23 cm (9 in) high. As the dunes accumulated in the straits, the water depth became shallower and the carbonate system became more effective.

Rafalowski (1982) posited a variety of environments for the Honey Creek, ranging from intertidal to offshore marine and from brackish to normal marine salinity, and from low to high energy environments. Stromatolites, oncolites, and algae and radial fibrous cement are thought to indicate low energy; the cross-bedded pelmatozoan sands indicate higher energy. Horizontal burrows and fossils are accepted as indicators of deeper water; since they occur near the top of the formation, they suggest deepening water following the

Table III

Physical Indicator	Probable Physical Cause	Uniformitarian Interpretation	Flood Interpretation
Rhyolite grains decrease from 80–90% in basal Reagan to 0% in Fort Sill	Increasing vertical & lateral distance between source and deposit	Development of regional carbonate platform cuts off clastic source	Same concept, accelerated time
Rhyolite pebbles in Reagan are generally rounded; those in Honey Creek are generally angular	Less time for rounding of pebbles by weathering, and for transport and deposition of pebble	Only basement islands available as source; limited erosion and transport	Rapid erosion and limited transport of pebbles combine with rapid burial of rhyolite sources
Conglomerate pebbles = phosphate nodules, rhyolite pebbles (some glauconitized)	Phosphate probably transported into area, rhyolite derived locally	Evidence of long ages of reworking and slow-acting chemical processes	Phosphate imported from antediluvian ocean; rhyolite eroded and redeposited locally, altered diagenetically later
Quartz in Timbered Hills is mature except for lower Reagan	Quartz derived from cratonic source; mature sand already present	Sand transported by rivers and wind from interior to coast (although unexpected during transgression)	Sheet flooding rapidly brings sand to coast at same time as transgression; sand mixed by marine front
Quartz grain size decreases up; from granules and coarse sand in Reagan to vfg sand and silt in Arbuckle Group	(1) decreasing energy or (2) increasing distance from source of coarser grains	Enlargement of Oklahoma Basin increases distance to source	Rising Flood waters result in longer distance from suitable source to deposit, and fining upward sequence
Biggest change in quartz grain size between “lower” and “upper” Honey Creek	Change in transport energy or source	Major regression (grand cycle) within Honey Creek	As marine front moves rapidly inland, coarser sand trapped there, only fines migrate offshore
Plagioclase found only in lower Reagan	Plagioclase derived from rhyolite	Plagioclase source cut off by burial.	Same concept, accelerated time
Glauconite most abundant in upper Reagan, then decreases through Honey Creek into Fort Sill Formation	Chemical environment forms glauconite in upper Reagan, Honey Creek; dominant in upper Reagan	Alteration of fecal pellets in normal marine waters can produce glauconite, but cannot explain why it decreases with increasing faunal diversity	Glauconite imported from antediluvian offshore; or precipitated rapidly in rare geochemical window
Phosphate trend tracks glauconite; most occurs as broken shells of brachiopods; nodules also present	Similar chemical environment for both glauconite and phosphate	not explained	Unusual chemical environment either from antediluvian ocean or from conjunction with volcanism at SOA
Glauconite peloids comprise up to 60% of upper Reagan sand; peloids are abraded and broken	Fragile peloids only transported short distance	reworking virtually in situ; no explanation for concentration in upper Reagan	Stratigraphic occurrence may mark rare chemical window; or initial migration from antediluvian sea
Hematite cement is present (up to 30%) in lower Reagan in disseminated form, overgrown by silica cement	abundant iron and oxygen	Iron from rhyolite weathering	Iron from late-stage volcanism; high heat flow; oxygen from rainfall
Hematite abundant in the “red limestone” member, in contrast to the upper Reagan, lower and upper Honey Creek.	iron is fixed in an oxidizing environment, probably in shallow water	Regression during Honey Creek exposed rock to subaerial processes	Short, energetic regression not inconsistent with Flood, oxygenated waters of Flood cause iron precipitation
Horizontal ichnofacies are found in fine-grained facies of Timbered Hills Group up into Arbuckle	organisms moving parallel to bedding boundaries	Indicative of deeper water, lower energy	Not environmental indicators; may have formed after burial
Skolithos ichnofacies occurs only in middle Reagan sands	Presence of vertical burrowing organism (such as shrimp)	Skolithos indicates higher energy environment such as beach	Skolithos is poor environmental indicator; may represent escape traces of rapidly buried organisms
Inverse relationship between Skolithos ichnofacies and glauconite sands	unknown	Greensands formed in less agitated water conditions; assumes Skolithos indicates higher energy	multiple explanations possible, insufficient data

Table III (continued)

Physical Indicator	Probable Physical Cause	Uniformitarian Interpretation	Flood Interpretation
Broken and abraded pelmatozoans form bulk of the Honey Creek carbonates	source of massive population of pelmatozoans	Pelmatozoans grew in place over long time; indicate shallow, oxygenated waters	Pelmatozoans transported from antediluvian sea and deposited
Broken, abraded shells of thick shelled trilobites in Honey Creek	thick-shelled trilobites present	Mobile benthonic organisms strong enough to withstand agitated water	Evidence of high energy transport; possible winnowing of thin shell types
Calcitic and phosphatic brachiopods; calcitic concentrated near base of Honey Creek, phosphatic throughout	Phosphatic shells indicate high organic activity and nutrient rich waters	Modern brachiopods are benthonic, tolerate range of depth, but not agitated water or low salinities.	Calcite shells may be replacement following deposition; Ca ions concentrated at lower boundary
Stromatolites, oncolite, and algae occur only at the Honey Creek-Carlton unconformity	algae population	Shallow subtidal or low intertidal environments	Antediluvian algal communities transported, deposited in quiet water; short time for growth
Basal Reagan is coarse alluvium; some deposited in channels cut in rhyolite	Erosion into rhyolite, short transport and deposition	Local erosion prior to transgression	Rapid tectonic change in base level cuts channels in rhyolite; rapid erosion and deposition of lower sands in "fresh water" Flood
Reactivation surfaces cut cross beds in Reagan and Honey Creek formations.	Change in current direction or strength during deposition; observed in fluvial and tidal environments	Indicates long time period during deposition of sands	Indicates current changes without respect to time
Silica cement throughout Reagan; postdates hematite	Silica ions present	Silica from rhyolite degradation	Silica possibly from late-stage volcanic fluids; higher heat flow enhances precipitation
Iron ooids in middle Reagan sands, deformed by compaction	Short range transport of ooids from unusual environment; time of compaction sufficient to deform ooids	Ooids formed in nearby quiet environment, then transported and deposited	Ooids from pre-Flood offshore source or formed rapidly at shoreline due to rare chemical window
Timbered Hill thickness is relatively uniform over entire state	Depositional processes operating in similar fashion over large scale	Greater variety in thickness due to variety of environments expected	Expect similar processes operating over regional area
Boundary between Reagan and Honey Creek is first appearance of carbonate - diagenetic ankerite	No carbonate formed prior to Honey Creek; ankerite from mixing of HC carbonate and Reagan iron	Change of environment to marine carbonate; ankerite from groundwater circulation	Deposition is a continuous process; boundary marks first appearance of offshore carbonate constituents
Very little detrital clay in the Honey Creek in contrast to the Reagan	clay not deposited, or winnowed after deposition	Increasing distance from clastic source, hard to explain quartz transport	High energy environment keeps clay in suspension
Rhyolite islands show different facies from one side to the other	Islands block strong currents	Lee side protected in tidal marine environment	Lee side provides local lower energy, different hydraulic environment
Bimodal NW-SE current during Reagan deposition; ebb flow dominant	Bimodal flow	Shallow marine setting; currents reflect tidal influences	Currents reflect interplay of "fresh-water" floodwater and marine front
Quartz sand spike in upper Honey Creek	Quartz sand source in upper Honey Creek	Regression in middle of Honey Creek allowed transport of sand from then distant shoreline by rivers and wind	Marks spike of "fresh water" flooding or current winnowing
Honey Creek = interbeds of quartz sandstone and pelmatozoan clasts	Source of both types of sediment and means to mix them	Low energy mixing of sand from regression and in situ pelmatozoans	Interbeds caused by hydraulic sorting or quartz and carbonate
Small-medium scale cross beds, occasional herringbone cross beds, mostly in lower Honey Creek	low flow regime	migration of bars and shoals in shallow marine setting; herringbone cross beds indicate tidal influence	Energy decreases as transgression migrates inland and water depth increases

transgression. The presence of glauconite grains is expected because of the supply of ferric oxide on the craton.

The three most important factors in the uniformitarian interpretation of the Honey Creek are (1) the paleogeography, (2) pulses in the ongoing transgression, and (3) the tectonic development of SOA (McElmoyl and Donovan, 2000). Rhyolite islands of the southern Oklahoma archipelago explain the presence of rhyolite clasts persisting well up into the formation. They also caused the development of unusual, restricted carbonate facies on the protected sides of the islands. Thickness variations were caused by differential compaction on the islands. Lateral variations in the ratio of quartz to carbonate are explained by the presence of pelmatozoan colonies around the islands and quartz sand in the tidally dominated channels between the islands. Faunal variations are explained by ecological partitioning (Donovan, 2000a).

As the Franconian transgression began to mantle the basement with sediment of the Reagan Formation, increasingly longer transport distances for cratonic clastics developed.

Whereas all the detritus of the initial deposits of the Reagan appears to be of local origin, the upper part of the Reagan, as well as the entire Honey Creek, contains abundant detrital quartz. Although some quartz may have been derived from the Carlton Rhyolite (which contains a small percentage of quartz phenocrysts), most must be of distal origin and was presumably incorporated into the sediments as the transgression advanced across the craton. (McElmoyl and Donovan, 2000, p. 73).

McElmoyl and Donovan (2000) argued for the existence of a "grand cycle" (regression-transgression) within the Honey Creek formation. There is some evidence of erosion at the base of the "red limestone" member and it may have been deposited as detritus created by erosion during a regression. Donovan et al. (2000) state that there is an easily recognized field break in the Honey Creek; in some places, a slight angular unconformity, in others, a disconformity. In other words, like the "red limestone," the erosion appears to have not been consistent throughout the Honey Creek. This regression is also used to explain changes in water chemistry between the "lower" Honey Creek member and the "red limestone" member. The "red limestone" member was apparently deposited in a protected environment because of abundant mud, diverse fauna, less abraded fauna, and abundant rhyolite clasts. The presence of islands means that the detritus that formed the "red limestone" member could have come from older, but topographically higher beds. It is not clear whether or not the "red limestone" member was originally deposited as discontinuous lenses, but there appears to be little evidence of

a sharp erosive boundary between the "upper" and "lower" members where the "red limestone" member is not present. (Donovan et al., 2000).

However, quartz sand in the "upper" Honey Creek had to have originated from a shoreline that was rapidly moving inland relative to the outcrop area. One of the reasons that a regressive-transgressive pulse is posited as having occurred during the middle of the Honey Creek is to provide a means by which sand was transported over the newly deposited sediment by rivers and wind. However, the interbedded nature of the sand throughout most of the Honey Creek defies that explanation. If a transgressive-regressive cycle occurred, the sand should occur as a thick transgressive lag above the "red limestone" member, rather than thin layers interbedded with carbonate throughout most of the member.

The unusual occurrence of interbedded sand and bioclasts in discreet alternating beds is thought to have resulted from energy levels sufficient to ripple the sea floor (forming cross beds) but too low to mix the quartz and carbonate sediments. Trace fossils in the "upper" Honey Creek are cited as support for quiet conditions (Rafalowski, 1982). McElmoyl and Donovan (2000) see a progression from the tidally influenced sands of the upper Reagan beds to the addition of a carbonate component to form the "lower" Honey Creek. They posit a widespread eustatic pulse led to the deposition of the "red limestone" member and continued regression allowed the migration of quartz sand into the area. Renewed transgression then mixed the quartz sand and carbonate bioclasts into alternating beds, forming the "upper" Honey Creek. They propose a eustatic, rather than tectonic, regression because of its correlation with other locales and the absence of any clear evidence of tectonic motion at that time. The rapid subsidence of the SOA did not begin until Arbuckle time.

Smaller cross beds in the Honey Creek (compared to the Reagan) indicate less water energy, or tidal power. Donovan (2000b) stated that the lower energy resulted from a spreading transgression across the shallow continental surface, since a broader platform would decrease the energy. In conjunction with the proposed decrease in tidal energy is a vertically upward decrease in tractive power and sorting. Ultimately, the decrease in energy resulted in the accumulation of lime mud and the proliferation of lime-mud-producing organisms. The base of the Arbuckle Group is marked by carbonate mud which implies a decrease in tidal energy, expansion of the carbonate platform, and increased algal growth.

During the lower Paleozoic transgression, the SOA was transformed from a locus of tectonic and igneous activity to a profound depocenter for the Oklahoma Basin (Figure

10). The boundaries of the SOA are partly defined by the isopach of lower Paleozoic sediments; the depocenter contains thicknesses of units up to four times their thickness outside the rift. However, uniformitarians consider the initial subsidence rates during Timbered Hills time to be slow, not speeding up until Arbuckle deposition (McElmoyl and Donovan, 2000). If the tectonism in the SOA was continuous, however, the “subsidence rate” of the Timbered Hills Group only indicates how quickly it was deposited.

It is worth noting that the presence of pelmatozoan plates does not require their *in situ* growth during Honey Creek time. They could have been transported and deposited during a short time. It is also possible that even stromatolites, oncolites, and associated mud could have been transported into the area and deposited in quiet areas in the lee of the rhyolite islands. As already noted, trace fossils are not necessarily diagnostic of particular environments. Other time indicators, such as glauconite grains depend on assumptions rather than field evidence. Rafalowski (1982, p. 84) admits this:

In addition to iron and other necessary ions, glauconite requires stable Eh conditions and considerable time to form. Many of the rocks of the Honey Creek Formation do not appear to have formed in such an environment. Considerable reworking of grains is implicit. The original environment of formation may have been distal offshore marine.

Discussion

Almost two centuries of research within the uniformitarian paradigm have created a fabric of stratigraphic analysis

where individual threads of data are interwoven with uniformitarian stories. Replacement of the “standard” interpretations requires both an understanding of the physical rock record, and an ability to discern the difference between legitimate cause and effect reasoning and that tainted by hidden assumptions of extended time and/or modern processes. Table III provides a brief summary of many of these issues as they relate to the Timbered Hills Group. Some of the topics, however, can be extrapolated to other locations, and for that reason are granted a place in this discussion section.

Extent of Basal Sequence

Flood geology and uniformitarian geology differ in their predictions of the scale of sedimentary processes. The former predicts large-scale synchronous deposits, the latter does not. The basic sequence that comprises the Timbered Hills Group (eroded igneous basement to immature sandstone to mixed siliciclastic/carbonate to thick carbonates) in Oklahoma extends far beyond, covering much of the midcontinent of North America. However, uniformitarians cloud this remarkable occurrence with different dates, nomenclature, and an emphasis on small scale lithologic variation, obscuring the forest by concentrating on the veins in the leaves. But positing differences based on small facies changes and fossil zonation cannot hide the true extent of this simple sequence. It exists over much of Texas, Oklahoma, Kansas, Missouri, and Iowa to the author’s knowledge, and perhaps it is present to an even greater extent.

This pattern of facies in which coarse sandstones and conglomerates pass upward into glauconitic sandstones and hence into carbonates is typical of the Reagan Formation and its equivalents. (Tsegay, 1983, p. 8, emphasis added)

It is argued that this sequence is merely that expected during a multi-million year transgression. However, strong arguments may be made against this assertion. First, the scale of the transgression alone refutes uniformitarianism. Where today do we see vast areas of continental crust becoming shallow marine environments? Where do we see continent-

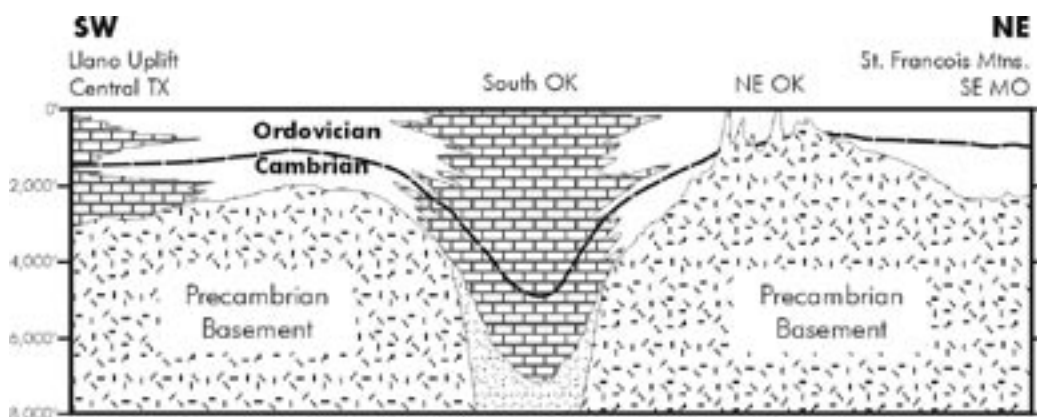


Figure 10. Cross-section of the Southern Oklahoma Aulacogen during “early Ordovician” time, showing development of depocenter. Solid white indicates areas of dolomitization, rather than limestones deposited in depocenter. Note significant vertical exaggeration. Modified from Johnson et al. (1988).

wide transgressions that include the large-scale transport of sand, erosion down into bedrock, large-scale tectonism, and intraplate volcanism? Second, and more telling, hydraulic and chemical parameters of deposition are usually fragile with regard to time. Long periods of time provide ample opportunity for environmental conditions to change. A better explanation of the regional similarity of erosion and deposition would be the wide scale flooding of the entire midcontinent rapidly enough to prevent major changes in the depositional regime from being reflected in the resulting sediments.

In that regard, very specific conditions would be required to produce the sequence observed in the rock record. The occurrence of a thin sheet of sand, particularly one with similar facies, and especially one with unusual widespread, similar facies, speaks to specialized depositional conditions. Both a consistent range of hydraulic energy changing in a consistent manner during deposition and consistent geochemical parameters would be required to produce what is observed. In addition, the burial and preservation of this sand over an equally large area again argues for very rapid processes operating within very narrow chemical and current ranges.

Parameters of Sedimentation

Analysis of the formation of any large sedimentary deposit must include several interrelated parameters: (1) erosion and provenance, (2) subsidence and the creation of accommodation space, (3) transport and deposition, and (4) preservation. These are accomplished under the influences of (1) tectonic motion of the crust, (2) hydraulic energy, and (3) time. Increasing hydraulic energy requires less time; decreasing energy, more time to accomplish the formation of similar thickness of strata. Since Genesis provides the duration of the Flood, we know that the hydraulic (and tectonic) energy levels must have been quite high (Reed et al., 1996).

The Timbered Hills Group supports this paradigm of rapid formation. The pre-sediment tectonism of the SOA indicates almost contemporaneous downwarping, igneous extrusion, erosion, and sedimentation. For example, at Bally Mountain the Carlton Rhyolite dips 74° toward 050° (NE), while the overlying sediments dip 50° toward 060°, a significant pre-sedimentation dip (contrary to the assumption of original horizontality). Donovan and Stephenson (1991) note that the Carlton Rhyolite underwent rapid subsidence and was not elevated above the craton when sedimentation started. The thickness patterns of the Arbuckle Group also reflect subsidence in the SOA. Should we believe that the SOA sank during emplacement of the Carlton Rhyolite, stopped for a long period while the Timbered Hills Group

was deposited, and then started sinking again during Arbuckle time?

Erosion was also rapid, creating the unconformity on the basement surface. I believe that erosion of the basement was accomplished primarily by the freshwater Flood; rainfall would have soaked the soil and eroded down to bedrock in short order (Genesis 7:11–12). The amount of rain would probably have resulted in sheet flooding leading to the basement being “swept clean of debris” (Johnson et al., 1988, p. 310) prior to marine transgression. This happened over a continental scale and would therefore have required sheet erosion of continental scale. Uniformitarians explain the basement surface in terms of long ages of erosion. “Not surprisingly, the unconformity beneath the Cambrian sedimentary rocks is exceedingly irregular...” (Donovan and Burchett, 2000, p. 27). However, the local irregularity can be explained easily within the Flood paradigm by the scale of the regional erosive event; another instance of uniformitarians missing the forest for the trees. Irregularities of even a few hundred meters over an area of thousands of square miles do not appear significant, especially when most of the irregularity occurs in areas of ongoing tectonism and igneous extrusion. The short period of intense rainfall and associated flooding would not have planed the newly-extruded rhyolite, especially since its rapid hardening may have resulted in an irregular surface. Also, current variations that might be envisioned in sheet flooding over thousands of square miles could have produced variations in the depth of erosion. Additionally, Gilbert (1983) concluded that the rhyolites were extruded at high temperatures (950–1000°C). Intense rainfall would have resulted in very rapid cooling, perhaps leading to the fracturing and the creation of an irregular surface. Finally, the sedimentation over the eroded basement would have had to occur quickly to preserve the clean eroded surface, again on a continental scale.

As the outgoing freshwater front met the incoming marine front, the hydraulic energy of the freshwater would have decreased with rising base level. Deposition would have begun as locally eroded sands were laid down, first in depressions in the irregular surface, and then over the entire area. Competing currents from the outgoing freshwater and incoming marine water would have resulted in an area of ebb and flow that uniformitarians have mistaken for tidal action. Quartz sand moved back and forth, and was deposited under increasingly marine influence across a broad front, resulting in the more widespread beds of the middle and upper Reagan. The lack of carbonate mud in the Reagan indicates continuing current strength sufficient to keep that mud in suspension that did not abate until Arbuckle deposition (Figure 11).

Both energy and provenance contributed to the final

sediment sequence. I believe that hydraulic energy peaked during the freshwater erosion of the basement, then declined as the marine front moved landward. Erosional sheet flow was replaced by a zone of mixing resulting in ebb and flow currents. As the marine front passed, wave action became dominant and hydraulic energy probably decreased farther with increasing water depth. Simultaneously, the siliciclastic content transported seaward was deposited first as the Reagan Formation, then was mixed with carbonate debris transported inland by the marine front. Irregularities in the surface allowed for the local precipitation of clays in protected areas. Finally, the continental source of sediment was cut off, and almost all of the sediment deposited was carbonate. This point is marked by the rapid transition to almost pure carbonates above the quartz spike in the upper Honey Creek. Subsequently, decreasing energy finally allowed the settling of carbonate muds in the Arbuckle Group.

Provenance of Quartz Sand

What is the provenance of the mature quartz sand found throughout the Timbered Hills Group? How far was it transported across the craton? How was it transported to the Honey Creek shoreline after large areas of the local base-

ment had been covered? These questions have a broader application. Megaregional carbonate platforms covered much of North America during the "lower Paleozoic." However, interspersed within this thick carbonate sequence are deposits of mature quartz sands. The question is how these sands could be transported across hundreds of miles of low energy, shallow water carbonate deposits in a coherent mass and be deposited as such. "The major problem associated with the quartz is that of provenance." (Tsegay, 1983, p. 62).

This process began almost immediately in the sedimentary record. Donovan et al. (2000) noted that the provenance of the upper Honey Creek (finer-grained, well-sorted quartz) was different from that of the Reagan and lower Honey Creek (coarser sediment). Since the source does not appear local, they interpreted the source of the upper Honey Creek as being from eolian dunes transported seaward during the mid-Honey Creek regression.

Whereas all the detritus of the initial deposits of the Reagan appears to be of local origin, the upper part of the Reagan, as well as the entire Honey Creek, contains abundant detrital quartz. Although some quartz may have been derived from the Carlton Rhyolite (which contains a small percentage of quartz phenocrysts), most must be of distal origin and was presumably incorporated into the sediments as the transgression advanced across the craton (McElmoyl and Donovan, 2000, p. 73).

However, if volumes of quartz sand had been deposited on the shelf during regressive lowstand by rivers and wind-blown dunes, then why would the sand have been interbedded in the upper Honey Creek to nearly the top of the formation? Why would it have not formed a basal transgressive sand at the base of the Upper Honey Creek member that used all of the quartz before being buried by carbonate? After all, the Honey Creek deposition should have occupied at least a million years, and a continual, but irregular source of small amounts of

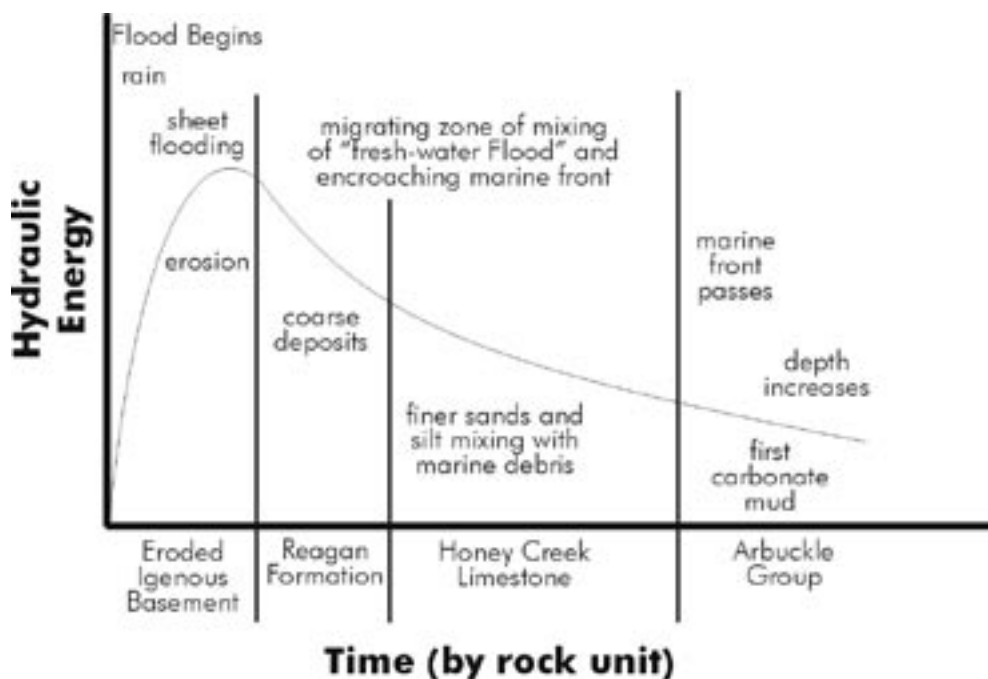


Figure 11. A paleohydraulic curve of the early Flood shows the expected sequence of erosion, followed by deposition of the Timbered Hills Group, as energy increased rapidly at the onset of the Flood and then decreased as the marine front moved across Oklahoma.

sand would have been required. The physical evidence rather demonstrates a continuous source of clean quartz sand that was hydraulically intermixed with the grainstones of the Honey Creek until the source or the pathway of the quartz dried up prior to Arbuckle deposition. Furthermore, long periods of time would have allowed the introduction of a significant silt and clay component, transported by wind (Froede, 2003).

Most of the uniformitarian authors speculated that the source of the quartz sand was the Canadian Shield, but were very limited on the specifics of how it was transported all the way across a continent, and how it was distributed evenly throughout the Honey Creek as discrete beds, rather than simply intermixed with the carbonate. None of these authors performed mineralogical or chemical analyses to verify provenance. I do not argue with the possibility of the provenance being the Shield, but would add another possibility. The northern midcontinent contains the erosional remnants of mature orthoquartzites (i.e., Baraboo, Sioux, etc.). If these were once a widespread, unified quartz sand body, then erosion by freshwater flooding during the early stages of the Flood might have transported a sufficient supply of very mature monocrystalline quartz to the continental margins, leaving the few indurated remnants that are present today. Mixing with eroded granitic basement would have provided the small percentages of feldspar and other minerals found in the Timbered Hills Group. What else besides the Flood could erode material from the Shield or upper Midcontinent, transport it across a continent and deposit it as we see it?

Origin of interbedded clastics and carbonates in the Honey Creek Limestone

In areas of mixed composition, there is a distinctive way bedding with alternating carbonate and siliciclastic beds with small scale cross bedding in each lithology.

Evidently, the current power available was insufficient to mix the two varieties of sand. In part, this may have been due to the discrepancy in size of the particles—very coarse sand to granule-sized carbonate grains, as opposed to very fine to fine-sand siliciclastics. In addition the carbonates appear to have cemented rapidly... (Donovan, 2000b, pp. 49–50).

This uniformitarian interpretation assumes a constant, relatively equal, regularly alternating supply of quartz and carbonate sands. But a review of the uniformitarian paleoenvironment shows that such an arrangement is not possible. By Honey Creek time, the basement was almost completely covered by carbonate deposits and there is no physical evidence (e.g., channels sand facies) of large fluvial systems importing sand onto the carbonate

shelf. The section above explained the dilemma from the standpoint of the source of the sand, but the nature of the sand-carbonate mixing is also worthy of comment.

Sand and carbonate grains are not completely segregated, nor are they completely mixed. Instead, they are discretely interbedded in thin alternating beds of each component. If it is true that the current power was insufficient to mix the two populations, then how was that same low current power sufficient to distribute the cratonic sands widely across the entire shelf area at specific times (the sand interbeds), yet not at others (the carbonate interbeds)? And why, given the time involved in the uniformitarian story, were not the two populations intermixed by bioturbation?

Uniformitarians are limited by their “stratigraphic” approach to sedimentology. One benefit of Flood geology is an emphasis (unfortunately not applied consistently enough) on the hydraulic framework of sedimentary deposits (Berthault, 1994, 2000). The interesting nature of the carbonate-quartz interbeds provides a good example of the superiority of the Flood framework. Although the relative density of quartz and limestone is similar (Allen, 2001), the disparate grain size and shape between the quartz and bioclasts (echinoderm plates) provides a basis for hydraulic sorting within the mixing zone of fresh and marine water which was migrating inland across the shelf. Quartz sand was transported from the cratonic interior to the marine front in the widespread freshwater sheet rushing to meet the marine transgression, not in narrow, restricted river channels. Pelmatozoans were being washed inland with the marine front and the two-grain populations were sorted into the interbeds of the Honey Creek that we observe today.

Persistence of Rhyolite Islands

According to the uniformitarian explanation of the southern Oklahoma region, the end of igneous activity (Carlton Rhyolite and late intrusive dikes) occurred ~525 Ma. The base of the Dresbachian (Upper Cambrian) is ~505 Ma, and the base of the Ordovician is ~495 Ma. Thus the three stages of the Upper Cambrian (Dresbachian, Franconian, Trempealaunean occupied ~10,000,000 years. If the time interval of all three is assumed equal, then the onset of Reagan deposition was ~501 Ma, and the Timbered Hills Group would have been deposited over a period of 1,000,000 to 2,000,000 years. (Figure 2).

This period of time raises the question of the endurance of the rhyolite islands of the southern Oklahoma archipelago, which lasted until early Fort Sill Formation deposition. Would these rocky islands resist erosion for that length of time?

Rocky marine shorelines are rarely preserved in the geological record... In general, most major marine uncon-

formities are planar surfaces. Rocky, island girt shorelines characterized by irregular relief generally involve rocks that are resistant to weathering... Preservation of this relief generally seems to involve rapid rates of subsidence... or rapid transgression, or a combination of the two. (Donovan, 2000a, p. 19).

The two northernmost islands are Bally Mountain and Ring Top, both visible in outcrop in the Slick Hills. They are covered by Cambrian sediments, then Permian conglomerates. The Timbered Hills Group laps onto Bally Island. This onlap is interpreted as a dramatic hiatus, but in reality could have occurred in a short time as the sediments were deposited on the preexisting irregularity in the surface. This question can be extended to the wider area. The Franconian transgression occurred across an irregular basement surface. Its irregularities are exposed in the St. Francis Mountains, the Arbuckles, and in the subsurface "Tulsa Mountains" of southeastern Oklahoma. How could this widespread Precambrian landscape remain both stripped clean of any surface cover and yet topographically irregular for hundreds of millions of years? Erosion of the basement would have occurred during that time, erasing the topography while creating a sediment and soil cover that does not exist. Only a high-energy hydraulic event could have stripped the surface cover and eroded down into bedrock, and only a short-lived, high-energy event would have left the surface irregularities in the "clean swept" surface.

Geochemistry of the Timbered Hills Group

The Timbered Hills Group represents an unusual geochemical environment, especially with respect to iron. A variety of interesting iron minerals and sediments occur throughout the section. Iron is seen in ankerite, hematite, and iron-rich illite cements, and replacement minerals such as ankerite, siderite, glauconite, and pyrite, and intraformational grains such as ferruginous ooids and glauconitic peloids (Figure 12). Hematite occurs as disseminated cement in the lower Reagan beds, while glauconite with

Fe^{2+} and Fe^{3+} dominate the upper. Ferruginous ooids are present in the middle Reagan beds.

It is clear that the Reagan Sandstone is characterized by an unusually high amount of iron. (Tsegay, 1983, p. 55).

Furthermore,

This iron is manifest in both valency states, as hematite cements, ferruginous ooids, a variety of forms of glauconite, iron-fixing bacterial stromatolites, ferroan-calcite and ankerite cements, and the widespread replacement of calcite by ankerite. (Donovan et al., 2000, p. 40).

There are several questions to be answered regarding this phenomenon. These include: (1) the source of the iron, (2) abundant hematite in the Reagan, (3) the presence ferruginous ooids in the middle Reagan, and (4) the origin of glauconite in the upper Reagan and Honey Creek, as well as the distribution of iron minerals upward through the section.

Uniformitarians answer the first question by pointing to weathering and erosion of the rhyolite (although I am not aware that the iron in the Timbered Hills Group is restricted to those locations overlying rhyolite). Was the iron derived from almost 20,000,000 years of weathering of the Carlton Rhyolite, which contains up to 8% iron? If so, would not the iron have been dispersed down to the ancient sea during

Lithology	Formation/ Facies	Iron Minerals	Iron Chemistry
	Fort Sill		
	Upper Honey Creek	glauconite, hematite, pyrite (assoc. with glauc.)	pyrite FeS_2 glauconite $(\text{K},\text{Na})(\text{Fe},\text{Al},\text{Mg})_2(\text{Si},\text{Al})_2\text{O}_{10}(\text{OH})_2$ hematite Fe_2O_3
	Lower Honey Creek	glauconite peloids and ankerite at basal contact	glauconite $(\text{K},\text{Na})(\text{Fe},\text{Al},\text{Mg})_2(\text{Si},\text{Al})_2\text{O}_{10}(\text{OH})_2$ hematite Fe_2O_3 ankerite $\text{Ca}(\text{Mg},\text{Fe}^{2+},\text{Mn})(\text{CO}_3)_2$
	Upper Reagan Greensand	glauconite peloids (up to ~50%); Fe-rich illite	glauconite $(\text{K},\text{Na})(\text{Fe},\text{Al},\text{Mg})_2(\text{Si},\text{Al})_2\text{O}_{10}(\text{OH})_2$ illite $(\text{K},\text{H}_2\text{O})(\text{Al},\text{Mg},\text{Fe})_2(\text{Si},\text{Al})_2\text{O}_{10}(\text{OH})_2 \cdot n\text{H}_2\text{O}$
	Middle Reagan marine sands	ferruginous ooids (up to 15%) and hematite cement	hematite banded with Fe-rich illite $(\text{K},\text{H}_2\text{O})(\text{Al},\text{Mg},\text{Fe})_2(\text{Si},\text{Al})_2\text{O}_{10}(\text{OH})_2 \cdot n\text{H}_2\text{O}$ hematite Fe_2O_3
	Lower Reagan Alluvium	hematite cement (up to 15% total)	hematite Fe_2O_3
	Carlton Rhyolite	source of heat, iron	

Figure 12. Iron mineralogy and chemistry of the Timbered Hills Group.

that time? Another possibility is that the iron was derived from the essentially synchronous volcanism occurring in the SOA as sedimentation initiated. In that case, iron would not be limited to crystalline rock, but might be present in outgassing water that would mix with the rain and/or marine floodwaters and be spread across a wide area. Certainly such a scenario would involve fluctuations in water chemistry and temperature not seen in modern environments. High amounts of dissolved or colloidal iron would provide a reservoir for the abundant glauconite and ooids.

Hematite is abundant in the lower Reagan beds, virtually absent in the rest of the Reagan, and is present throughout the Honey Creek. Hematite is associated with oxidizing environments; its presence in sediments deposited by the "freshwater" Flood is not then unexpected. Hematite occurs as disseminated particles that combine with silica to cement those strata. It may well have been rapidly precipitated from iron rich pore fluids as the fresh, cool rainwater changed the temperature and Eh-pH environment quickly. Even uniformitarians recognize that the distribution of hematite must have been followed quickly by its being locked into place by cementation. Otherwise, the dramatic density difference between hematite and quartz sand (Allen, 2001) would have concentrated the hematite.

Hematite is most common near the base of the [Honey Creek] formation suggesting that the mineral was quickly fixed during early stages of the Franconian transgression. (Rafalowski, 1982, p. 83, brackets added).

With regard to the third question, uniformitarians envision ooids forming in quiet offshore waters, prior to transport inshore to the middle Reagan sands. The ooids are of two types, hematite on a nucleus particle or alternating bands of hematite and iron-rich illite on a particle. Most of the nuclear particles are rhyolite and clay, and Tsegay (1983) speculated that ooid formation would have been easier on a clay surface, forming in shales and then being transported to the sands. Uniformitarians note that ooid formation requires (1) a stable craton during transgression, (2) mild climate supplying iron from weathering, (3) embayed or lagoonal coastline, (4) variations in sediment supply allowing oolites to form in low supply conditions. But there are many places in the rock record where these criteria are met and iron ooids are not present.

Iron-rich oolites have been observed forming in shallow marine and muddy delta mouth settings as alternations of goethite and nontronite (iron smectite). If the Reagan ooids formed in this way, then the goethite has altered to hematite and the nontronite to illite. In the first transgressive shoreline sand at Bally Island, up to 15% ferruginous ooids occur. Donovan and Burchett (2000, p. 13) are puzzled by the occurrence of the ooids.

They are an unlikely grains [sic] to have formed in a robust shoreline setting and may well have nucleated in quieter, offshore estuarine settings prior to their reworking into shoreline sands.

Tsegay (1983, p. 57) was more straightforward.

Unfortunately, uniformitarianism is muted where the formation of ferruginous oolites is concerned.

One of the problems that must be overcome is the relative fragility of the ooids. They deformed easily against harder quartz grains during compaction indicating that they were relatively soft. How then, did not migrate through a relatively high-energy shallow marine setting and survive the pounding of wave action on the ancient beaches?

Glauconite is a name given to a variety of green aggregates of iron silicates, but most properly to an iron-rich monoclinic mica. It occurs in modern marine environments with a great depth range, but in minor amounts, commonly as bright green pellets, usually smaller than 0.5 mm (Blatt et al., 1980). However, "greensands," or glauconite sands occur in various Cambrian sands across the midcontinent, often spatially associated with phosphate accumulations.

All of the sandstones above the basal shoreline sand contain some glauconite in the form of medium to fine-grained peloids that show various degrees of abrasion. (Donovan and Burchett, 2000, p. 32).

Glauconite is found in the upper Reagan beds as peloids, rhyolite replacement, and as matrix. The occurrence of matrix glauconite in both the Reagan and Honey Creek suggest precipitation under an Eh of 0.

However, the other two forms of glauconite, peloids and altered rhyolite fragments, are more difficult to interpret. It is probable that neither type of grain is in its original environment of formation. (Tsegay, 1983, p. 59).

Tsegay (1983) thought that the glauconite peloids, found in cross-bedded sands, and altered rhyolite were evidence of grain reworking during low sediment supply times. Phosphate occurs in two forms in upper Reagan (Tsegay, 1983) as shell fragment (all broken) and as pebbles up to 1.5 cm, usually in fringing conglomerates. Nodules also include clastic grains of quartz, rhyolite, and glauconite, replaced by collophanite. But reworking could also mean catastrophic deposition.

Although this scenario [transgressive reworking] may well have operated during Honey Creek time, it is clear that many of the glauconite pellets were reworked as they are now found in association with cross bedded pelmatozoan sands immediately adjacent to the basal unconformity. This suggests that the Franconian transgression may have been accompanied by short term sea level oscillation. (Rafalowski, 1982, p. 82).

Short term sea level oscillation is exactly what would be found in the mixing zone of fresh and marine waters as the Flood transgressive front moved inland. The occurrence of chemically unusual sediment, concentrated in a particular zone (the upper Reagan) across a broad area speaks to rapid formation and preservation. The rapid deposition of the Flood sediments would have provided the means for preservation, and the interactions between the freshwater and marine front may have provided the rapid variations in Eh and pH that might have allowed precipitation of the glauconite forming the fragile peloids.

Flood Interpretation of the Timbered Hills Group

The currently accepted uniformitarian explanation of the Timbered Hills Group is clearly inconsistent with a history that includes the Genesis Flood as well as good science. The current interpretation focuses on processes operating over millions of years, but the observational basis for such processes must be extrapolated from poorly correlated analogs. Any viable explanation of the Timbered Hills Group must rely upon empirical data, and must recognize the interpretive role of any extrascientific frameworks. Both the biblical record and the presupposition of uniformitarianism fall into this category. Table III shows a list of empirical data discussed in the literature and deemed relevant by this investigator. Interpretations offered by uniformitarians and possible alternatives within the creationist paradigm are compared.

Data from Oklahoma indicate that the onset of the Flood included magmatic, tectonic, and sedimentary events. Figure 13 displays both uniformitarian and

Flood concepts in a block diagram of the Slick Hills region. The distance from the Slick Hills area to the Ouachita front (the possible pre-Flood shoreline) is a little less than 500 km (300 mi), and the basement slope between the two

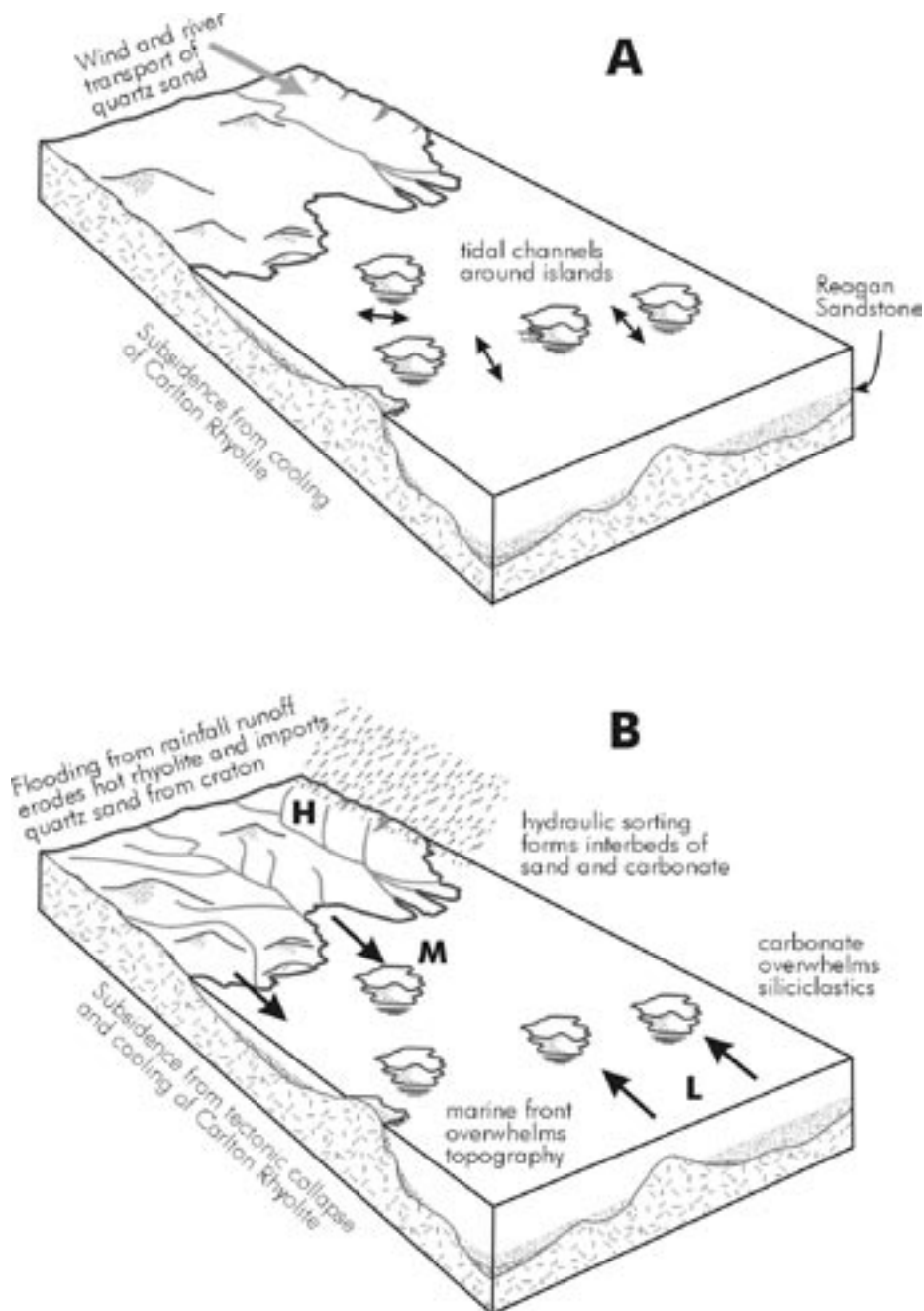


Figure 13. Block diagram of the Slick Hills region during deposition of the Timbered Hills Group modified from McElmoyl and Donovan (2000). Upper diagram (A) shows uniformitarian interpretation, based on modern-day processes operating over several million years. Lower diagram (B) shows a Flood interpretation of the same marine transgression that led to the deposition of the Reagan and Honey Creek facies. H = relatively high hydraulic energy; M = moderated hydraulic energy; and L = relatively low hydraulic energy.

points was probably insignificant. Therefore, the migration of the marine front across Oklahoma probably would not have taken many days. However, there was certainly some time before the arrival of the marine front when sedimentary processes would have been the result of rainfall and its flooding. Farther inland, this time would have been longer and its impact greater. Following the arrival of the marine front, sedimentary processes would have changed. The events that led to the Timbered Hills Group can be summarized as follows:

1. *Preparation of the basement surface.* Intense rainfall and its local flooding on the newly formed rhyolite of the SOA resulted in its rapid cooling and the creation of channels and gullies in the cooling surface. In the lower elevations, rhyolite was eroded, transported, and redeposited over short distances, but the energy of the current rapidly rose as sheet flooding covered the ground, leading to greater erosion and the breaking and rounding of individual grains.
2. *Lower Reagan alluvial facies.* Locally eroded sediment and basement debris filled channels and surface irregularities. As the marine front approached, the gradient decreased, current energy decreased, and siliciclastics began to settle out across the basement. No fossils were present in the lower Reagan beds because the freshwater runoff did not carry any marine organisms. The introduction of body fossils marked the beginning of the marine provenance. Abundant iron, contributed to the surface by expulsion of fluids associated with the volcanism, oxidized and fixed to the basal sediments as hematite (or goethite that later altered to hematite) that accumulated in the available pore space. Silica, also present in the system, precipitated as cement. Cementation was rapid due to the heat and abundance of water moving through the early pore system precipitating silica cement. The lower Reagan is supposed to represent 20,000,000 years on a marine margin. This length of time should have yielded thick, well-developed deposits. If they were eroded from the immediate area, then it should be present as thick shallow marine deposits down-dip. The absence of any such sediment argues against the uniformitarian model.
3. *Marine Reagan facies.* When the marine front finally reached the SOA and the surrounding craton, transgressive sands of reworked rhyolite and quartz were deposited over the basement and the lower alluvium. Quartz began to appear in greater quantity as erosion and transport from the northern midcon-

tinental brought increasing amounts to the migrating shoreline. The unusual geochemical environment and the abundance of iron in the water led to the precipitation of ferruginous ooids, which were mixed with the basal marine sands. Cementation was rapid, but early compaction deformed the ooids prior to cementation. The interplay of the marine transgression and the freshwater flooding resulted in a bimodal paleocurrent, with the freshwater flooding apparently having greater local energies, or having a greater source of sediments to generate migrating sand dunes out into the marine waters.

On the assumption that the transgression was to the northwest... flood tides were evidently less effective than ebb tides in moving sediment. In other words, the adjacent craton was a net contributor of large volumes of siliciclastics to the transgressing seaway. (Donovan, 2000b, p. 49).

4. *Upper Reagan greensand.* As the marine waters inundated the land, temperature, pH, Eh, and ionic concentrations shifted. Uniformitarians suggest that the glauconite peloids represent altered fecal pellets, but glauconite has been observed to precipitate directly from marine water under ideal chemical conditions. The concentration of glauconite peloids in a spatially widespread, but temporally restricted zone suggests their formation in a discrete, short-lived chemical environment.
5. *Introduction of carbonates.* Carbonates were introduced to the system as clastic grains, transported inland following erosion in offshore shallows. Pelmatozoan (echinoderms) fields were evidently prevalent offshore Oklahoma prior to the Flood. The pelmatozoan fields evidently included populations of trilobites and brachiopods. The lowest Honey Creek beds include abraded and broken pelmatozoans and minor shell debris, with reworked quartz, rhyolite, glauconite, and phosphate grains. A major distinction between the uniformitarian and Flood interpretations is the allochthonous origin of the carbonates in a Flood scenario as opposed to their *in situ* origin in the uniformitarian scheme. Evidence of hydraulic sorting of pelmatozoan plates and siliciclastics in their intricate interbedding suggests mixing of the two grain populations at the marine Flood front (Berthault, personal communication). Siliciclastics were transported to the zone of deposition over a wide area, as evidenced by the extent of the Honey Creek, not transported in narrow rivers whose paleochannels have not been described in the literature. Carbonate was

introduced both as grains and as dissolved ions, as evidenced by the introduction of carbonate cement. In fact, the ankerite is used to mark the boundary between the Reagan and Honey Creek Formations. This raises the question as to why the stratigraphic contact is picked on a lithologic boundary that has no inherent time value. The cement also indicates unusual chemical conditions, too. If glauconite was replaced by ankerite, then the iron was mobile as Fe^{2+} and thus the environment was reducing. "The coarse crystal size and baroque morphology of much of the ankerite suggests that these diagenetic solutions were relatively hot (50°C)."

(Cloyd et al., 1986, p. 20). The irregular basement topography formed islands as the transgression progressed. The protected sides of those islands provided "dead" hydraulic areas allowing the deposition of finer grained carbonates. As the shoreline continued to migrate inland, the islands were covered by carbonates.

6. *Transition to Arbuckle Group.* The succession of interbeds of carbonate grainstone and terrestrial quartz and local debris continued well up into the Honey Creek. Near the top of the formation, however, a transition occurs. Siliciclastic contributions to the formation increase to form the "quartz spike" and then rapidly decrease, marking the removal of the inland sediment source for the area. Carbonate percentages increase rapidly; the Arbuckle Group contains very little quartz. At the same time, the percentage of carbonate mud increases significantly, marking the establishment of marine conditions over this part of the craton. The great North American carbonate shelf will be established and will persist as the Flood covers the continent. "This iron-rich siliciclastic milieu gradually gave way to a carbonate factory of unusual efficiency and duration." (Cloyd et al., 1986, p. 17).

Conclusion

A Flood explanation of the Timbered Hills Group of Oklahoma is sufficient to account for the published data. Several points stand out in favor of this model. The basement surface was eroded, swept clean of debris, and then covered before terrestrial sedimentary facies could be redeveloped, even though under the uniformitarian model, millions of years were clearly available. A hydraulic approach to deposition provides a better explanation for the sedimentary sequence than a paleoenvironmental one. The mixing of the freshwater and marine flood fronts provided a unique

depositional and geochemical environment that is reflected by unusual sedimentary products: geochemically, a glauconite greensand, ferruginous ooids, and hematite cement; hydraulically, unusual interbedding of siliciclastics and carbonates through an extended section.

At the onset of the Flood, freshwater flooding from rainfall eroded the granite basement, transported sand from the cratonic interior, and rapidly cooled the lava of the Carlton Rhyolite. As ocean encroached upon the continent, possibly from as close as the Ouachita Front, hydraulic energy decreased and sand was deposited over the erosional surface. Opposing currents from the marine front and the freshwater flood gave the appearance of tidal action. Abundant iron, possibly from the ongoing volcanism, manifested itself as hematite cement, ooids, and glauconite, in that order. Marine currents transported large numbers of carbonate organisms (echinoderms) across the shallow shelf, where they were broken, hydraulically sorted and interbedded with cratonic sand. As the marine front continued inland, the clastic sources decreased until finally overwhelmed by the regional carbonate factory that marked the geochemistry of the early Flood.

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Book Review

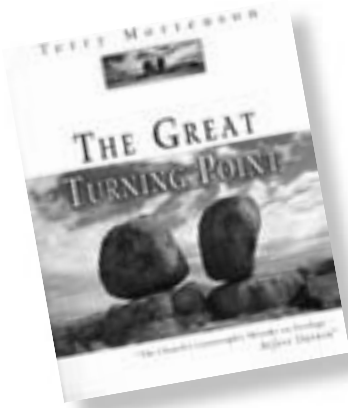
The Great Turning Point: The Church's Catastrophic Mistake on Geology—Before Darwin by Terry Mortenson
Master Books, Green Forest, AR, 2004, 272 pages. \$16.00.

Terry Mortenson describes a sad time in the Church during the early 1800s. This was a time when new ideas from the so-called enlightenment strongly invaded the Church. The Church was not only caught unprepared, but also some of the theological leaders aided the infiltration of the new ideas within the walls of the Church. Terry is not speaking of evolution, although evolution followed later as a logical consequence, but of the infiltration of the idea that the Earth is old and that the Genesis Flood was either myth, local, or tranquil. Against this trend before Darwin published, a brave group of men, most whom were knowledgeable about geology, published books and articles opposing the new uniformitarian trend, as well as the ideas of those scientists who believed the Flood was the last of a long series of catastrophes and new creations. These men are the Scriptural geologists, the subject of Terry's doctoral thesis.

I found it interesting that the Scriptural geologists had many of the same arguments that we use today. There were some inconsistencies, to be sure, but one must remember that at the time they wrote, geology was in its infancy. The most outstanding motivation of these men is that they were defending the authority of God's Word to mankind from Genesis to Revelation. It is also interesting that the Scriptural geologists received the same type of treatment from the new cultural elite as we do today. It is definitely a worldview conflict.

The reader will gain much knowledge from this book not only about our own time, but also how we arrived at the many problems unleashed on the Church and society from the invading ideas. We discover that the problems did not start with evolution, but from the precursors of evolution.

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Book Review

***The Great Turning Point: The Church's Catastrophic Mistake on Geology—Before Darwin* by Terry Mortenson**
Master Books, Green Forest, AR, 2004, 272 pages. \$16.00.

This is an important book. It deserves to be read by those interested in the debate between the Young Earth Model (YEM) and Old Earth Creationists (OEC). Some OEC and secular evolutionists have charged that the Young Earth approach is relatively recent. They comment that the Creationist revival of the past forty years has been largely fueled by the recycling of ideas popularized by George MacReady Price in the early 1900's. This book conclusively refutes the myth.

Terry Mortenson is well qualified to address the subject. He has his Ph.D in the history of geology from Coventry University in England and has done extensive research in the early literature concerning the scriptural geologists. The book starts off with a short historical overview of those in earlier centuries who believed in a straightforward view of Genesis with a recent creation and a global, catastrophic flood. Early church fathers including Tertullian, Chrysostom and Augustine are mentioned as well as 17th and 18th century scientists Niels Steenson (Steno), John Woodward, William Whiston, Alexander Catcott, and others who advocated a recent creation and worldwide deluge. During this period others argued for a more ancient date for the formation of the earth and denied that the biblical Flood was significant in producing much of the Earth's sedimentary and fossil bearing geological deposits. Mortenson is careful to set the historical context for what comes next with thorough and meticulous research that is the foundation to his doctrinal dissertation. He has amassed a wealth of data that points out principled and intelligent opposition to the forceful tide of geological uniformitarianism that swept academic circles in the late 18th and 19th centuries. This tide was largely stimulated by the works of James Hutton and Charles Lyell. The opposition was carried by those who would come to be known as scriptural geologists.

The main portion of the book is dedicated to an examination of these Scriptural geologists. There is a brief biography of each individual and how they viewed scripture and geology. The author examines the qualifications each man had in order to write competently on scriptural and geological subjects. Since geology was in its infancy,

qualifications were far different than they are now and two criteria were used to judge credentials. One was knowledge of the geological literature of the period and the other was field experience. The men Mortenson examines fair well in these areas and compare favorably to their early uniformitarian opponents. Some were competent theologians such as George Young, George Bugg, while others were well known scientists like John Murray, William Rhind, and Andrew Ure. Each man wrote well-reasoned books and publications expressing views concerning a recent creation and the global and catastrophic nature of the Genesis Flood. While they were writing in the same general time frame, (1820-1850), they seemed like lone prophets crying in the wilderness. They were individually opposing what they rightly realized was an attack on the foundations of biblical Christianity and the Judeo-Christian worldview that had been dominant for centuries. They were not a cohesive, unified movement and apparently had limited knowledge of each other's work and little if any contact.

The last and very important section of the book "Generalizations and Conclusions" wraps up the historical significance of the scriptural geologists. It covers such questions as what impact the scriptural geologists had, how critics treated their work, and the historical and societal reasons why their work had little lasting influence. This section deserves special attention.

The scriptural geologists of the early nineteenth century opposed atheist thinking in geology and compromises in Biblical interpretation. Progressive creationists, day age and gap theory advocates, as well as secular naturalists, were the foes of the scriptural geologists. While Darwin's articulation of his theory of descent with modification was still several decades in the future the notion of evolution was present during this period. While scriptural geologists were unified on the recent origin of the earth and the globally destructive flood they developed differing approaches to issues. This included whether the antediluvian climate was uniformly tropical, if the flood accounted for most of the secondary and tertiary geological formations, if God recreated new animal species after the flood, and the precise chronology of the events in Genesis. Much of this echoes current debates between YEM and OEC advocates and

even within the YEM community. This book clearly shows that a literal, normative interpretation is historically valid, and as the YEM contends, is the correct approach to the early chapters of Genesis.

This book deserves to be widely read. While Moretenson made every effort to make this a lay reader friendly publication, it still rings with a labored and academic tone. For those comfortable with today's journalistic "easy read" prose, the author's use of lengthy quotes laden with passive

voice and seemingly endless qualifiers make this book, for some, a challenging reading experience. My suggestion to the non-academic reader: read the first and last sections and as you have interest peruse the chapters on the individual scriptural geologists.

This book has extensive footnotes, and bibliography, and scripture, person and subject indices.

Don Ensign



Book Review

The Secret of Ararat by Tim LaHaye and Bob Phillips
Bantam Books, New York, 2004, 384 pages. \$25.00.

This historical novel follows the style of Tim LaHaye's popular *Left Behind* series. Coauthor Bob Phillips has written eighty other books, many in the area of counseling. These men clearly have had a lifetime of successful writing. This book is actually volume 2 of the current series *Babylon Rising*.

Michael Murphy is the hero of the story, a creationist professor and archaeologist. He seeks Noah's Ark in Turkey while fighting off terrorists, demonic conspirators, and other assorted hoodlums. I was surprised by the many descriptions of violent murder. People, both good and bad, fall like dominoes in this book. The Ark is fought over to the death because of amazing relics that are known to be on board. These include advanced battery devices which somehow are capable of supplying cheap energy for the world. Are novels allowed to defy the law of conservation of energy?

During this dramatic story there is valid material presented on actual historical sightings of the Ark. The exploration data is given as Murphy lectures to his classes and handles questions from doubting students. I wonder

how this data is perceived by readers when it is embedded in a fictional story?

Parts of the book appear to refer to some technical research from the creationist RATE (Radioactivity and the age of the earth) research initiative. The RATE group suggests that living creatures in the pre-flood world, including people, had an absence of potassium-40 in their bodies, unlike today. The reason is that the RATE team proposes an acceleration of nuclear decay around the time of the Flood. This would include the rapid decay of K-40 to Argon-40. The heat generated by this decay would cook any organism containing a substantial amount of K-40. The book mentions the idea without elaboration. This radiation reference is perhaps beyond the interest and understanding of many readers.

The book is a quick read and gives the flavor of the other astoundingly successful writings of Tim LaHaye.

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Conference Reports

On Eugenie Scott's Address to the American Astronomical Society, Winter 2005

Introduction

Eugenie Scott gave a morning address on Tuesday 8:30–9:20, January 11, 2005, at the 204th semiannual national meeting of the American Astronomical Society. She is the head officer of the private anti-creationary organization, the National Counsel for Science Education (NCSE, url: www.NCSEWEB.org). It has some 4000 members. Early word was that the AAS meeting was one of the best attended of all times. Indeed, many hundreds attended the meeting even at the early hour. The AAS is largely made up of university professors that teach and do research in some field of astronomy. Among the attendees that morning were several noted creationary astronomers including myself. The title of her talk was “Intelligent Design (ID) and the Creation Controversy.” This was the first talk that Dr. Scott, a Ph.D. biologist, has made to this professional group.

A Static Universe?

She was introduced by the former director of NOAO (National Optical Astronomy Observatories), who said that she was shocked that more than 50% of the US population believes that God directly created mankind less than 10,000 years ago. Dr. Scott began by characterizing the Bible-based creation community as believing that God created the universe in its present form about 10,000 years ago. She repeated on several occasions that all creationists, whether Bible-believing or not—including the ID movement believes the first part of this statement—that God created the universe in much its present form. This statement was made as a thesis that would support her later definition of evolution. There was a deliberate effort to characterize the creationary community as believing in a static (non changing) universe and the evolutionary community as one that looks at the universe as dynamic. She lumped the ID movement in with the creationists.

The Grand Canyon

She targeted ICR and AIG as the primary antievolution organizations and stated that the new, soon to be opened,

AIG museum that would be located, by design, at the “hub” of America in Northern Kentucky, which is near many high population centers. She regarded AIG as the second largest creation organization. In her comments about the Grand Canyon, she noted that the NCSE, like ICR, offers a Grand Canyon tour, albeit an anti-creationist one, during which she critiques a well known creationary guide book. A slide was shown with her sitting on a boulder in the canyon holding the paper back book. She stated that creationists believe that the canyon formed in one year following the flood of Noah. She repeated Ken Ham's well known statement, which goes something like, “Evolutionists believe that the Canyon was created by a little bit of water acting for a long time while creationists believe that it was made by a lot of water acting for a short time.” She said these two actions are not equivalent.

Evolution—Only Science on the Block?

She stated that one of the main contributors to the recent creation surge has been in written decisions by Judges. In *Aguillard vs. Edwards*, 1987, Justice Brennan made a ruling allowing, “flexibility to supplant the present scientific curriculum with...alternative scientific theories, besides evolution, about the origin of life.” However, Dr. Scott reminds that evolution is the only real science “on the block.” So, creation is not science. In addition, it is not even in the mainstream of religion since most Catholics and Protestants teach theistic evolution.

ID Equals Gap Finding?

She typified ID as “gap finding.” Presently unexplainable phenomena are ascribed to God. Michel Behe's “irreducible complexity” and William Dembski's “explanatory filter” arguments were included in this message with the emphasis on the later. She described ID as a “science stopper” and an “argument from ignorance,” and treating the unknown as the unknowable.

Circumventing the Process?

She also criticized the creationary movement for doing an end run around the scientific community by going directly to the public with their case instead of going through the normal scientific publication process with peer review. Creationists are pictured as circumventing the scientific process. Of course this was the same argument against the cold fusion movement. They went to the news papers before their work was accepted by a scientific journal. I would remind the reader that Space Telescope Science Center has done this repeatedly. One example was the imaging of a supposed planet swirling off a double star. Later, we found out that neither “planet” (which turned out to be a star) nor the double star were ever associated.

Philosophical vs. Methodological Materialism

Next Dr. Scott criticized the ID group of 40 scientists and philosophers, now called the “Discovery Institute—the Center for Science and Culture” for changing its logo and name several times to make it become less religious. Scott believes that ID has been trying to make inroads into public schools by appearing increasingly secular. She stated that this group had confused methodological materialism with philosophical materialism. Methodological materialism was described as the correct method of doing science—that is, ignoring God in the scientific process. My department chair, who was a “born-again” Christian once told me, “You must play science by the rules of the game.” By this he meant we should not consider God in our science. In other words, a methodological materialist can believe in God, but his science should be divorced from any mention of God. On the other hand, philosophical materialism is the belief that Carl Sagan espoused in his statement which is something like, “the cosmos is all there is and all there will ever be.” It is outright atheism. Dr. Scott, believes that scientists may be theistic while their scientific methods should be atheistic. Atheism does not necessarily follow from atheistic science. Based on this type of thinking, one would never be allowed to use a Flood model—at least one that was a part of God’s judgment—to explain the fossils, the Grand Canyon, or anything for that matter.

The Wedge

Then she warned the astronomers about Philip Johnson’s “Wedge” in his book, *The Wedge of Truth*. The wedge is the false (in Dr. Scott’s estimation) interjection of an atheism vs. theism argument for the creation vs. evolution controversy.

Dr. Scott decries Philip Johnson’s conclusion that, “If you imply a natural cause, you are denying that God had anything to do with it.” She states that this is an unfortunate conclusion. This reminds me of the criticism creationary scientists get when they develop a model that is other than the statement that, “God did it miraculously.”

Changed Terminology

Dr. Scott defines evolution is simply “change through time.” The universe is not static but dynamic. Of course, every modern creationary scientist I know believes in a dynamic universe! This is certainly not what we are referring to when we say evolution. Also, Dr. Scott asked the attending educators to take the Academy of Sciences definition of three scientific terms. This is done in reaction to the oft heard statement, “Evolution is a Fact.” She urged her audience not to say this. The gist of the definitions was:

Facts: A confirmed observation (lowest order truth)

Laws: Descriptive generalizations (next in order)

Theories: Well-substantiated explanations of some aspect of the physical world (the end result of science)

She said the most important results in science are the theories—the explanations of phenomena. In this scheme, evolution is touted as a theory. Creationists have long said that Evolution is not a fact but a theory. The above definitions work into the evolutionists hands. Suppose a student says, “evolution is a just a theory.” The instructor could counter with, “that is exactly what science is all about—it is about explaining nature.” And since evolution is a theory, like the theory of quantum mechanics, it is good science. It has explanatory power. We need to be careful about our terms.

Creation Science All Negative?

Scott levels another criticism at creationists, and in particular the ID movement. She states that ID’s main thrust is to criticize evolution and not to do science. It has nothing to contribute in the way of models. It is all negative and has no positive value. Of course, one has only to look at the issues of the Creation Research Quarterly or the Technical Journal to see that Eugenie is wrong. While not being supported by NSF or being recognized by mainline secular journals, creationary science is making headway. But I must admit that much of the past and even present creationary writings are negative and “gap finding” in nature. Some creationists leap for joy when the evolutionary scientist stumbles or when he does not seem to have the answer.

Creationists need to be working more on finding answers rather than criticisms. We need to be concentrating more on producing creationary models rather than on identifying gaps in evolution.

As the CRS creationary community, we need to consider Dr. Eugenie Scott's arguments. Although most are false criticisms, knowledge of our opposition will help us to do battle and also help identify our short comings.

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Editor's Note: Dr. Samec's description of Dr. Eugenie Scott's speech provides us creationists with some clear insight into the thinking of many evolutionists (certainly the more "outspoken ones"). She arbitrarily defines both science and scientific facts/theories in a manner that serves evolution and discounts creation. She also makes generalizations about what creationists accept (such as stasis of the creation) and creates a "straw man," enabling evolutionists to then claim that any and all changes, whether biological or astronomical, demonstrate the universe is evolving and that creationists are foolishly ignoring the obvious evidence of these changes. Her speech continues to demonstrate why it is so imperative to require evolutionists to more carefully define their "theory," and creationists to more clearly define ours.

Book Review

The Camellia Lover's Guide to the Galaxy by James K. G. Waterhouse

Published by the author, 37/96 Formby St., Calamvale,
Queensland, Australia, 2004, 87 pages. \$30.00.

The subtitle of this unusual book is *Where Botany Meets Astronomy*. The Waterhouse family has long been involved with camellias which are plants with shiny leaves and roselike flowers. The author's grandfather, E. G. Waterhouse (1881–1977), was a world camellia authority who co-founded the International Camellia Society in 1962. EGW's home in Sydney is a botanical garden open to the public called Eryldene (eryldene.clom.au). The author's father, Gordon Waterhouse (1913–1986), continued the botanical lineage by developing several new camellia varieties. The camellia is the oldest cultivated plant, originating in the Orient and flowering during the dormant winter months. It is the state flower of Alabama. The plant is named for George Joseph Kamel (1661–1706), a botanist and Moravian Jesuit missionary.

This book combines the author's camellia heritage with a thorough knowledge of astronomy. There are scores of camellia varieties and a surprising number of them are given names connected with astronomy. Examples include Andromeda, Buzz Aldrin, Christmas Star, Dark of the Moon, Evening Star, Flying Saucer, Ganymede, and so on right through the alphabet. The book is organized as an A–Z atlas with hundreds of camellia and astronomy entries. There

are many excellent color pictures of camellia blossoms and astronomical objects.

The author sees a serendipitous convergence between the worlds of botany and astronomy in his own life (p. vii). The book gives strong support to the creation worldview. I see this convergence of botany and creation as another significant point. Walter Lammerts (1904–1996), cofounder and past president of the CRS, was a worldclass expert on rose breeding who introduced 46 new rose varieties during his career. I recently met a board member of the International Hosta Registry. He is a believer with a keen interest in creation studies. And Dr. George Howe, member of the CRS board, is a botanist with a special expertise in desert plants. Here may be the seeds for an international creationist botanical society.

Thanks to James Waterhouse for writing an attractive book. The topics cover the beauties of the camellias below and the stars above. The book is spiral bound with a full index and bibliography.

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Notes from the Panorama of Science

Geology Beyond Plate Tectonics

In the year 1980, I circulated to geologically-minded friends a short polemical article with the title: “Free the crust from mantle serfdom” (Fowler, 1977). It was a splendid catalyst for discussion, because it contrasted the plutonic, mantle heat-driven model of geodynamics with a tectonic, athermal, surface-driven alternative. My interest in this debate was stimulated by the implications for historical geology. The plutonic paradigm locks geologists into timescales measured in millions of years, whereas the active-crust paradigm permits both catastrophism on short timescales as well as actualistic processes over millennia.

The plutonic approach has matured into the contemporary theory of plate tectonics and the athermal alternative is today a minority view championed by Don Anderson of the University of California. An excellent overview (Anderson, 2003) of the contrasting positions is available as a preprint via www.mantleplumes.org. Anderson refers to the active-crust paradigm as the “General Theory of Plate Tectonics” or “Plate Theory” and the conventional plutonic approach is referred to as the “Special Theory of Plate Tectonics.” This terminology appears to be chosen to emphasise the common ground shared by advocates of the two theories, but it could be said that this nomenclature understates the differences.

Anderson considers that plate tectonic theory, as practiced by most geologists today, has reached an impasse. Some features of the Earth are well explained by the theory, but there are other major problems in explaining continental deformation, continental breakup, large igneous provinces and island chains. Numerous concepts have been invented by geologists to address these anomalies, and Anderson sees them as adding unnecessary complexities to basic plate tectonic theory. A recurring theme in the paper is that by applying Occam’s Razor, these extraneous concepts may be stripped away. Anderson ranks them (notably the mantle plume hypothesis) alongside the concepts of “ether, geocentric, phlogiston, caloric, impetus, permanence and immutability” (Anderson, 2003, p. 4) which are described as having “held back the natural and physical sciences for millennia.” (p. 4).

Mantle convection has gripped the imagination of geologists ever since Arthur Holmes included it in his classic textbook: *Principles of Physical Geology* (Holmes, 1944).

The concept of a convection cell goes back to 1900 when Henri Bénard “heated whale oil in a shallow pan and noted a system of hexagonal convection cells.” (p. 6) This was analysed mathematically by Lord Rayleigh and the theory was regarded as robust. “Rayleigh-Bénard convection has been taken as the classic example of thermal convection and the hexagonal ‘honeycomb’ planform has been considered to be typical of convective patterns at the onset of thermal convection.” (p. 6).

However, as Anderson has often pointed out in the past, the Earth’s plates do not fit the model at all well.

Computer simulations of mantle convection have been unable to reproduce plate tectonics. Furthermore, it is now known that surface tension effects are responsible for the honeycomb structures, and the phenomenon has been renamed. Bénard-Marangoni convection “is organised by the surface tension on top, which serves as a template.” (p. 6)

Anderson then draws attention to the work of Ilya Prigogine, who “has shown that open systems, which are far from self-equilibrium, have a tendency to self-organise.” (p. 6) This leads to an active-crust scenario, in which other crustal plates drive their own movements (powered by gravity) and where the plates organise flow in the mantle.

Many other important issues are discussed by Anderson, notably whether the mantle is homogeneous (well mixed) or heterogeneous, whether the crustal plates are fixed and rigid, and whether mantle plumes exist:

The first thing to realise about hotspots is that they are not hot. It is important to realise that they are not, strictly speaking, spots either (p. 17).

The conclusion includes this concise overview of the two positions:

The general theory of plate tectonics, discussed here, drops most of the assumptions, adjectives and limitations of the special theory and makes it evident that plate tectonics is a much more powerful concept than generally believed. The general theory is put forward as a topdown, stress and plate controlled, largely tectonic and athermal alternative to the bottoms-up deep thermal plume hypothesis. Lithospheric architecture and stress, not concentrated hot jets, localize volcanism. Melting anomalies are due, in part, to fertility variations. The perceived limitations

of the plate tectonic theory, which are thought to require special mechanisms to drive and break-up the plates and create volcanic chains, are semantic, not real, limitations (p. 19).

Those who challenge the reigning paradigm have to stand aside from “the comfortable path of conventional wisdom” (p. 2). Anderson is very aware that questioning the plutonic approach is revolutionary. “The history of science is replete with examples of scientific revolutions and paradigm shifts. The earth sciences have had their share. Plate tectonics is one, and we are currently living through another” (p. 2).

Is this controversy of interest to Diluvialists? Most certainly it is. Evidences of catastrophism are not hard to find in the geological record, and geologists are more than ever willing to consider catastrophist scenarios. Yet the overall timescale is never rethought, partly because of radiometric dating, and partly because of a “plutonic” mindset. When geology is driven by heat released from the mantle, or by heat from the sun, overall timescales have to be small and whatever catastrophism is recognised punctuates a uniformitarian background. This is not the Diluvialist paradigm.

**There are significant problems
with explaining the
global patterns of volcanism
from the perspective
of plate tectonics theory.**

Tyler (1990) has proposed a tectonically controlled rock cycle as an alternative to the “Rock Cycle” that introduces successive generations of students to Earth science. He argued that tectonic control provides a different mindset for approaching geological data and that it has the potential for harmoniously bringing catastrophism into the portfolio of recognised geological processes. Insofar as the General Theory of Plate Tectonics is a surface-driven, tectonic alternative to plutonism, it provides a useful complementary framework for studying and understanding contemporary geological activity.

Some convergence with Anderson’s approach is shown also by a radical and insightful analysis of volcanism produced by Cañón-Tapia and Walker (2004). They refer to the dominant paradigm of plate tectonics as “trying to force a preconceived explanation of volcanism in the light of only three tectonic settings” (p. 180). The reality is, say these authors, that observations do “not fit the predictions” and that there is a “conceptual gap left between plate tectonics and most (if not all) of the characteristics of volcanic activity at a global scale” (p.163).

Classic plate tectonic theory has three tectonic settings for volcanism, all defined by reference to the Earth’s tectonic plates. These are as follows:

- Rift volcanism (two neighbouring plates move away from each other)
- Subduction volcanism (converging plates lead to one plate descending below the other)
- Hot Spot volcanism (mantle plumes generate activity that may be far from plate margins)

These tectonic settings do have some explanatory power. There is a predominance of volcanism at plate margins and the geochemistry of the magmas can be modelled by reference to the three settings.

Nevertheless, there are significant problems with explaining the global patterns of volcanism from the perspective of plate tectonics theory. Examples include:

- There are a significant number of volcanic centres that do not fit easily into any of the three tectonic settings listed above;
- the occurrence of monogenetic and polygenetic volcanism regardless of tectonic scenario. (Monogenetic volcanism involves magma that has essentially the same composition throughout the sequence of eruptions, whereas polygenetic volcanism involves significant changes in magma composition with time); and
- the distribution of volcanic centres along plate margins tends to be point-like and there are significant gaps in volcanic activity.

Instead of seeing these examples as ‘exceptions’ and ‘anomalies’ to plate tectonic theory that require individualised explanations, Cañón-Tapia and Walker say that “all of these hard-to-explain volcanic features... seem to be the result of common rules controlling volcanism at a global scale; rules that are not included explicitly on the paradigm of plate tectonics” (p. 164).

In order to provide an alternative conceptual model of volcanism, the authors advocate the concept of “Volcanic Systems.” The term is not new, but neither has it been formally defined and treated independently from the framework of plate tectonics. This is the task the authors

undertake (in a qualitative way) in their review paper.

A significant shift in thinking has taken place concerning magma chambers. Earlier models of volcanism postulated sizeable pools of magma below volcanoes and ocean ridges—but geophysical research has failed to confirm their existence. The emerging models have “vertically distended mush columns” (p. 166) produced by partial melting.

What can cause the partial melting? There are three ways to melt a rock: heating, decreasing the pressure of hot rocks, and changing the chemical composition. Heating becomes important, for example, when there is an injection of hot basaltic magmas into continental crust, where the rocks can melt to form granitic magmas. Decreasing the pressure is the focus of interest in this review paper. Changing the chemical composition can become important with the injection of water or mineralising fluids.

The rates of volcanic processes are described as occurring “at a much faster rate than that characteristic of tectonic processes” (p. 167). Plate tectonics operates on timescales of thousands and millions of years, whereas volcanic processes are measured in hours, months and years. The authors say that “it is reasonable to assume that the time required to melt mantle rocks will not be much greater than the characteristic times observed for crystal dissolution, or the achievement of textural equilibrium, once the [pressure/temperature] conditions for melting have been reached” (p. 167). Crystal dissolution rates are measured in hours to months, and textural equilibrium is thought to be achieved in just a few years. Over these timescales, inferred plate tectonic motions are almost negligible. “Therefore, there seems to be a contradiction in the fact that a basically stationary mantle ... is directly responsible for processes that occur at much faster rates like melting or volcanic activity on the surface” (p. 167).

The key process linking activity at depth and the surface is rock-fracturing. “The birth of a volcanic system can be defined as the moment when hydraulic fracturing allows a significant amount of magma to be transported out of the source region” (p. 167). The authors note that there are a variety of alternatives to conventional plate tectonic mechanisms, and all of them are compatible with the definition of a volcanic system.

The authors then go on to delineate their “volcanic systems” model and to identify different modes of behaviour

over time. In their discussion section, they return to the three features of volcanism that are not readily explained by plate tectonics but which are in their proposed model. They see plate tectonics as the framework within which volcanism takes place, but also that new theoretical work is needed “to fill the gap left between the characteristic time-scales of either phenomena” (p. 180).

The authors conclude: “it is considered that “Volcanic Systems” is the blueprint that should be used to guide future “fresh insights” required to understand in a quantitative sense the global aspects of volcanism, and their relation with plate tectonics” (p. 180). For those of us who are not persuaded to adopt the long timescales of plate tectonics, this is a very positive contribution to knowledge. Our interest in developing an alternative framework of geological activity is one that will find much common ground with the “Volcanic Systems” approach. Catastrophism, of course, extends the range of processes available for interpreting the past, especially when considering features like the Earth’s large igneous provinces.

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A Look at Sheldrake's Strange Hypothesis of Formative Causation

Rupert Sheldrake (1998) could not accept the idea that the genetic make up of an organism can be totally responsible for the passing on of its life form. The alternative idea that he puts forth is one in which all the atoms, organs and overall forms of organisms have their own morphic field and it is these fields that pass information on. He thinks this happens at the present day level, but also believes that such fields from past forms can play a part in the formation of an organism (Sheldrake, 1988). The interesting thing about these theoretical fields is that anything that happens at the genetic level is supposedly passed on to the field. The field then passes such information on to either the adult form of that organism or its offspring.

The Creator created the various kinds of life, the atoms and chemicals involved would have been brought together to produce each life form and this would have yielded the overall "morphic field" of each life form. Any genetic changes thereafter would be passed on to the morphic field and none of this would upset the creation hypothesis. The original genetics would still be in charge because whatever happens at the gene level is passed on by way of the morphic field. Created kinds would still be maintained by what I have called symmetric variation (Brown, 1999, p. 100). But information would be carried from generation to generation by the morphic field as well as by the genetic code.

I think this morphic field view falls down on a number of points, however. If the information of any genetic system were passed on through morphic fields we would expect people to have natural resistance to rabies or other illnesses because their ancestors would have lived through such attacks and would pass on the morphic field information to produce whatever is needed to ward off such attacks. The more people that live through an attack the more people

in later generations would not need much looking after because they would have a natural, built-in resistance to it. But I am unaware of anything like this happening. A strange thing about these hypothetical "fields" is that they are believed to be non-energetic, so that they are neither mass nor energy and do not obey the normal laws of physics. Indeed, they could operate outside of space-time and "re-enter" whenever the time is right, or they may be connected to other dimensions or "tunnel" through space-time to emerge unchanged (Sheldrake, 1988, p.100). I cannot understand why anyone would accept all this "baggage" when the simple idea of passing on features through the genetic system works very well indeed.

In a point aside, it has recently been shown that the organism's own, actual inner electric fields will indeed both heal it and help in its cell migration and cell divisions (Copley and Page, 2002, p.15)

Sheldrake (1988, p.113) says that form is brought about by polarity in using such things as light, chemical gradients, and electric currents to name a few. But if you have these options and others, why is there the need for something that is outside space-time and is neither energy nor matter when something much simpler will produce and form? In the case of the fruit fly the head can be produced at either end of the embryo or even at each end by the action of known genes and gene products (Brown, 2001, p. 48); (Nusslein-Volhard, 1996, p.41). Interesting though Sheldrake's ideas may be, I think this hypothesis will be shown to be wrong.

Acknowledgements

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Letters to the Editor

Objections to “Beyond Scientific Creationism”

The serious effort to look “Beyond Scientific Creationism,” (CRSQ, Dec 2004) was wonderfully insightful, point by point, but dangerously wrong, I believe, in its major theme. The intent is to formulate strategy and tactics to “finish the job started by the scientific creationists” through the use of “formal (instead of) empirical arguments.” Once it is shown that Naturalism has hijacked Christian axioms, “the Naturalists will have only one way out. They must provide self-consistent substitute presuppositions... If they cannot do so, then their worldview will be demonstrably flawed...” Thus a Christian worldview must follow, one supposes.

This top-down approach is contrary to experience and, more importantly, to the pattern of Scripture. The target would seem to be academia, whose professors are perhaps the most anti-Biblical group of scorners on the planet. Consider Proverbs 14:6 (KJV) “A scorner seeketh wisdom, and findeth it not: but knowledge is easy unto him that understandeth.” The reason is simple: “the natural man receiveth not the things of the Spirit of God: for they are foolishness unto him: neither can he know them, because they are spiritually discerned.” (1 Corinthians 2:14 KJV). The authors acknowledge this with the caveat, “Total victory is unreasonable since the inherent biases of fallen human beings will believe anything, even a failed worldview, as long as it is not Christianity.” But they still press their thesis, as if there is a human judge who will declare Naturalism formally invalid, and somehow force naturalistic professors and other educators to capitulate.

Satan, however, is tenacious and as plastic as necessary to keep multitudes in darkness and on their way to judgment and hell. Note, for example, how naturalistic atheism is giving way to New Age philosophies. Atheists, always in the minority in this nation, are shrinking in number even more as New Age pantheism, infested with evolutionary philosophy, grows rapidly. One acquaintance of mine, to whom I’ve witnessed the Gospel for many years, finally quit atheism for various “spiritual” explorations in pantheism. His evolution remains intact and his soul is still lost.

Rather than expend effort in the direction of formal proofs, I would encourage born again, Bible believing creationists (redundancy deliberate) to pursue the following:

1. Get out on the street and witness to a thousand individuals this year. Find out what the real issues

are in the minds of those who reject Christ.

2. Pull your children out of the enemy’s public schools (that would be 100% of the public schools), rather than hope your kids can hang tough.
3. Pray for spiritual power, strength, and boldness, “For we wrestle not against flesh and blood, but against principalities, against powers, against the rulers of the darkness of this world, against spiritual wickedness in high places.” (Ephesians 6:12).

I’m not against philosophical arguments if they’re brought down to the lower shelves. When you witness to a polite atheist (some are) on the street, a philosophical argument is often better than a factoid. For example, the authors pose, “How can scientists act as objective observers unless they transcend nature? How can they transcend nature if they are simply a part of the system?” On the street I would offer it this way, “Why should I respect your argument more than that of the rock over there? If you’re just a bunch of molecules in motion, you have no argument. In fact, what do you mean by ‘you’?”

However, factoids are often useful, such as the evidence of a global flood, because we see billions of dead things, buried in rock layers, laid down by water, all over the world, as Ken Ham has put it. For the mathematically inclined, like computer science or physics majors, who seem disproportionately atheistic, a three-minute, back-of-the-envelope calculation on protein improbability can cause a jaw to drop in astonishment.

Do not disparage the factoids. We all know of many testimonies of lost people saved and Christians strengthened in their faith, because they were just waiting for some simple facts to cast out the darkness of their evolutionary worldview. When someone is open to the leading of the Holy Spirit, just a little help from a Christian may go a long way.

The authors quite correctly point out that “Because human beings learn well through stories and examples, much of Scripture consists of historical narrative and explanation.” As opposed to formal proofs, for example.

I have shared the Gospel with thousands of young people, teenagers, college students, and the vast multitude of heart-hardened people beyond the college years. We need to reach people while they are young. Teach our own kids and find ways (like bus ministries) to reach the rest. The

people most likely to understand logical proofs, namely, the academics and the hyper-educated, are most likely to respond with visceral disdain when offered such.

One last point: it's true that the Intelligent Design camp has missed the connections between science and history. But the *major flaw* in the ID movement has been their flagrant disbelief of Scripture. This is spiritual warfare and cannot be won without God's help. Because God has magnified His word above His very name (Psalm 138:2), they cannot call God a liar by disbelieving Genesis and then expect God-given victory. And real victories are necessarily God-given. They can be counted in individual souls saved.

Reply to Dr. Stone

We appreciate Dr. Stone's interest in our paper and his enthusiasm for evangelism: certainly one of the important means by which God allows us to participate in man's greatest undertaking - that of reflecting God's glory. Fighting for truth is another facet of that image-bearing purpose (II Corinthians 10:5). As we made plain in our paper, apart from God's Spirit Christian apologetics will not automatically turn atheists into believers. And although our paper was not intended to deal explicitly with evangelism, there is a connection. Since faith comes through hearing (Romans 10:17) it behooves Christians to remove roadblocks to truth such as the fog of Naturalism. Only God changes hearts, thus neither formal nor empirical arguments will do so for any hardened against God's wisdom. Yet we believe that many thinking people both inside and outside the faith are struggling with questions addressed by our paper. As Will Rogers observed, "It's not the things we don't know that hurt us the most; it's all the things we know that just aren't so."

But the focus of our paper was not Christian evangelism. Perhaps this fundamental misunderstanding led Dr. Stone to argue that our paper was "dangerously wrong." The few criticisms offered do not seem to substantiate this serious charge. We do not believe that defeating Naturalism is wrong, nor do we believe that the age-old method of challenging assumptions is either. Instead, such a strategy is a fundamental principle of critical thinking. That being the case, our arguments become "dangerous" only to advocates of Naturalism. Dr. Stone implies that our paper is wrong because it is a "top-down approach," but he never defines what this means. He states that our approach is "contrary to experience," yet the application of logic is part of human experience every day. He states that it is "contrary to the pattern of the Scripture," but offers no specifics to substantiate this serious charge.

We should clarify a few of Dr. Stone's other misappre-

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hensions. Creationists, not "academia" were our target audience. Perhaps Dr. Stone will reflect on how many members of the Creation Research Society are academics before consigning all academics to the category of "anti-Biblical scorners." Second, a formal refutation of Naturalism does not depend on any human judgment, rather on the force of coherence and consistency, which the Bible presupposes as hallmarks of truth. What people do with that truth does not alter the fact that uncovering and understanding it is worthwhile in and of itself. Pascal said that reason itself establishes the boundaries of reason and allows the wise to see that there is much that reason cannot know and that this truth may be apprehended by anyone, regardless of his faith relationship to Jesus. And as Dr. Stone concedes, we understand that people will be disinclined to accept the truth. What he should realize is that this *does not diminish its apologetic value*. One might as well say that all Christian scholarship is worthless because some disregard its truth! He may be interested in reading Herbert Schlossberg's (1983) compelling case that New Age thinking is the other side of the coin of materialistic naturalism. Whether he agrees with that assessment or not, his concern with such thinking presupposes an argument about worldviews—precisely our point. Finally, although Dr. Stone appears to think little of philosophical argument, characterizing ours as "top-down," "academic," and "dangerously wrong;" he sates that he is willing to apply such argumentation himself, provided it is sufficiently simple. We prefer the example of Scripture, which is replete with witnesses who spoke in terms best understood by the target audience: Queen Esther; Paul on Mars Hill; and God Himself, both in Nature (Psalm 19) and the person of His Son (John 1). Simplicity is desirable, but there is no advantage in being simplistic by avoiding a conscious analysis of root issues and logic. None of the Scriptural examples alluded to here are simplistic.

Dr. Stone asks us not to disparage factoids. We do not. We simply believe that: (1) the application of scientific data to historical truth involves a number of presuppositions that are best brought out in the open, and (2) that formal errors are more destructive of the Naturalist Worldview than empirical data. As we pointed out, the hidden nature of Naturalism's assumptions has contributed to confusion among many Christians for many years. What we do disparage is any Christian acquiescence to the positivist mindset that would declare the objective truth and wholesale applicability of scientific data, especially to history. We hope that this distinction was clear to most of our readers and regret that it was not to Dr. Stone.

Finally, we disagree firmly with Dr. Stone's blanket depiction of Intelligent Design proponents and regret his inaccurate and inappropriate characterization. We stand by our analysis of the Intelligent Design position as presented in our paper.

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Book Review

Bones of Contention: A Creationist Assessment of Human Fossils by Marvin L. Lubenow

Baker Publishing Group, Grand Rapids, MI, 2004, \$22.00.

This is a revised and updated version of Marvin Lubenow's 1992 book. The first third of the book is fairly close to the original but updated. Lubenow emphasizes that there is much confusion, disagreement, hiding of evidence, censorship, artistic license, fraud, and biased reconstructions in the field of paleoanthropology. It is also rather anomalous in science that few researchers ever get to examine the original fossils. Furthermore, there is actually an abundance of fossils, and newer ones tend to result in the human evolution story becoming regularly outdated. In this field, evolution is assumed and pushed, no matter what the fossils say.

Lubenow adds much new material while including some of his previously published but updated material. He explains the sea-saw status of Neandertal Man in the evolutionary model and adds much material on the new mtDNA results for Neandertals. He demonstrates that Neandertal Man was a type of *Homo sapiens*. The unique facial features likely are due to non-evolutionary causes. The author adds new information that *Homo erectus* is also a type of modern man, and a generally smaller version of Neandertal Man. More is written about *Australopithicus* in this volume than in the first edition. *Australopithicus* is easily shown to be nothing more than an ape. There is a new section with four chapters on the inherent racism of human evolution, with this racism is being covered over

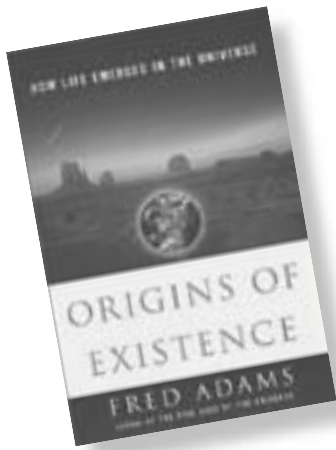
with dogmatic stories about "African Eve" or the "Out of Africa" model.

Marvin emphasizes in the text, and with excellent graphs and tables at the end of the book, that man and his putative ancestors all lived at the same time, based on the evolutionary dates. *Homo erectus* spans an age range of over 4 million years in the evolutionary timescale—a problem for those who believe in human evolution. A new section on the creationist RATE project has been added, but I was disappointed that the appendix from his previous edition, called *The Dating Game*, was deleted.

One concern that I have is that the book does not mention Jack Cuozzo's hypothesis that the Neandertal features are a result of great age. Maybe this is because Marvin did not want to mention creationist disputes in a popular book, since such disputes are more pertinent for the creationist technical journals. I would like to see both sides of this issue discussed eventually and in charity, possibly in a future issue of the *CRS Quarterly*. In this way as much data as possible can be placed on the table for creationists to evaluate.

In summary, Marvin's book is a good addition in support of the creation model. The book overwhelmingly shows that a man is a man and that an ape is an ape with significant variety within the kinds, just as implied in Genesis where all organisms reproduce after their own kind.

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Book Review

Origins of Existence by Fred Adams

The Free Press, New York, NY, 2002, 266 pages. \$25.00.

Fred Adams received his Ph.D. in physics from the University of California, Berkeley. He is an astrophysicist and active member of the Big Bang cosmology establishment with a long list of research publications. Adams is presently a professor of physics at University of Michigan, Ann Arbor. This book purports to be the story of “global cosmic ecology” and “microscopic particles organizing themselves into ever-larger molecular structures, with ever-increasing levels of complexity, and culminating in the everyday miracle that we call life” (p. 5). In other words it is the story of evolution from Big Bang to man. He adds a short section at the end in which he predicts possible directions of evolution into the future.

The book subtitle is “How Life Emerged In The Universe.” Under that theme the author attempts to fit all presently known physical processes in our universe into the ultimate cause for evolution of life on earth and possibly in other parts of the universe. According to the author the origin of life is only another inevitable step in the evolutionary process begun at the Big Bang. The physical laws which governed the evolution of the universe and everything in it also lead to the natural development of life here on earth.

The book is well organized with a table of contents, eight chapters, glossary, notes, references for further reading, acknowledgments and an index. In chapter 0 *Beginnings* he sets the stage for the remainder of the book with this brief statement: “These physical laws, and the astronomical structures they create, are apparently not only necessary but are also sufficient for the genesis of life itself” (p. 2). He uses chapter 1 *Physics* to redefine physics to match: “physics is, by definition, that which exists in a more permanent way than the universe. It is the set of rules that governs not only the workings of the physical universe but also the actual genesis of our universe and perhaps many others” (p. 7). The following five chapters give the specific physics rules for genesis of universes, galaxies, stars, planets and life. These are the latest “just so” stories we hear from evolutionists in the news. He gives two versions for the genesis of life. The first version must be for historical purposes, since “Darwin’s warm little pond” theory does not lead to nucleotides required for life as demonstrated by all the

Miller-type experiments (p. 171). The problem is blamed on oxidizing by atmospheric oxygen and uv radiation on the earth’s surface if oxygen didn’t exist in the atmosphere. The latest version has life begin deep under the surface of the earth where these problematic conditions are not found but living Archaea cells exist in abundance. He admits that “the intermediate step—the transformation from complex organic molecules to the simplest organisms—remains beyond our grasp” (p. 188).

The part of the book I found most interesting is chapter 7 *Reflections* in which he tries to make his case stronger for global cosmic evolution. In the short section entitled *The Tuning of the Cosmos* he lists the evolutionary steps required to reach earth’s present condition. In this progression I am forced to interject the phrase “then a miracle happens” to get from one step to the next. For example the first result of the Big Bang is “Our cosmos has a well-defined matter content, roughly one-third of the critical value required to make the universe geometrically flat” (p. 203). I would consider this an example of intelligent design or a miracle. Of course he uses the excuse that our knowledge is insufficient at the present time to explain the details. But he also neglects to point out that without any intelligent being directing these processes there is a probability of zero for all the necessary steps that were taken in the correct order at the right time. In my opinion physical laws don’t think, create or determine what will happen next under the conditions where they are applied. They also have no ultimate outcome they are striving to achieve even if they have billions of years in which to operate. The ultimate question is faced on page 209: “If the laws of physics could have been different, why does our universe have the particular suite of properties for the emergence of life?” The suggested answer is the anthropic cosmological principle that the laws of nature must allow for the appearance of living beings capable of studying the laws of nature. To me this is circular reasoning at best or just plain nonsense. Creation requires a Creator and it is obvious from the author’s own evidence that physical laws are a result of intelligent design and therefore can not be that Creator.

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

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Special Sections

Letters to the Editor:

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

Editor's Forum:

Occasionally, the editor will invite individuals to submit differing opinions on specific topics relevant to the *Quarterly*. Each author will have opportunity to present a position paper (1000 words), and one response (500 words) to the differing position paper. In all matters, the editor will have final and complete editorial control. Topics for these forums will be solely at the editor's discretion, but suggestions of topics are welcome.

Book Reviews:

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

Creation Research Society

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The membership/subscription categories are defined below:

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2. **Sustaining Member** Those without an advanced degree in science, but who are interested in and support the work of the Society.
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Creation Research Society

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

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

fund for these purposes are tax deductible. As part of its vigorous research and field study programs, the Society operates The Van Andel Creation Research Center in Chino Valley, Arizona.

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

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

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

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

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

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