Reinventing Stratigraphy at the Palo Duro Basin

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Abstract

Instead of futilely squeezing time from the uniformitarian geologic column, creationists should allow biblical presuppositions about natural history to revolutionize stratigraphy. This type of approach is tested at the Palo Duro Basin, a cratonic sedimentary basin located in the Texas Panhandle. An assessment of the basin fill allows revision of strata out of the uniformitarian framework and into genetic units that reflect depositional and tectonic episodes. These in turn can be interpreted within the framework of the Genesis Flood, and the genetic units assigned a tentative position along a geologic energy curve as a basis for regional correlation based upon Flood stage rather than time. In this framework, the Palo Duro Basin's history provides several clues to the nature of the Flood in central North America.

Introduction

How should creationists pursue the interpretation of the rock record? Were Whitcomb and Morris (1961) right in calling for a reinterpretation of empirical data, or do we merely need to shrink the timescale of the uniformitarian geologic column? If we reinterpret, how do we draw the line between the purely descriptive, proper genetic, and improper genetic propositions? After all, descriptive and genetic aspects of forensic writing often intertwine. And layers of often unrecognized assumptions infiltrate even apparently descriptive texts. What do we reject and what do we keep? These are all difficult questions, and although many creationists have offered advice on how to proceed, no consensus of principles and methods for creationist stratigraphy exists. Our difficulties begin to be resolved by recognizing that natural history is a subset of history, not science (Reed, 2001). It requires an extrascientific framework that recognizes hard boundaries of biblical truth, but does not slight forensic aspects. Klevberg (1999; 2000) discussed distinctions between scientific and nonscientific facets of stratigraphy. What about the uniformitarian geologic column? Can it be applied as long as the time is properly condensed?

The rapidity of the Flood event seems to preclude even a condensed time-stratigraphic interpretation (Reed et al., 1996; Froede and Reed; 1999; Reed, 2000). Any regional topographic variation relative to "mean Flood level" (MFL) at any given time would result in depositional systems created by similar Flood environments being radically time transgressive. In other words, as the Flood moved across a region, its final vertical signature of rock units might be similar over the entire area, but the individual units in the vertical sequence might be strongly diachronous. For example, if a hypothetical vertical sequence consisted of units A, B, C, and D, the arrangement of A-B-C-D might be present over a wide area, but units A and C may have been deposited at the same time. Given this potential, *time* should not serve as the primary correlation key to the rock record as applied in the uniformitarian column. In place of time, Reed et al. (1996) suggested geologic energy as a new means of stratigraphic correlation. Although drawbacks exist, primarily in the difficulties of quantifying the concept, it has seemed applicable where attempted (Lalomov and Tabolitch, 1999; Reed, 2000). Other means are possible and should be developed and tested by creationists.

If geologic energy is a way of ordering stratigraphic units, then its utility must be demonstrated in a wide variety of settings. The Palo Duro Basin provides a location for testing this concept. It is a relatively undeformed cratonic basin that has been extensively explored for oil and gas (with little success): more than 1,000 exploration wells have been drilled in the basin (Ruppel, 1985) and many thousands more provide regional context in the surrounding area. It was investigated in the late 1970s by the Texas Bureau of Economic Geology as a potential storage site for high-level radioactive waste for the United States Department of Energy. Abundant data and the skilled efforts of many geologists combined to supply a descriptive understanding of the basin and its sedimentary fill (Johns, 1989; Nativ, 1988; Ruppel, 1985; Dutton et al., 1982; Dutton, 1980; Handford and Fredericks, 1980).

An advantage of this basin is its strategic location between the Texas Permian Basin and the southern midcon-

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tinent basins along the northern boundary of the Amarillo-Wichita Uplift (Johnson et al., 1989). Any interpretive success in the Palo Duro may pave the way for extrapolation both north and south. Such extrapolation might prove interesting indeed, for though the Palo Duro has proven relatively barren of hydrocarbons, the Anadarko and Permian Basins are prolific producers. The Permian Basin alone has produced over 25 billion barrels of oil and over 75 trillion cubic feet of gas (Tyler and Banta, 1989).

Challenges for Creationist Stratigraphy

Natural history includes the interpretation of forensic evidence within an historical framework. Reed (2001) has explored the role of presuppositions and some implications of applying biblical assumptions to natural history. Since the bulk of this forensic evidence of the earth's past is found in the rock record, the science of geology (not to be confused with uniformitarian historical geology) is particularly applicable. But the nonscientific framework cannot be ignored: in spite of common confusion, the rock record and the uniformitarian geologic column are not one and the same. Therefore, natural history within the Biblical Worldview requires replacing that naturalistic construct with a framework built on other assumptions.

The rock record has been interpolated worldwide by the correlation of rock units. Stratigraphy is the discipline which is concerned with how rock units are correlated. Sometimes the distance over which units are to be correlated is the width of an outcrop, sometimes the width of a basin, sometimes the width of a continent. As the scale increases, so usually does the uncertainty. It is helpful to assess this uncertainty in any evaluation of the geologic column. Physical correlation of outcrops provides the greatest degree of confidence. Indirect physical correlation of rock units and their bounding surfaces can be done by subsurface well logs and reflection seismic techniques, and the degree of certainty can usually be assessed from the data. When physical correlation becomes impossible, then other methods are applied: correlation by lithology, bounding surfaces (e.g., Sloss, 1963), and fossil content.

Correlation across physical discontinuity by lithologic similarity and fossil content engenders less confidence. The impossibility of biological evolution severely undermines biostratigraphy (although fauna may be useful in defining depositional conditions), and the work of Berthault (1994) requires that care be applied even in deriving timing and environment from lithostratigraphic correlation. These problems raise two questions for creationists:

1. If conventional *methods* are rendered inappropriate by faulty presuppositions, what methods are appropriate for stratigraphic analysis? and
2. If conventional *interpretation* is also suspect because of faulty presuppositions, what part of the current body of knowledge requires correction?

Biblical natural history offers some constraints (Reed and Froede, 1997). Assumptions of deep time, uniformitarianism, and the role of present-day depositional environments to interpret the past all need to be rejected. How should we proceed? The first step applied here is to convert the time-stratigraphic framework into an event-stratigraphic framework, and then interpret those events inside the boundaries set by the Bible. Careful use of current descriptions is encouraged, but interpretation must follow new presuppositions. To what extent are description and interpretation separable? Description at the most fundamental level includes geometry and composition. Those aspects of existing works are often of high quality, even when interpretive conclusions are not.

Beyond the scope of clear correlation by outcrop, log, or seismic line, creationists must reject biostratigraphy and focus on parameters deduced from the fact of a global Flood: environment, tectonics, and relative sea level (i.e., Flood water level). In addition to deriving explanations of the lateral relationships of geometry and composition, creationists must also address vertical relationships with more care than uniformitarians. The timing of the Flood event forces us to explain vertical relationships that uniformitarians have been able to ignore by an appeal to missing section and supposed large temporal gaps. When we encounter vertical changes in lithology or geometry, we cannot so easily escape the implication that our models are deficient when they do not explain the transition. How will this approach work in the Palo Duro Basin?

Description of the Palo Duro Basin

The Palo Duro Basin is a part of a complex of basins and arches in the Texas Panhandle and southern midcontinent (Figure 1). Prior to its formation during Pennsylvanian[1] sedimentation, it was part of the regional lower Paleozoic Oklahoma Basin (Johnson et al., 1989). It occupies approximately 19,000 mi^2 (Handford and Fredericks, 1980) and is relatively shallow; usually less than 10,000 ft. from land surface to Precambrian basement (Dutton, 1980). To the south, it is bounded by the Matador Uplift, which separates it from the much larger and deeper Permian Basin. To the north, the Amarillo-Wichita Uplift separates it from the Anadarko Basin, and to the northwest over a low in the Bravo Dome lies the Dalhart Basin. Low structural features separate the basin east and west from the Hollis/Hardeman and the

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[1] I use the local nomenclature of the geologic column for ease of reference to existing literature.

Tucumcari Basins, respectively. The Dalhart Basin and Hollis/Hardeman Basin are commonly included in discussions of the Palo Duro Basin (e.g., Dutton et al., 1982).

The dominant tectonic feature of the Texas Panhandle is the Amarillo-Wichita Uplift. However, during its early history this feature was a deep trough, the Southern Oklahoma Aulocogen (Gilbert, 1983), initially infilled by up to 20,000 ft. of extrusive and intrusive silicic igneous rocks (Johnson et al., 1989; Hogan and Gilbert, 1997). Continued tectonic downwarping led to the development of a deep trough (see Figure 3 of Johnson et al., 1989). Rapid reverse motion was initiated during early Pennsylvanian (Morrow) sedimentation that led to the dramatic elevation of the Amarillo-Wichita Uplift along reverse faults with up to 40,000 ft. of throw. Reverse faulting is dated to a short interval of the lower Pennsylvanian system, although some motion continued until the end of Pennsylvanian sedimentation. Sediment distribution patterns strongly suggest that this uplift was regional: surrounding arches and basins appear to have been activated during this same interval (Johnson et al., 1989). To the south, the Matador Arch was uplifted at the same time in a series of discontinuous east-west fault blocks which form the southern boundary of the Palo Duro Basin.

The Palo Duro Basin contains predominantly marine carbonate and evaporite rocks with locally abundant terrestrial clastics, including thick deposits of "granite wash." Stratigraphically, the Palo Duro Basin fill ranges from Precambrian to recent on the uniformitarian column (Figure 2), but the bulk is Pennsylvanian and Permian. I will eschew the time-stratigraphic framework of the geologic column and introduce an alternate interpretation explicitly compatible with biblical natural history.

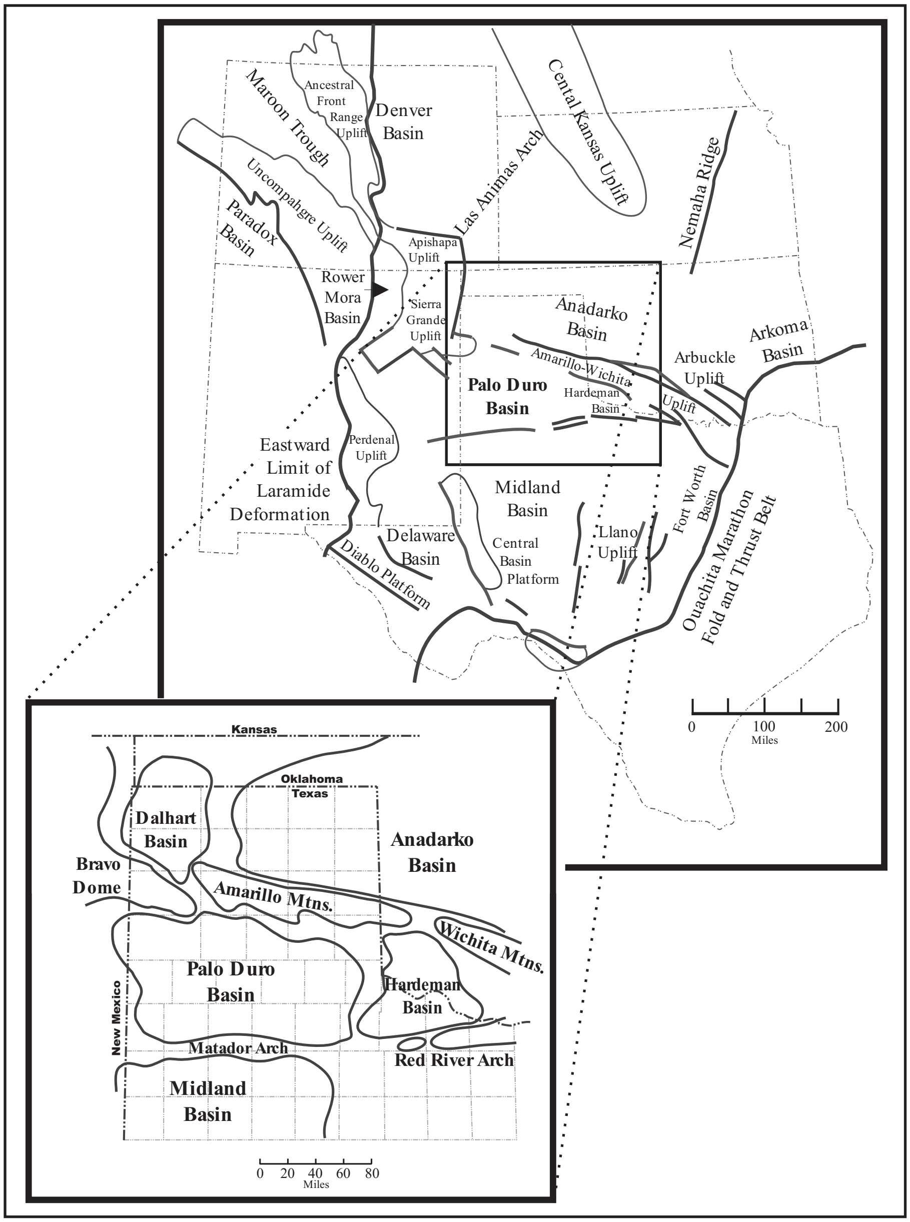
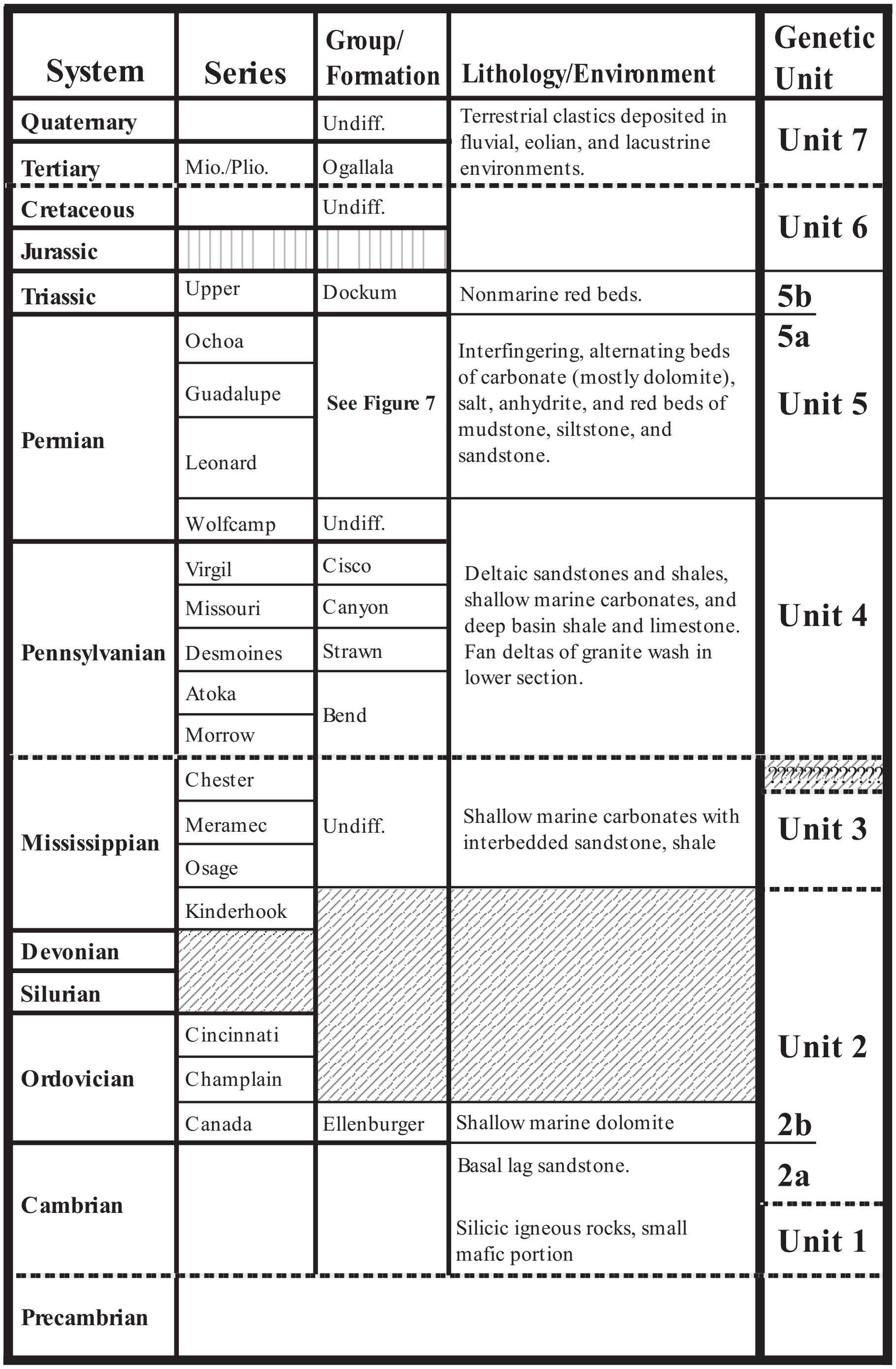


Figure 1. Location and regional tectonic setting of the Palo Duro Basin. After Johnson et al., 1989; Dutton et al., 1982, and Ruppel, 1985.

Escape from Deep Time: Event Stratigraphy in the Palo Duro Basin

The fill of the Palo Duro Basin can be divided into seven genetic units—combinations of strata that reflect similar environmental or event settings with consideration given to intervening major physical unconformities (Figure 2). I derived these units from the description of the range of properties of the rock units, including lithology, geometry, and the nature of their bounding surfaces. Immediately noticeable is the relative thickness of the units (Figure 3). Unit 1 is thick, but is composed of igneous rock. Units 2 and 3 are relatively thin marine strata, while Units 4 and 5 are relatively thick marine strata. The thickness of these units can be related to two different factors: Unit 4 to the tectonic history of the basin, and Unit 5 to the expected increase in thickness of units deposited during Flood regression as compared to those deposited during its advance across the continent and its increase to highstand. Predom-



System	Series	Group/ Formation	Lithology/Environment	Genetic Unit
Quaternary		Undiff.	Terrestrial clastics deposited in fluvial, eolian, and lacustrine environments.	Unit 7
Tertiary	Mio./Plio.	Ogallala		
Cretaceous		Undiff.		Unit 6
Jurassic	▥	▥		
Triassic	Upper	Dockum	Nonmarine red beds.	5b
Permian	Ochoa	See Figure 7	Interfingering, alternating beds of carbonate (mostly dolomite), salt, anhydrite, and red beds of mudstone, siltstone, and sandstone.	5a Unit 5
	Guadalupe			
	Leonard			
	Wolfcamp	Undiff.	Deltaic sandstones and shales, shallow marine carbonates, and deep basin shale and limestone. Fan deltas of granite wash in lower section.	Unit 4
Pennsylvanian	Virgil	Cisco		
	Missouri	Canyon		
	Desmoines	Strawn		
	Atoka	Bend		
	Morrow			
Mississippian	Chester	Undiff.	Shallow marine carbonates with interbedded sandstone, shale	???????????? Unit 3
	Meramec			
	Osage			
	Kinderhook	▨	▨	Unit 2
Devonian	▨			
Silurian	▨			
Ordovician	Cincinnati			
	Champlain			
	Canada	Ellenburger	Shallow marine dolomite	2b
Cambrian			Basal lag sandstone.	2a
			Silicic igneous rocks, small mafic portion	Unit 1
Precambrian				

Figure 2. Stratigraphic column of the Palo Duro Basin showing the relationship between time-stratigraphic units classified by uniformitarian researchers and the genetic units proposed in this paper (modified from Dutton et al., 1982, Ruppel, 1985, and Gustavson, 1980). Gray areas represent absent section.

inantly nonmarine sediments of Units 5b, 6, and 7 reflect the waning stages of the Flood. These genetic units are presented outside of their time-stratigraphic classification. That information is available in the references cited in the following section.

Unit 1

The first unit does not consist of any sedimentary rocks, but is a part of the basin's development. The basement complex beneath the Palo Duro Basin is a combination of several terranes. The Panhandle Rhyolite is a thick complex (3,821 ft. drilled in Potter County, Texas; up to 20,000 ft. modeled [Dutton et al., 1982; Johnson et al., 1989]; and up to ten kilometers in a seismically-imaged basin [Ewing, 1990]) with sparse interbedded sediments. The Amarillo Granite terrane is considered its intrusive analog, and the regional Western Granite-Rhyolite Province is located to the east and south of these panhandle units. Diabase and gabbro of the Swisher Terrane (Muehlberger et al., 1967) appear to overlie the rhyolite. Granite in the subsurface is present as both batholiths and sheets (Hogan and Gilbert, 1997). Uniformitarians date much of the local basement complex between 1400 and 1200 Ma, with another episode of tectonically associated igneous activity at the Amarillo-Wichita Uplift in the early Cambrian reported between 577 and 514 Ma (Hogan and Gilbert, 1997).

In addition to the pre-Flood basement, I believe that part of this igneous complex was formed during a significant tectonic event that marked the onset of downwarping of the Southern Oklahoma Aulocogen—a dramatic tectonic disruption of the crust on the north edge of what would become the Palo Duro Basin. I interpret this episode as the onset of the Genesis Flood. The abrupt nature and scale of the tectonic disruption and resulting igneous activity are correlative to the Midcontinent Rift System to the north and similar basement features across North America (see Figure 2 of Reed, 2000). The Southern Oklahoma Aulocogen and the Midcontinent Rift System are similar in the scale and magnitude of tectonic and igneous activity. Both are regional linear to arcuate zones of extensional crustal disruption with severe downwarping and associated igneous

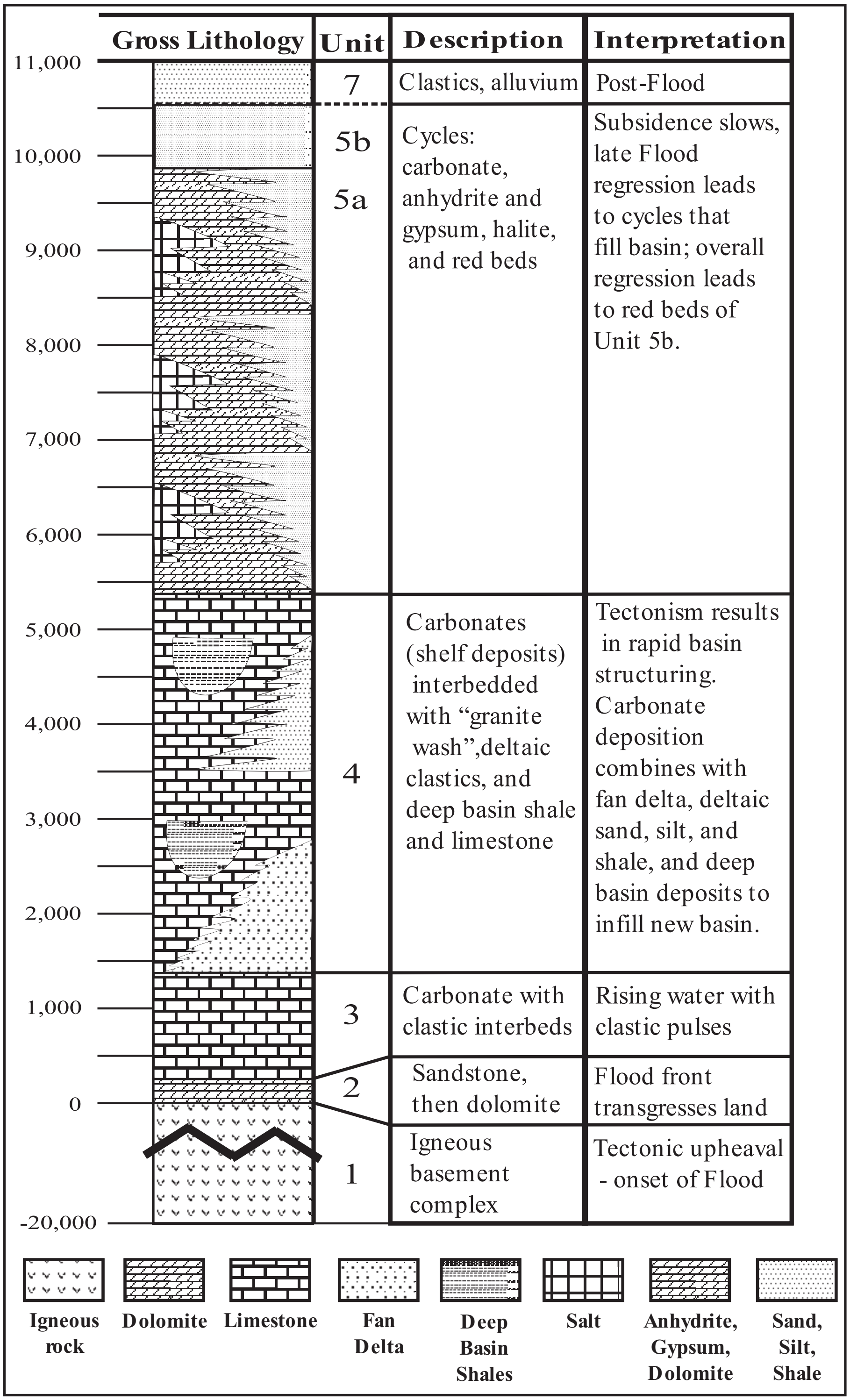


Figure 3. Relative thickness and gross lithology of genetic units. Brief description and interpretive summary shown in adjacent columns. The maximum sedimentary thickness was generated by deposition of Units 4 and 5. Note artificial shortening of Unit 1 section.

activity. Both experienced later inversion along early faults, forming sedimentary basins of great depth adjacent to uplifted blocks.

Two distinctions between them are (1) the dominant silicic nature of the intrusive and extrusive rocks at the Southern Oklahoma Aulocogen, and (2) the absence of thick sections of non-marine sediments found in the Mid-continent Rift System basins. The difference in rock composition reflects a difference in magma composition, and that topic is well beyond the scope of this paper. The absence of non-marine clastic sediments at the Southern Oklahoma Aulocogen supports the thesis in Reed (2000) that the Flood transgressed the continent from south to north. The rapid inundation of the southern part of the continent prevented significant accumulations of non-marine sediments; those that were washed into the Flood front by runoff were probably reworked into the basal lag of Unit 2.

Unit 2

The second unit consists of the thin veneer of clastic sedimentary rocks that immediately overlie the igneous complex, and the Ellenburger Dolomite. These two lithologies are similar in their lateral extent and appear not to be separated by any significant unconformity. The quartz sandstone contains clasts of limestone and dolomite, suggesting marine conditions, but also appears to grade downward to the weathered basement, suggesting some degree of *in situ* breakup of the igneous rocks and limited transport of the resulting lithic fragments. This unit thickens significantly to the north, suggesting that much of the initial downwarping of the Southern Oklahoma Aulocogen was accomplished quickly, and the subsiding submarine trough was rapidly infilled by carbonates. Unit 2 is absent on the Texas Arch, which was a positive structure covered later by sediments of Unit 3. It may have been active early during the Flood, leading to thinning over it and subsequent ease of erosion during changing relative MFL.

The earliest sedimentary unit is sandstone, commonly dated as Cambrian and often correlated with the Hickory or Reagan sandstones, the Riley Formation, or the younger Wilberns Formation (Ruppel, 1985). This unit rarely exceeds 50 ft. in thickness and is composed of rounded quartz sandstone, conglomerate, and gray and green shale. The thickest accumulations in the Palo Duro Basin (>200 ft.) coincide with a structural depression on the Texas Arch. The sandstone is the basal transgressive lag deposit of the earliest recorded transgression of the continent (Ruppel, 1985).

The Ordovician Ellenburger Dolomite (Barnes et al., 1959) is generally correlative to the Arbuckle Group farther north on the midcontinent (Johnson et al., 1989) and is a prolific oil producing horizon in southwest Texas (Tyler and Banta, 1989). The Ellenburger is widespread across west Texas and eastern New Mexico. It occurs over much of the eastern and western Palo Duro Basin; its local absence on the Texas Arch is attributed to later erosion (Ruppel, 1985) but may also have resulted from non-deposition on an existing high (Wright, 1979). Where present, it averages approximately 200 ft. in thickness, but reaches 1,200 ft. in the east and northeastern Palo Duro Basin in fault blocks against the Amarillo-Wichita Uplift and more than 2,000 ft. in the Anadarko Basin (Dutton et al., 1982). It is commonly gray to brown, but includes white, cream, yellow and pink, fine- to coarse-grained, rhombic to sucrosic dolomite. Shale, rounded quartz sandstone, pink to white chert, and pyrite are common. Glauconite is also common at the base and top of the unit. The upper unit is commonly brecciated with dolomite clasts, sand, and glauconite. The dolomite is considered diagenetic, but the precursor limestone was apparently predominantly massive. Relict sedimentary structures, where visible, include parallel, planar laminations and burrows. The Ellenburger is predominately dolomite in west Texas, but grades to limestone as it thickens in areas of central Texas and Oklahoma (Johnson et al., 1989).

I interpret Unit 2 as deposits resulting from the initial transgression of the Flood waters over the Palo Duro Basin region. Igneous rocks were strongly eroded by both pre-transgressive rain and then by the transgressive front of the Flood itself. The sandstone shows evidence of marine deposition. There do not appear to be any preserved non-marine clastic sediments as are seen farther north at the Midcontinent Rift System. Therefore, I believe that the marine waters of the Flood covered this area quickly, moving south to north across central North America.

As the water covered this area, carbonate deposition rapidly overcame clastic deposition. This could have resulted from (1) a decrease in clastic source material, (2) an interruption in clastic transport; or (3) a significant geochemical impetus toward carbonate precipitation, probably caused by heating and CO_2 degassing of the upwelling marine waters. Although all of these factors may have contributed to the carbonate buildup in the Palo Duro Basin, the most singular is the third. In addition, the introduction of ions from early volcanic and associated igneous activity and the dissolution of pre-existing carbonates or other chemical rocks may have also driven carbonate precipitation. The presence of iron and silica minerals within the Ellenburger may have originated from volcanism associated with the onset of the Flood at the Southern Oklahoma Aulocogen and to the south, near the Marathon Basin (Ewing, 1990).

By reference to the uniformitarian geologic column, Middle and Upper Ordovician, Silurian and Devonian strata are absent from the Palo Duro Basin, as is the lowest Mississippian, or Kinderhookian, section (Figure 2). However, these units are thick and regionally pervasive to the south in the Permian Basin (up to 4500 ft., Wright, 1979) and to the north in the Anadarko Basin (up to 5,000 ft., Ruppel, 1985). These lower Paleozoic strata may be absent in the Palo Duro Basin by either non-deposition or later erosion (Dutton, 1980). The differences between the Palo Duro Basin and the Permian and Anadarko basins relative to the composition and presence of lower Paleozoic rocks suggests several possible explanations. The rapidly sinking Southern Oklahoma Aulocogen and basins to the south may have acted as clastic traps and kept the area around the Palo Duro Basin a carbonate province during the entire time. Or, as posited by uniformitarians, those sediments may have been deposited and later eroded. This question is an example of the need to carefully evaluate the vertical relationships between rock units and attempt alternate explanations. Such an investigation in this particular case is beyond the scope of this paper, requiring regional analysis.

Unit 3

Separated from the underlying Ellenburger by a physical unconformity surface is Unit 3. It comprises carbonates mixed with clastics that are classified as the Osage, Meramec, and Chester series of the Mississippian (Figure 2). Mississippian carbonates are present over much of the Texas Panhandle, reaching up to 900 ft. in the Palo Duro and up to 1,400 ft. in the Hollis/Hardeman Basin. Unit 3 pinches out to the northwest against the Transcontinental Arch, but increases up to 4,000 ft. in the Anadarko Basin (Ruppel, 1985).

Kinderhook sandstones are present in the Anadarko Basin, but basal clastics of Unit 3 in the Palo Duro Basin are shales, assigned to the Osage series (Ruppel, 1985). These rocks are widespread across the basin and range in thickness up to 300 ft., compared to 175 ft. in the Dalhart, and over 1,000 ft. in the Anadarko Basins. They include gray or brown argillaceous dolomite with chalky, dolomitic limestone and gray to green shale (Dutton et al., 1982). The dolomite content increases from east to west across the

Panhandle. Chert is ubiquitous, and pyrite, glauconite and sand are common. Wackestones and grainstones alternate and contain abundant skeletal debris from bryozoans and echinoderms (Ruppel, 1985). Breccia is present, but not common. Siliceous sponge spicules are also present in the dolomite.

Osage carbonates grade conformably upwards into Meramecian limestones, present across the Palo Duro Basin up to 300 ft. thick, and up to 1,500 ft. thick in the Anadarko. The top of Meramecian limestones is regionally recognized by SP (spontaneous potential) and resistivity changes on electric logs. Limestones are buff to white, fine to medium-grained, oolitic, non-argillaceous beds with common dolomite and dolomitic limestone. Chert is rarer than the underlying Osagean units, and quartz sand is common at the top of the section. Meramec limestones are interpreted as reflecting regional shallowing (Ruppel, 1985) that culminated in erosion and clastic deposition during early Chester time.

Meramecian strata are separated from overlying Chesterian strata by a physical unconformity, more pronounced in the western Panhandle. It is marked by limestone and quartz conglomerates and is thought to represent continued shallowing and the introduction of a clastic source in the area. Chester rocks are found in the middle and eastern part of the Palo Duro, and are less than 300 ft. thick—in contrast to the more than 1,700 ft. reported in the Anadarko (Ruppel, 1985). These rocks include light colored, fine-grained, oolitic limestone with rare chert and interbedded calcareous shales. Clastic to carbonate ratios of these rocks are higher in the eastern Palo Duro and to the south along the Matador Arch, implying earlier uplift there. Clastics are also more abundant (nearly 100%) north of the Amarillo Uplift in the Anadarko and Dalhart Basins (Ruppel, 1985).

I interpret Unit 3 as commencing with a relative fall in MFL, generating the erosional unconformity at the top of Unit 2. Shortly thereafter, MFL rose again, and deposition continued, first with a basal clastic sequence, followed by argillaceous dolomite. Clastics were probably eroded from the Texas Arch, although they might have been transported from another source. In either case, the clastic source was covered by rising water and limestone covered the Texas Arch. The decrease in chert content within the limestone also suggests a decreasing silica source from early Flood igneous activity. Deposition of Unit 3 ended with the onset of a new episode of tectonism that led to the development of new clastic sources that would become more pronounced during the deposition of Unit 4.

Unit 4

Unit 4 is a thick sequence of mixed carbonates and clastics that were deposited as the Palo Duro Basin underwent structural changes that configured the present-day basin. Tectonism increased sharply at this time and the Palo Duro Basin began to subside. Structural changes triggered changes in source areas and basin depth which strongly influenced subsequent sediment thickness and composition. Sedimentation initially lagged behind subsidence, leading to the formation of a deep basin which was subsequently filled. Coarse-grained clastics were deposited near the uplifts that formed the basin margin and fine-grained sediments were deposited in the central basin. Unit 4 also includes thick carbonates, both limestone and dolomite which were deposited laterally between the granite wash and deep basinal clastic sediments.

Unit 4 consists of sediments classified as Pennsylvanian and lower Permian (Figure 2). These strata form the bulk of the basin fill (Figure 3). Pennsylvanian units average 2,000 ft. in thickness and range up to 4,000 ft. against the Amarillo-Wichita Uplift (compared to over 25,000 ft. of Pennsylvanian-Permian strata in the Anadarko). The Pennsylvanian is conventionally subdivided into four stratigraphic groups: Bend, Strawn, Canyon, and Cisco. However, these subdivisions are not easily applied in the Palo Duro Basin, and its Pennsylvanian sediments are described instead by reference to depositional systems (e.g., Dutton et al., 1982). These include: (1) fan delta, (2) shelf and shelf margin (3) high constructive delta, and (4) slope and deep basin.

The Pennsylvanian has been divided lithologically into upper and lower sections. These are considered to stratigraphically coincide with the Bend and Strawn Groups (lower) and the Canyon and Cisco Groups (upper) (Dutton, 1980). However, there are no regional marker beds or unconformities within the Pennsylvanian system. The lower section is roughly 45% of the system and includes mixed clastic and carbonate rocks. Fan delta deposits are prevalent in the lower section adjacent to block faulted uplifts. Carbonates in the lower Pennsylvanian section occur away from terrigenous sources, and the deeper basinal shales are found only in a small area of the southern basin, just north of the Matador Arch.

The upper mixed clastic and carbonate beds of Unit 3 mark the initial pulse of renewed tectonism. However, Unit 4 marks the most significant uplift, that resulted in the erosion and local transport of great volumes of carbonate and "granite wash" (coarse-grained, arkosic clastics) from the Amarillo-Wichita, Bravo, Matador, and Sierra Grande uplifts (Figure 4). As erosion continued and the basin subsided, fan deltas prograded into the basin reaching thicknesses of up to 1,200 ft. A fan delta is an alluvial fan that progrades into a water body from an adjacent highland (McGowen, 1970), characterized by steep gradients, short transport distance, and high-energy deposition. The typical vertical sequence includes prodelta clay and silt overlain by sand and clay of the distal fan and sandstone and conglomerate from braided fan channels.

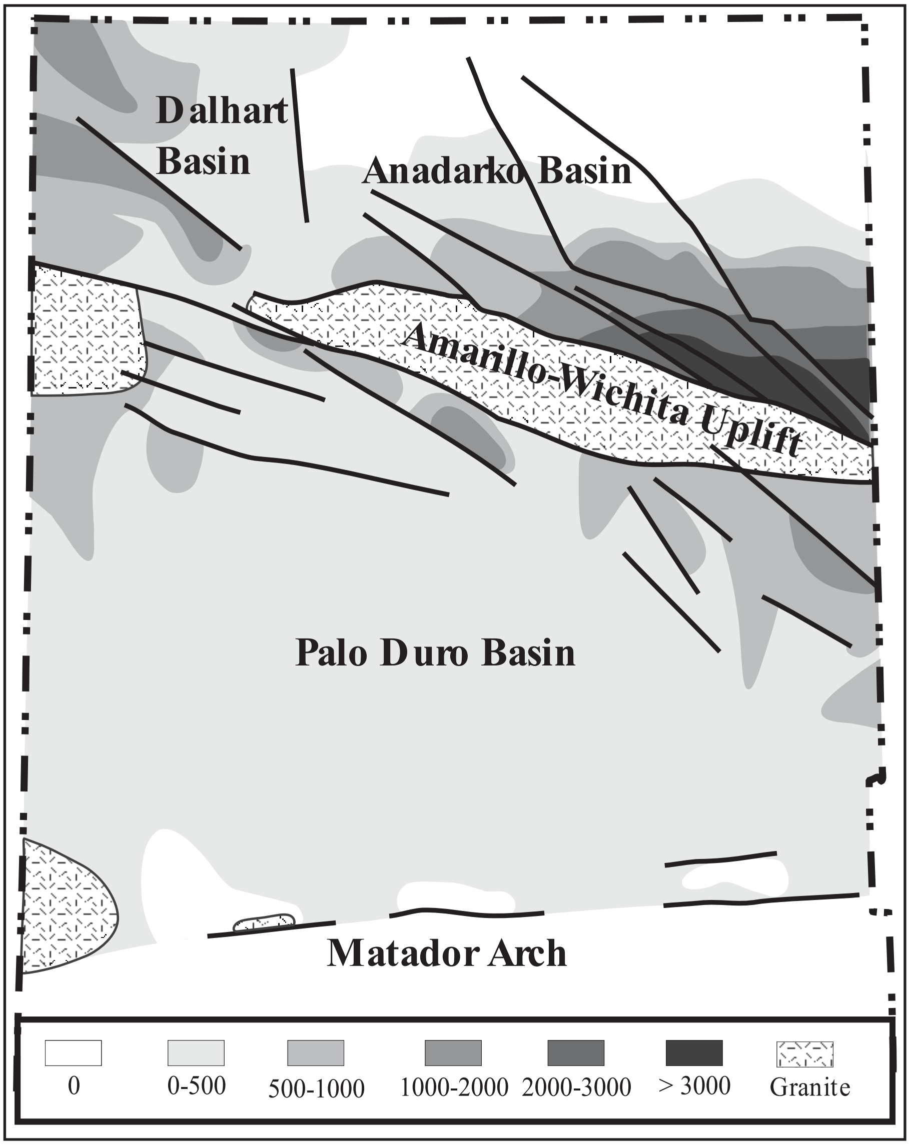


Figure 4. Distribution and thickness of granite wash facies in the Palo Duro Basin, after (Dutton et al., 1982).

As Unit 4 was deposited, faulting attenuated, relative sea-level rose, and the exposed uplifts were finally buried under a broad carbonate platform (Handford and Fredericks, 1980). This upper section contains abundant marine carbonate and fine-grained deep basin fill deposits. Before being submerged by Wolfcamp (lower Permian, see Figure 2) sediments near the top of Unit 4, the uplifts contributed clastics to the upper section as high constructive delta lobes (Dutton et al., 1982) in the Hardeman and eastern Palo Duro basins. These deltas are composed of elongate to lobate sandstone bodies that prograde into the basin. In contrast to the fan deltas, they are found primarily in the upper part of Unit 4, the clastics are usually finer-grained, and the sandstone bodies in these delta systems are thinner (up to 400 ft. versus less than 30 ft. in the uppermost sequences), suggesting a decrease in water depth (Dutton et al., 1982).

Carbonate shelf and shelf margin limestones and dolomites up to 2,800 ft. thick developed throughout Unit 4 basinward of the fan deltas, away from clastic source areas. The early shelf margin bounded a deep north-south basin (Dutton, 1980). The carbonate shelf opened to the south towards the Permian Basin and probably stood more than 200 ft. above the basin floor (Handford and Fredericks, 1980). Before the end of Unit 4 deposition, the shelf margin extended to the northwest into the Dalhart Basin, before migrating south into the Permian Basin. Although the carbonate buildups are not considered ecologic reefs, they are classified as stratigraphic reefs (Dutton et al., 1982), and algae, sponges, fusilinids, bryozoans, and brachiopods are common. Much of the shelf margin carbonate in the Palo Duro Basin is dolomite, apparently formed diagenetically since the mineral changes cross both bed and facies boundaries.

Deep basin and slope deposits consist of dark limestone, silty shales and thin sandstones. Dutton et al. (1982) postulated that clastics derived from uplifts migrated across the carbonate shelf and were deposited in the deep central basin by submarine fans.

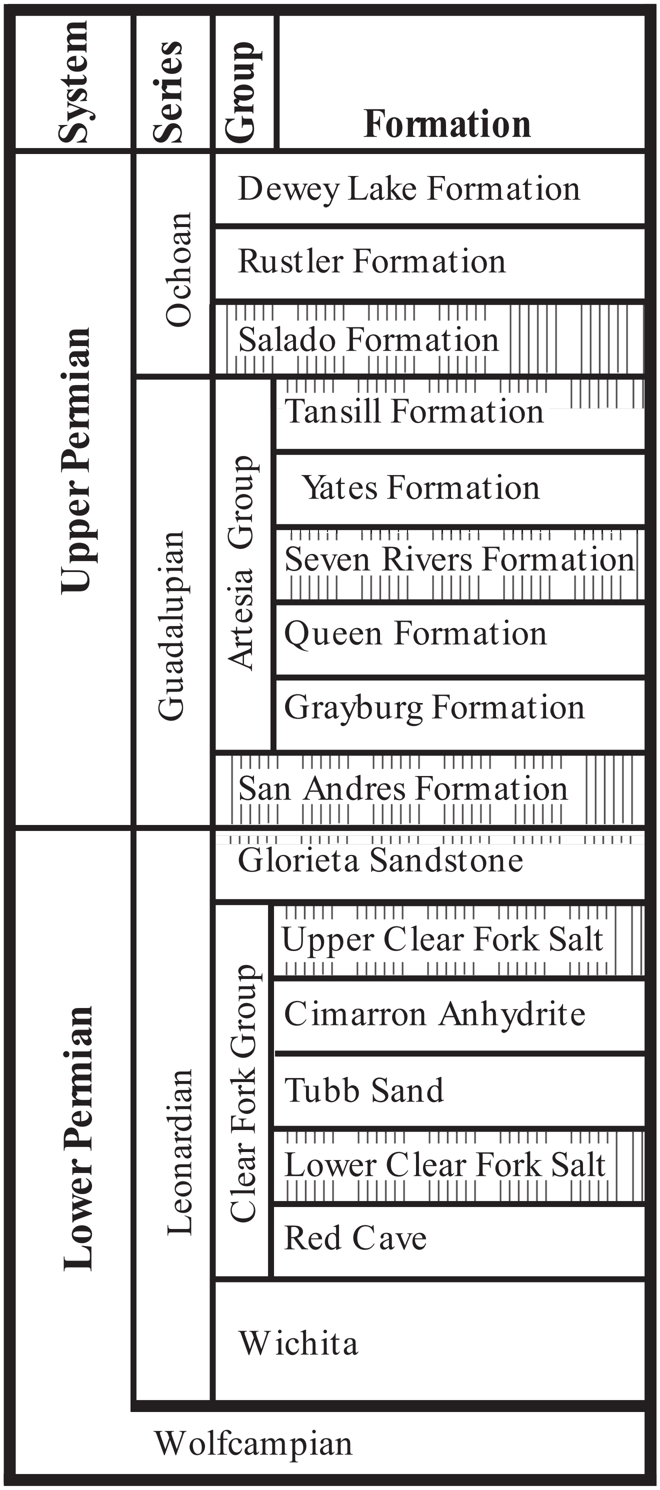
I interpret Unit 4 as marking a resurgence of a tectonism more intense than had occurred in the Palo Duro Basin since Unit 1 formation. Most of the depth, sediment volume, and present day configuration of the basin were developed following this rapid pulse of tectonism. Although the waters were energetically generating carbonate deposits, the rapid uplift of the surrounding arches and the downwarping of the basin center led to a flood of clastics; early in the form of fan deltas of granite wash and later as a decreasing contribution of sand, silt, and clay in high-constructive delta systems. However, carbonate formation prevailed and by the end of Unit 4 deposition, limestone and dolomite covered the surrounding uplifts and the infilled deep central basin. This time marked the highest relative sea-level stand in the Palo Duro Basin's history.

The tectonic event that marks the onset of Pennsylvanian subsidence reversed the downwarping of the Southern Oklahoma Aulocogen with uplift of the Amarillo-Wichita and other basin-bounding blocks. There appears to have been a sharp and abrupt beginning to this tectonic event with the rate of subsidence decreasing over the remainder of the Flood, allowing sedimentation to overtake the newly-increased accommodation space. It also appears that the initial phase of this tectonism manifested itself locally, as the individual basins were formed. It continued in attenuated form over a larger area, represented by the widespread but thick deposits of Unit 5.

Unit 5

Unit 5 comprises the middle and upper Permian system (Figure 5) and the red beds of the Triassic Dockum Formation (Johns, 1989). It includes a suite of mixed carbonate, precipitite (a synonym for chemical sedimentary rocks commonly called "evaporites" by uniformitarians), and clastic sedimentary rocks that marks the pulsating retreat of marine waters from the Palo Duro Basin (Table I) until the nonmarine clastics of the Dockum Formation blanketed the area. The apparent termination of marine sedimentation at the top of the Permian section marks the boundary between Units 5a and 5b, although Unit 6 may include some marine sediments and mark the true end of marine sedimentation in the Palo Duro Basin. Although this change marks certain changes in lithology and environment, it follows the same pattern set during the earlier cycles of Unit 5a. Unit 5 marks a time of subsidence and deposition across a wide area of Texas known as the West Texas Basin (Ewing, 1990). The Palo Duro Basin is merely the northern extension of that much larger depocenter, which captured more than 8,000 ft. of post-Wolfcamp Permian sediments alone in the Midland and Delaware Basins. Unit 5b has been interpreted as being deposited in a closed freshwater basin that extended from central Colorado to southwest Texas, was centered on the northern Midland Basin and filled by clastic sediments from surrounding highlands (Johns, 1989, see his Figure 1 inset). The maximum preserved thickness exceeds 2,000 ft. (Nativ, 1988).

Individual cycles in the Unit 5 progression consist of dolomite followed by anhydrite, followed by halite, followed by red beds of fine-grained terrigenous sediment. Combinations of these units are also present, i.e., mixed dolomite and anhydrite or mixed salt and mudstone. Vertical changes in Unit 5a reflect widespread lateral facies changes. As sea level rose, dolomite was formed across the basin. As sea level fell, anhydrite and salt would form in the broad tidal[2] environment. These rocks are interpreted by uniformitarians as having been deposited across marginal marine environments, similar to the sabkhas of the present-day Middle East. The lithofacies are thought to represent a series of marginal marine environments including (1) subtidal carbonates, (2) supratidal to subtidal dolomite, (3) lower sabkha anhydrite, (4) upper sabkha salt, and (5) terrigenous red beds (Gustavson et al., 1980). I believe that



System	Series	Group	Formation
Upper Permian	Ochoan		Dewey Lake Formation
			Rustler Formation
			Salado Formation
	Guadalupian	Artesia Group	Tansill Formation
			Yates Formation
			Seven Rivers Formation
			Queen Formation
			Grayburg Formation
			San Andres Formation
Lower Permian	Leonardian		Glorieta Sandstone
		Clear Fork Group	Upper Clear Fork Salt
			Cimarron Anhydrite
			Tubb Sand
			Lower Clear Fork Salt
			Red Cave
			Wichita
	Wolfcampian		

Figure 5. Post-Wolfcamp Permian stratigraphy of the Palo Duro Basin. Gray areas show major salt units. Lateral variations across the basin cause differences in vertical sequences depending on location (after Gustavson et al., 1980; Dutton et al., 1982).

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[2] "tidal" as used by uniformitarians and "tidal" as that it might be applied to the cyclical motions of the Flood obviously represents a distinction worthy of exploration.

Table I. Sea level during Unit 5 deposition as inferred from lithofacies distribution (after Dutton et al., 1982; Gustavson et al., 1980; Ramondetta, 1982; McGillis and Presley, 1981). Sea level, increasing from right to left (shown by dots), shows several cycles in the overall regressive trend of the late Permian.

Sea Level inferred from lithology:	High			Low
Middle/Upper Permian Unit	**Dolomite**	**Anhydrite**	**Salt**	**Red Beds**
Dewey Lake Formation				X
Ruster/Alibates Formations	· · · X	· · · X	· · ·	· · ·
Tansill/Salado Formations	· · ·	· · · X	· · · X	· · ·
Tansill/Salado Formations		· · ·	· · · X	· · ·
Tansill/Salado Formations				X
Tansill/Salado Formations		· · ·	· · · X	· · ·
Yates Formation				X
Seven Rivers Formation		· · ·	· · · X	· · ·
Seven Rivers Formation				X
Queen Formation				X
Grayburg Formation				X
San Andres Formation		· · ·	· · · X	· · ·
San Andres Formation	· · ·	· · · X	· · · X	· · ·
San Andres Formation	· · ·	· · · X	· · · X	· · ·
San Andres Formation	· · · X	· · · X	· · ·	· · ·
Glorieta Sandstone				X
Glorieta Sandstone		· · ·	· · · X	· · ·
Glorieta Sandstone				X
Upper Clear Fork Salt	· · ·	· · · X	· · · X	· · ·
Cimarron Anhydrite	· · ·	· · · X	· · ·	· · ·
Cimarron Anhydrite	· · · X	· · ·	· · ·	· · ·
Tubb Sand				X
Lower Clear Fork Salt		· · ·	· · · X	· · ·
Lower Clear Fork Salt	· · ·	· · · X	· · ·	· · ·
Lower Clear Fork Salt	· · · X	· · ·	· · ·	· · ·
Red Cave Formation				X
Wichita	· · · X	· · ·	· · ·	· · ·
Wolfcamp	· · ·	· · ·	· · ·	· · ·

depositional cycles were generated by oscillations in relative MFL with red beds derived from newly-emergent clastic sources. When MFL rose, clastic sources were cut off and chemical sedimentation dominated. Overprinting the transgressive-regressive cycles of Unit 5 is an overall retreat of marine waters to the south marked by the southward advance of shelf margin facies over time (see Figure 2 of Ramondetta, 1982). This resulted in the deposition of red beds of Unit 5b, marking the end of the cyclic marine sedimentation.

The later morphology and hydrology of the area was influenced by the dissolution of Unit 5 salt beds at locations of outcrop and along faults (Gustavson et al., 1980). This phenomenon is especially marked along the breaks of the Canadian River and has been cited as a factor in the drainage pattern of the Pecos River and the hydrologic isolation of the Llano Estacado[3].

I interpret Unit 5 as the sedimentary record of the retreat of Flood waters from this region of North America, with the Triassic red beds of Unit 5b marking the end of cyclic marine regression in this area. However, the retreat here was not abrupt or rapid, in contrast to the onset of the marine front recorded in Unit 2. Small cycles within the thick sequence demonstrate that the marine waters rose and fell cyclically as they retreated off of the continent. This is consistent with a gradual decline in MFL combined with ongoing tectonic movements associated with vertical uplift of major parts of the landmasses and vertical subsidence of the ocean basins. Rocks of Unit 5 are helpful in showing (1) the late-Flood geochemical preference of anhydrite and halite over carbonate, and (2) the limited emergence of nearby clastic sources.

It is possible that the West Texas Basin formed as a restricted inlier of retreating Flood waters. Tidal fluctuations associated with retreating Flood waters, geochemical changes in the waters themselves, and the increasing influence of fresh water from rain all probably contributed to the complex sedimentary sequence of Unit 5. But it is clear that this unit marks a retreat of marine waters from this area and the ascent of clastic sedimentation over chemical.

Unit 6

Unit 6 is represented by a very limited sedimentary record that includes outliers of Cretaceous in the southern part of the basin, in Bailey, Lamb, Hale, and Floyd Counties. These sediments include sands, shales, and limey shales of the Trinity, Fredericksburg, and Washita Groups that are common farther east along the Gulf Coast shelf margin in central Texas. They are interpreted as having been deposited in shallow marine environments.

I interpret Unit 6 as outliers of late-Flood regressive deposits that are prominent to the east in the Gulf Coast sequence. Their limited presence in the Palo Duro Basin does not provide much information for genetic interpreta-

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[3] the "staked plains" were named for location markers implanted to guide travelers across this wasteland.

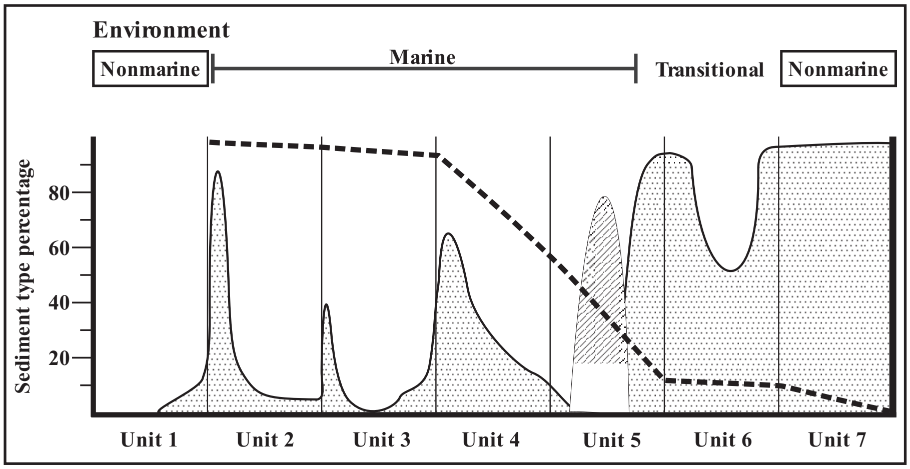

Figure 6. Lithology and inferred environment of Palo Duro Basin genetic units. Gray area represents an approximate percentage of clastics and white area represents approximate carbonate percentage. The patterned peak in Unit 5 represents precipitites. Clastic peaks at the beginning of Unit 1 and Unit 4 suggest a response to major tectonic events. General trend of Flood is seen in the nonmarine to marine to nonmarine transition shown at top of chart. The dashed line across the figure represents an uncorrected sediment accumulation curve, based on present day thickness of the units. Sedimentation rates were relatively slow during deposition of Units 2 and 3, increased during deposition of Units 4 and 5, and decreased again during deposition of Units 6 and 7. UCSA is an uncorrected sediment accumulation curve showing relatively thin units 2 and 3 followed by thick deposits in units 4 and 5, and thin units 6 and 7.

tion. Although erosion associated with late uplift of the Rocky Mountains probably removed some of the sediment column, it is not clear to what extent this occurred in the Palo Duro Basin, and thus to what extent a late marine pulse affected the region.

Unit 7

Unit 7 is composed of terrigenous sediments of the Miocene-Pliocene Ogallala Formation and overlying Quaternary loess and alluvium. There is an erosion surface between Units 5 and 7 that has removed most of Unit 6 and cut river valleys up to 150 ft. deep (Johns, 1989) into the top of Unit 5b. Clastic sediments were deposited up to 800 ft. thick on top of the red beds of Unit 5b. Coarser fluvial conglomerates and sands were deposited in paleovalleys and finer silts and clays, interpreted as eolian, were deposited in the interfluve areas (Nativ, 1988). There is a general fining upward trend in the Ogallala (Nativ, 1988).

I interpret Unit 7 as nonmarine, post-Flood sediments derived from erosion and deposition of clastics during and after the uplift of the Rocky Mountains and the Great Plains. During this time, it is likely that the continents and oceans were moving towards a new isostatic equilibrium resulting from earlier mid-Flood tectonic readjustments in the earth's crust.

The Palo Duro Basin and the Energy Curve

The genetic units defined above can be useful for interpretation outside the Palo Duro Basin if a method of correlating them to other units can be derived. Physical correlation can carry some distance, but the diachronous nature of deposition in the Flood during both its transgressive and regressive phases presents difficulties. In this context, the *stage* of the Flood at a particular point is more important than the absolute time correlation. The geological energy curve of Reed et al. (1996) offers a possible means of correlating a given geologic sequence to the Flood stage and then allowing regional correlation to stage rather than absolute time.

The sequence of units in the Palo Duro Basin is consistent with deposition during the Genesis Flood (Figure 7). The initial tectonic and igneous event that led to the formation of the Southern Oklahoma Aulocogen, the ensuing marine incursion recorded in the basin, a late-stage tectonic inversion, and the thick regressive sequence culminating in continental clastic sediments all point to the general sequence of the Flood outlined on the energy curve. Even different timing for a similar sequence elsewhere in North America does not preclude correlation of Flood *stage* via application of the energy curve.

The challenge to creationist stratigraphy is to demonstrate that the rock record is amenable to coherent interpretation by the Flood event both laterally and vertically. A step in that direction is taken by showing that the Palo Duro Basin and its fill show the gross characteristics expected of the Flood. Further demonstration should take the form of more detailed work within the basin, showing that features of the formations themselves are explicable within the short time constraints of the Flood. Also, interpretation should resolve the lateral extent of particular features of each Flood stage that can be identified at the Palo Duro Basin and identify others not represented there by reason of nondeposition or missing section.

Clues to the Nature of the Flood

Because the Flood was a global event and episodes within that event would affect large regions of the earth, informa-

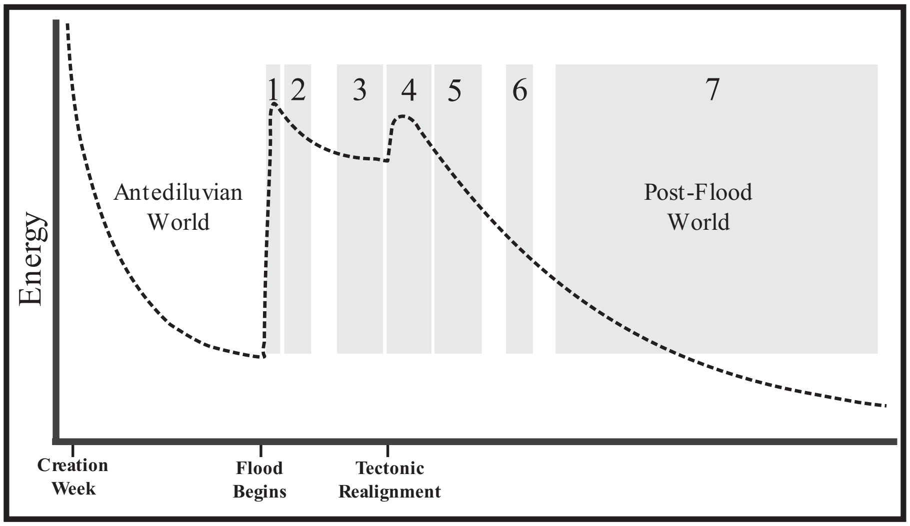

Figure 7. The position of the seven units relative to the energy curve. Unit 1 marks the tectonic and igneous onset of the Flood. Abrupt structuring and extrusive and intrusive events correspond to the initial increase in energy. Units 2 and 3 follow the curve during its transgressive phase. I correlate the base of Unit 4 with the mid-Flood increase in tectonism that signaled the onset of crustal reequilibration that prepared the ocean basins and continents to assume their present isostatic relationship. Unit 5 matches the decreasing energy and correlative regression of the Flood's waters, and Unit 7 was deposited under late to post-Flood terrestrial conditions. The thick alluvium of the Ogallala has been correlated by uniformitarian researchers to the uplift of the Rocky Mountains and Great Plains and the subsequent erosion and deposition of clastics following that uplift.

tion gleaned from specific areas such as the Palo Duro Basin can provide clues about the nature of the Flood in general. Extrapolation requires caution and must not exceed scope or confidence for local interpretation. However, evidence from the Palo Duro Basin suggests some tentative conclusions about the Flood that might be applied regionally, or even more cautiously on a greater scale.

Unit 1 provides the first clue. It represents an intense igneous and tectonic upheaval along the Southern Oklahoma Aulocogen. Extensional deformation of the crust was combined with the intrusion and extrusion of massive volumes of predominantly silicic magma. Its similarity to the Midcontinent Rift System suggests that numerous epicenters of extensional crustal deformation and associated igneous activity developed at the onset of the Flood. Defining these epicenters in terms of their locations, stress fields, and extent might help resolve questions about the tectonics of the early Flood and any potential role for plate tectonics in a creationist framework (Austin et al., 1994 versus Reed, 2001). The absence of thick sequences of nonmarine sediments at the Southern Oklahoma Aulocogen also suggests rapid inundation by marine waters, in contrast to the lag between the tectonic onset of the Flood and marine transgression observed at the Midcontinent Rift System (Reed, 2000).

The composition of Units 2, 3, 4, and 5 provide clues to the physical and geochemical systems that developed during the Flood. Following a thin basal lag, Flood deposits in the Palo Duro are composed predominantly of carbonates, both dolomite and limestone. The uprush of marine waters onto the continental areas, combined with epicenters of igneous activity provided a combination of temperature gradients, influxes of ions such as calcium, magnesium, and iron, and solution and outgassing of CO_2 and other gases. Given these conditions, it is reasonable to speculate that the physical progression of the Flood from transgression to highstand to regression was overprinted by geochemical changes in the waters themselves. If this is true, then clastic deposits would represent areas where the erosion, transport, and deposition of sand, silt, clay, and larger grains overwhelmed the underlying carbonate-generating system, resulting in an interruption of otherwise ongoing carbonate deposition (Figure 6). Uniformitarians commonly depict a change from clastic to carbonate deposition as involving a change in environment over long periods of time. Away from clastic sources, carbonates would dominate. The presence of clastic sediments would not then necessarily imply the absence of carbonate deposition, only the relative dominance of clastic sedimentation. The presence of accessory minerals such as chert, glauconite, and pyrite might also point to volcanic sources of iron and silica.

Late-forming gypsum, anhydrite, and salt may then be the result of changes in the underlying geochemical equilibrium of the Flood waters, and not simply related to specialized environments where these minerals are formed today. An investigation into these questions would be well worth the time of any geochemically-minded creationists.

Unit 4 provides insight into a very significant event during the Flood. Regional tectonism was renewed and significant vertical motion occurred—as inversion along prior normal faults at the Southern Oklahoma Aulocogen. This vertical movement led to the formation of the basins of the southern midcontinent region as we known them today: the Palo Duro, Permian, Anadarko, Ardmore, Arkoma, Dalhart, and Hollis/Hardeman Basins (Figure 1) all formed during this episode. The intervening uplifts also formed during this time period. I believe that this regional tectonic event represents the initiation of the new crustal equilibrium that resulted in drainage of the Flood waters into the present-day ocean basins. Vertical motions may have been first manifested locally on the continents and increased in areal extent even as it decreased in intensity. It may also be noted that mid-Flood deformation might have initiated in the continental interiors and then migrated towards the continental margins. A comparison of Units 4 and 5 shows that although both sections are thick, that formations of Unit 4 are restricted to the newly-developing basins, while Unit 5 contains beds of more regional extent.

Conclusion

Rejecting a time-stratigraphic framework for an event-oriented one correlated to episodes of the Genesis Flood provides a reasonable explanation of the Palo Duro Basin. The tectonic and igneous upheaval at the onset of the Flood (Unit 1), a transgressive carbonate section (Units 2 and 3), renewed structuring leading to basin formation near Flood highstand (Unit 4), and a thick cyclical regressive sequence (Unit 5), culminating in continental alluvial deposits (Unit 7) are all recorded in the fill of the Palo Duro Basin. Correlation beyond the bounds of the Palo Duro Basin may be performed by relating its event-stratigraphic units to a geologic energy curve which reflects Flood stage rather than absolute time. The relative position of these units on the energy curve can provide a comparative tool for other basins.

Reinventing stratigraphy to conform to the Biblical Worldview requires developing a logical structure consistent with foundational assumptions (Reed, 2001), but it also requires application to field examples. This overview of the Palo Duro Basin demonstrates that such an approach is both feasible and fruitful. Just what does the Palo Duro Basin tell us about the Flood? It speaks to the crustal disruption and associated igneous activity at the onset. It speaks to a geochemical drive towards carbonate precipitation and presents clastic pulses as overprints of that baseline. It speaks of mid-Flood renewed tectonism and basin formation. It speaks of cyclical regression of the Flood waters off of the continents as a new isostatic equilibrium is reached. Finally, and most importantly, it speaks to the ability to apply the Bible as a bounding framework for natural history.

This study of the Palo Duro Basin is an overview and cannot answer all questions. However, sometimes just asking the proper questions enables progress. In that light, this study raises several important questions for creationists to address. These include:

1. In addition to the West Texas Basin, many locations across the globe have a rock record that includes a vertical section of extensive salt and anhydrite deposition. The Jurassic in the Gulf of Mexico, the Triassic and Jurassic of North Africa are just two examples of regional extensive salt and anhydrite formation. What is the origin of these deposits in the context of the Genesis Flood? Do these units reflect a unique geochemical phase of the Flood? If so, are they correlative across the globe?
2. The first set of questions leads to another. The assumption of a generally static geochemical marine environment over geologic time should be revisited by creationists. It is likely that the geochemistry of the Flood's waters underwent dynamic change and perhaps even started at a different equilibrium from that observed today. Evidence for these changes should focus on the chemical impetus to generate carbonates throughout most of the Flood (relative changes from carbonate to clastic sediments may be explained by relative rates of deposition). The presence of abundant chert, pyrite, and glauconite in older sediments suggests changes perhaps related to igneous activity, as does the relative rates of dolomite and limestone formation. Late precipitation of anhydrite, gypsum, and salt also bears greater scrutiny.
3. The crucial question of stratigraphic correlation by time or event (Flood stage) stands clearly as a divide which creationists must address. I have offered reasons why time is a poor correlation key for the rock record and I infer that the time-based geologic column is thus flawed and requires revision beyond the mere compression of its absolute time scale. I am aware that other creationists disagree with this approach (e.g., Tyler and Garner, 2000 versus Reed and Froede, 2000). It would be helpful to resolve this issue; if not, then we must agree to disagree and enjoin respect for each other's efforts.

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Book Reviews

He Made the Stars Also by Stuart Burgess

Day One Publications, Surrey, England. 2001, 186 pages, $10

This is a delightful book, clearly written and arranged. Author Stuart Burgess is a design engineer with experience in the space industry. He wrote an earlier creationist book, *Hallmarks of Design* (1999. Day One Publications, Surrey England). Burgess discusses in detail a mature creation, solar system design, and extraterrestrial life. He also critiques science fiction and states some rules for not undermining biblical doctrines: *Wholesome* science fiction must have no aliens, evolutionary philosophy, or human superheroes. *Star Trek* and *Star Wars* clearly do not measure up in Burgess' view (pp. 148, 158).

For the creation of the heavens, Burgess suggests a *speeded-up stars theory* (p. 24). God supernaturally made star aging processes occur at near-infinite speed. The more distant the star, the more rapid the decay process and the faster was the light speed. After all of this light information reached earth, rates of change then were reduced to what we now measure. In other words, like a video tape, the speed of universe aging was temporarily put on *fast forward*. The theory appears somewhat *ad hoc* and artificial, but no less so than many other theories about the fourth day of creation.

The book discusses six similarities between the Tower of Babel and the International Space Station. However, Burgess does not predict a further confusion of languages! Several problems on the high school level are included at the end of the book with answers. There is no index.

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When Christians Roamed the Earth

by Ken Ham, John Morrris, Carl Wieland, Jonathan Henry, and Jack Cuozzo

Master Books, Green Forest, AR 2001, 192 pages, $12

The six authors each take a chapter to give independent thoughts on the impact of evolution on society. The book title is based on the imagery of dinosaurs in earth history. This title may be somewhat confusing in view of the continuing Christian influence in society today.

Henry Morris' chapter provides a nice summary of evolutionary influence throughout history. Jack Cuozzo's chapter is the longest and is filled with his original writing style. He challenges evolutionists "to question their own theories as intricately as they question ours" (p. 77). Jonathan Henry's chapter asks some basic questions about the current search for new planets in space, a futile attempt to gather evolution evidence. Carl Wieland gives new background on the moral decay of Australia. Authors Ken Ham and John Morris also provide solid evidence of the evolutionary denial of real data.

A final chapter would have been useful on strategies for promoting truth in a post-Christian world. The book has endnotes but no scripture or subject indexes.

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