Local Catastrophes or Receding Floodwater? Global Geologic Data that Refute a K-Pg (K-T) Flood/post-Flood Boundary

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Abstract

Five major arguments are put forth that challenge the K-Pg boundary as the Flood/post-Flood boundary: (1) the presence of the Paleocene Whopper Sand in the Gulf of Mexico, (2) the tremendous amount of Cenozoic sediment deposited globally, (3) the fact that the thickest and most extensive coal seams are found in Cenozoic sediments globally, (4) the identification of uninterrupted carbonate deposition across the K-Pg boundary upward through Miocene strata across North Africa and the Middle East, including Iraq, and (5) the tremendous amount of rapid ocean crust/seafloor spreading that continued right across the K-Pg boundary and through much of the Cenozoic up to the Pliocene, with no indication of a significant change in velocity. These data collectively establish that the Flood/post-Flood boundary had to have been much higher in the Cenozoic rock record, at least as high as the top of the Miocene. The Tertiary (Paleogene and Neogene) likely represents the receding-water phase of the Flood. The results of this paper also call into question much of the claimed paleontological evidence for a K-Pg Flood/post-Flood boundary, including the evolution-saltation process that has been recently proposed.

Introduction

Determining the boundary surface that marks the end of the Flood is extremely important in any Flood model. It is generally assumed that there should be significant changes in both stratigraphy and fossil content across this boundary. Over the years, various stratigraphic levels have been suggested as the level marking the end of the Flood, but no consensus has been reached. Some early creationist authors suggested that all the Tertiary (Paleogene and Neogene) strata were late Flood deposits (Whitcomb and Morris, 1961; Coffin and Brown, 1983). Most mid-nineteenth-century scriptural geologists (SG) also believed all Tertiary rocks were part of the Flood record and did not attribute them to the post-Flood period (Johns, 2016). The only SG who argued the Tertiary was post-Flood was Frederick Nolan (Johns, 2016), who, in 1833, claimed the Tertiary consisted of a series of local catastrophic deposits. This view, of small, localized or regional post-Flood deposits, is the same concept

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being promulgated by many prominent creation geologists today (Austin et al, 1994; Ross, 2012, 2014a, 2014b; Wise, 2002; Whitmore, 2006).

A major shift in thought occurred, at least among many creation geologists, when Austin et al. (1994, p. 614) defined the Flood/post-Flood boundary in their catastrophic plate tectonics (CPT) paper:

> For our purposes here we would like to define the Flood/post-Flood boundary at the termination of global-scale erosion and sedimentation. Based upon a qualitative assessment of geologic maps worldwide, lithotypes change from worldwide to continental in character in the Mesozoic to local or regional in the Tertiary. Therefore, we tentatively place the Flood/post-Flood boundary at approximately the Cretaceous/Tertiary (K/T) [now the K-Pg] boundary. We believe further studies in stratigraphy, paleontology, paleomagnetism, and geochemistry should allow for a more precise definition of this boundary.

This definition was included in the catastrophic plate tectonics paper almost as an addendum, failing to achieve a complete consensus even among the coauthors (J. Baumgardner, personal communication, 2017). Although determined "tentatively," this definition became entrenched soon thereafter as near "fact" in a large segment of the creation geology community (Wise, 2002; Whitmore and Wise, 2008; Whitmore and Garner, 2008; Whitmore, 2013; Ross, 2012, 2013, 2014a, 2014b; Snelling 2009, 2014a; Ross et al., 2015). Other authors, like Oard (2006, 2007, 2010a, 2010b, 2011, 2013a, 2013b, 2016a, 2016b, 2017a, 2017b), Baumgardner (personal communication, 2017) and Holt (1996), have disagreed with this interpretation, placing the Flood/post-Flood boundary much higher instead. Snelling (2010), to his credit, recognized the need to raise the boundary higher locally in Israel as

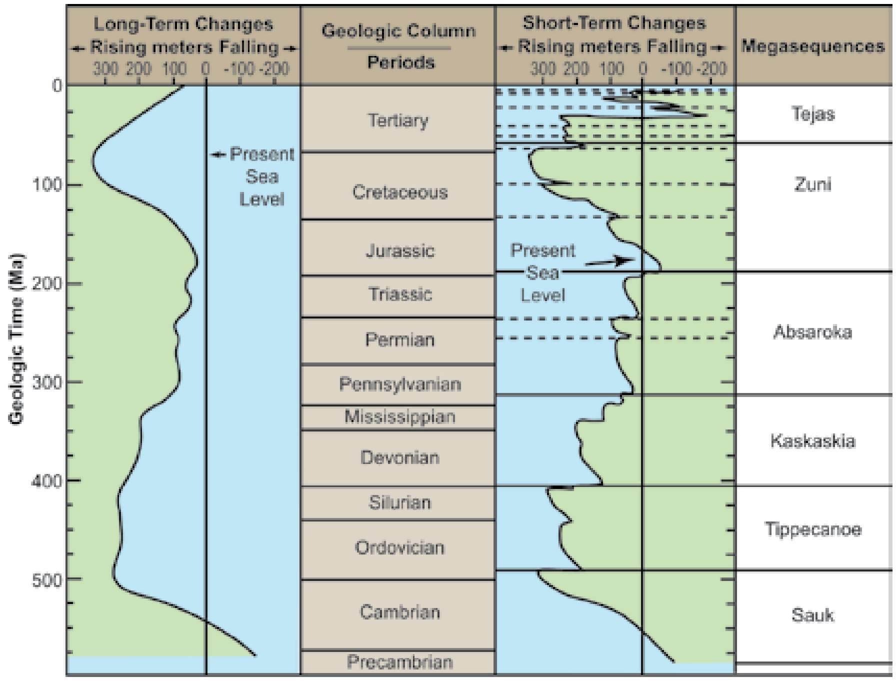


Figure 1. Chart showing the secular timescale, presumed sea-level curve, and the six megasequences (modified from Snelling, 2014c). The Tertiary system is now composed of the Paleogene and Neogene systems. The Quaternary is not shown.

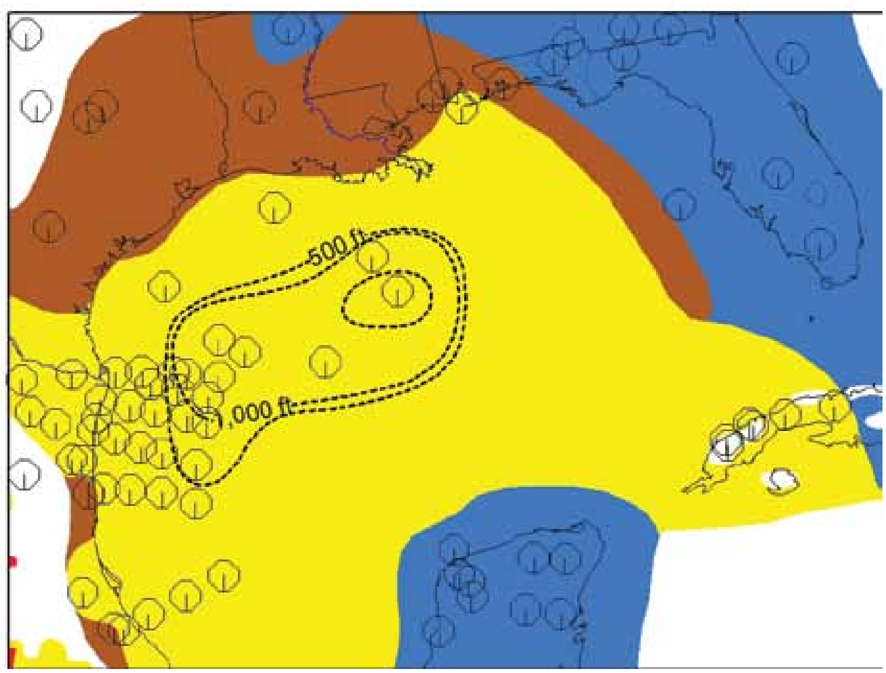


Figure 2. Map of the basal Tejas lithology showing the extent and thickness of the "Whopper Sand" in the Gulf of Mexico (Paleocene Lower Wilcox SS). 500 ft = 152 m, 1000 ft = 305 m, 1500 ft = 457 m. Yellow represents sand, blue represents limestone, and brown represents clay/shale. State outlines are shown for reference. Circles represent stratigraphic columns used in this study. © 2017 Institute for Creation Research. Used by permission. Diagram courtesy of Davis J. Werner.

he found continuous carbonate deposition from the Cretaceous through the Oligocene (Upper Paleogene), placing the Flood/post-Flood boundary at the top of the Oligocene in Israel.

Snelling (2014a, p. 178) has previously pointed out that a "biostratigraphic break expected to characterize the Flood /post-Flood boundary" was never identified at the Pliocene/Pleistocene level. He used this to argue in favor of a K-Pg Flood/post-Flood boundary instead. However, the more recent discovery of a sixth global extinction event at the top of the Pliocene makes Snelling's argument less compelling (Pimiento et al., 2017). Indeed, Pimiento et al. (2017) found that 36% of Pliocene genera failed to survive into the Pleistocene and that extinction rates were three times higher in the Late Pliocene relative to the rest of the Cenozoic. This discovery of a hitherto unrecognized global "break" in fossil content (known as a paleontological discontinuity) calls for reevaluation of some of the rationale used to define the Flood/post-Flood boundary.

Furthermore, Snelling and Matthews (2013) determined the time between the end of the Flood and the onset of the Ice Age (Pleistocene sediments) was about 100 years (Clarey, 2016a). Therefore, advocates for a K-Pg end of the Flood must assume that all of the Tejas megasequence (Paleogene and Neogene), which includes most of the Cenozoic, was deposited in about a century of time.

Sanders (2009) attempted to stretch the period of time between the Flood and the Ice Age to between 102–315 years. However, his arguments were based largely on Pleistocene-age human fossils and attempts to tie them to the life span of Peleg and passages about Babel in the Bible. He apparently did not consider the timing of ice build-up and the onset of the Ice Age as did Snelling and Matthews (2013) and Clarey (2016a). Sanders (2009, pp. 67–68) concluded by stating:

> Admittedly these estimates are mathematically unsophisticated and geologically naïve, but I believe they are reasonable enough to properly bracket the dates of interest and provide consistent comparisons for the purposes of this paper.

Regardless of whether it is 100 years or 300 years, this time span severely limits the amount of catastrophic activity possible and the number of generations possible, especially for the largest mammals. Recently, Wise (2017) has even used this limited amount of time to justify major evolutionary jumps, which he calls saltation, to explain the Cenozoic mammal record.

Surprisingly, the K-Pg interpretation for the Flood/post-Flood boundary has never been adequately tested through large-scale stratigraphic studies. Most of the claims of "proof" that the K-Pg represents the end of the Flood have come from studies of paleontological data (Ross, 2012, 2014a; Wise, 2009; Whitmore and Wise, 2008) and/or local studies of individual units like the Green River Formation (Whitmore, 2006) and Israel (Snelling, 2010).

The goal of this paper is to reexamine the geology of the Tertiary system, now known collectively as the Paleogene and Neogene systems, on a more global scale and address the validity of a K-Pg Flood/post-Flood boundary in light of new and available geologic data. Hopefully, this paper will help to answer the central question: Are the geologic features of the Tertiary (Neogene and Paleogene) system better explained by local catastrophes or by the large-scale effects of the receding-water phase of the Flood?

Methods

Some of the geologic data was generated as part of an ongoing research project at the Institute for Creation Research, termed the Column Project. Stratigraphic columns were compiled from published outcrop data, oil well boreholes, cores, cross sections and/or seismic data tied to boreholes. Other data come from published reports by various authors. Lithologic and stratigraphic interval data (megasequence boundaries) were entered into a database, allowing the creation of a three-dimensional lithologic model for each of the three continents in this study. These models also allow the correlation of rock types within individual megasequences and along their bounding surfaces. The megasequences and their relation to the secular timescale are shown in Figure 1.

Our database consisted of selected COSUNA (Correlation of Stratigraphic Units of North America) (Childs, 1985; Salvador, 1985) stratigraphic columns across the United States, stratigraphic data from the *Geological Atlas of Western Canada Sedimentary Basin* (Mossop and Shetsen, 1994), and numerous well logs and hundreds of other available online sources. Using these data, we constructed 710 stratigraphic columns across North America, 429 across Africa, and 405 across South and Central America from the pre-Pleistocene, meter by meter, down to local basement. We input detailed lithologic data, megasequence boundaries, and latitude and longitude coordinates into RockWorks 17, a commercial software program for geologic data, available from RockWare, Inc. Golden, Colorado, USA. We classified each column, meter by meter, according to 16 rock types. Depths and thicknesses shown in all diagrams are in meters.

Each column includes the complete record of sedimentary rocks at that location from surface to crust along with the corresponding Sloss (mega) sequence boundaries (1963). Any erosional "gaps" in the COSUNA columns were collapsed so that only the rocks present at each location were used in the study.

Megasequences were used in this study because, while not entirely independent of the fossil record, they do reflect major shifts in depositional patterns as the seas transgressed and subsequently regressed off the continents. Many of these shifts left behind erosional surfaces at the top and base of the megasequences and changed the rock type abruptly (called xenoconformities; Carroll, 2017a). These major shifts in depositional architecture are recognizable and traceable across continents and offshore alike using distinctive characteristics observed on seismic reflection records, such as abrupt truncations and strong reflecting horizons.

Results and Analysis

This paper presents five geologic arguments that defy a local catastrophic explanation. Some of these features are so large and/or unusual in scale that local catastrophes could not conceivably produce them. Others demonstrate geologic conditions that could have existed only while the Floodwaters were still covering large portions of the continents. Collectively, they severely damage the claim that the Flood ended at the stratigraphic level of the K-Pg boundary.

1. The Whopper Sand

During the course of our intercontinental studies, we came across the recent discovery of a large, unusually thick and extensive sand body in the deep water of the Gulf of Mexico. This sand was so large and completely unexpected that the oil industry dubbed it the "Whopper Sand" (Higgs, 2009).

The Whopper Sand is part of the Lower Tertiary exploration "play" or target zone in the Gulf of Mexico (GOM) (Techentien et al., 2017). The sand layer is part of the Paleocene-Eocene Lower Wilcox Formation. What makes the Whopper Sand unusual is its location in deep water, nearly 200 miles (300 km) from the Lower Wilcox shelf margin and far from any conventional sand source (Higgs, 2009). Secular geologists consider the Whopper Sand to be part of an extensive system of sheet sands deposited in a regional basin floor fan system (Techentien et al., 2017) but cannot seem to explain its unusual thickness or great extent (Lewis et al. 2007).

Since 2001, with the drilling of the BAHA-2 well, billions of barrels of oil have been discovered in the Paleocene-Eocene Wilcox-equivalent Whopper Sand (Higgs, 2009). This well reportedly encountered 1100 feet of sand in the Lower Wilcox in over 7000 feet of water within the Perdido Fold Belt of Alaminos Canyon. In Keathley Canyon, the Sardinia-1 well encountered over 1200 feet of sand and in Walker Ridge, the Jack-2 well and Chinook and Cascade-2 wells reached similarly thick Lower Wilcox sands approaching 1900 feet thick (Trammel, 2006). Average porosity in the Whopper Sand is 18%, and permeabilities range from 10–30 millidarcys (Trammel, 2006). Up to 15 billion barrels have been discovered in this trend since 2001 (Figure 2).

Two competing secular interpretations have been suggested to explain the presence of the Whopper Sand, one by Higgs (2009) and Sweet and Blum (2011), and a second model supported by Berman and Rosenfeld (2007), Rosenfeld and Pindell (2003), and, more recently, Cossey et al (2016).

Berman and Rosenfeld (2007), Rosenfeld and Pindell (2003), and Cossey et al (2016) argue for the "GOM drawdown hypothesis," where the Gulf of Mexico became isolated from the open Atlantic Ocean by the closure of the Florida straits. These authors have suggested a drop in sea level in the center of the GOM of well over 200 m in order to transport the Whopper Sand into its deepwater position.

Higgs (2009) and Sweet and Blum (2011) have counterargued that the lack of evaporite-type deposits within the stratigraphic interval precludes this interpretation, claiming the evidence for a major drop in sea level is lacking. Higgs (2009) has countered with a more traditional river transport interpretation with drops in sea level of more modest values (100 m) to explain the Whopper Sand and the deepwater canyons. Instead of evaporative drawdown as called on in the first model, Higgs (2009) believes sustained river flow into the lowered GOM exceeded evaporation, lowering the salinity and turning the GOM into a brackish lake. Sweet and Blum (2011) have proposed a less extreme model and advocate more traditional long-distance river flow to explain the Whopper Sand.

However, critics argue the "river model" still does not address the high purity (70% sand) and the thickness (>1000 feet) of the Whopper Sand. Rivers today mostly transport clays, with minimal silts and even sands out into deep water.

Research by Blum and Pecha (2014) may help provide an answer to how the Whopper Sand formed in deep water. These authors used detrital zircons to map out the direction of drainage in the Cretaceous and in the Paleocene across North America. They determined that the drainage patterns shifted dramatically between these two depositional episodes (Figure 3).

These authors found that during deposition of the Cretaceous (Zuni Sequence), the drainage pattern was dominantly to the north and northwest across much of the USA. Drainage was to the Boreal Sea near present-day Alberta and Saskatchewan. They also determined that very little area was draining to the Gulf of Mexico (GOM) during this time.

In contrast, they determined that the Paleocene drainage shifted dramatically from that of the Cretaceous, resulting in much of the USA draining southward to the GOM. As noted on their map, this was not a single river like the modern Mississippi River, but a series of rivers, effectively behaving more like sheet wash, draining into the GOM all at once. This shift in drainage coincides nicely with the end of the Zuni Sequence and the onset of the Tejas Sequence.

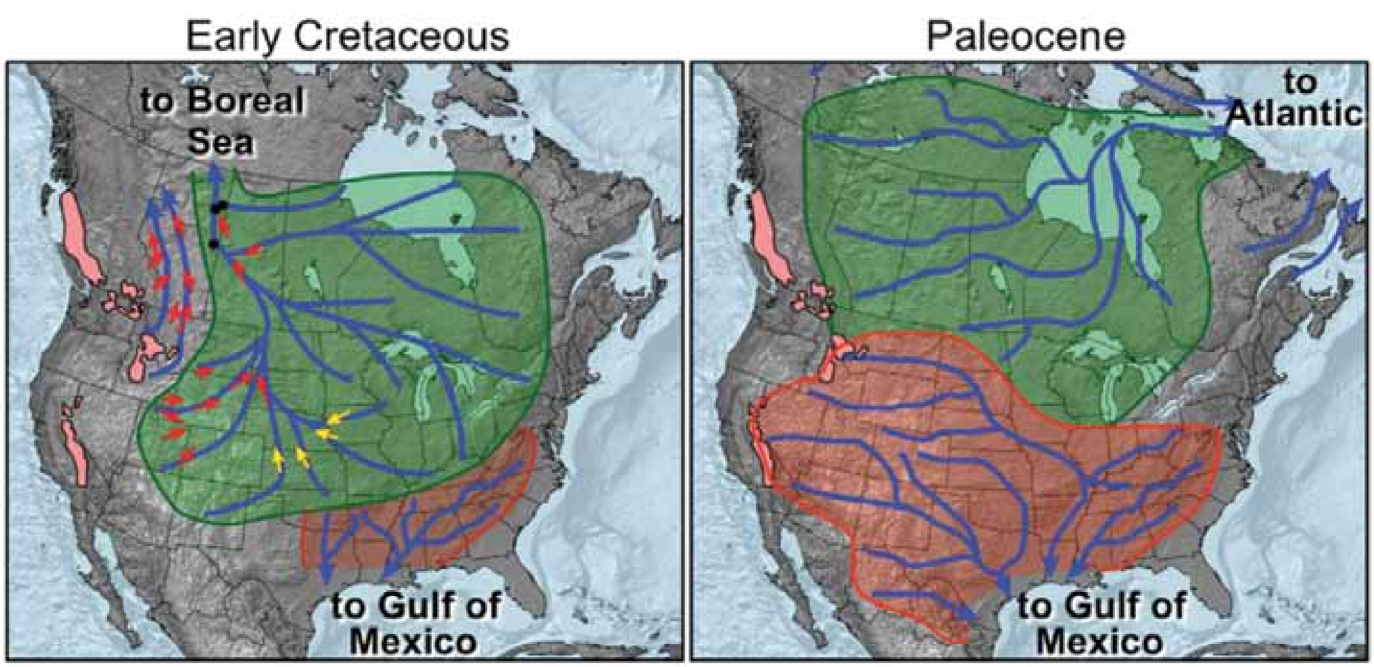


Figure 3. Paleo-drainage maps based on detrital zircon analysis across North America in the Early (Lower) Cretaceous and in the Lower Tertiary (Paleocene). Modified from Blum and Pecha (2014).

Blum and Pecha (2014) believe this change in drainage occurred because of the high flooding levels of the North American continent during the Upper Cretaceous, known as the Cretaceous Interior Seaway. They claim that the withdrawal of the floodwaters during the uppermost Cretaceous and earliest Paleocene caused significant reorganization in the drainage pattern and a reverse in flow toward the GOM.

Clarey and Parkes (2016) interpret the Whopper Sand as a result of this rapid drainage shift at the Zuni/Tejas (K-Pg) boundary, when water suddenly began to drain off the North American continent (Interior Seaway) into the GOM, permanently reversing the earlier direction of flow. This shift is marked by the sudden change in deposition from the uppermost Zuni layer (the Lower Paleocene Midway Shale) to the lowermost Tejas (Paleocene-Eocene Whopper Sand). In a Flood model, this would coincide with the change in water direction described for Day 150+ of the Flood. Initial drainage rates in the Paleocene, coinciding with a sudden drop in sea level at the onset of the Tejas, were likely high volume and highly energetic, providing a possible mechanism to transport the thick Whopper Sand into deep water. Over time, the drainage volume lessened, lowering the energy available for transport, until the present-day pattern developed. We now observe small flows compared to what was likely happening during the initial draining of the vast Cretaceous Interior Seaway at the start of the Tejas.

If this is a post-Flood deposit, what local catastrophe can explain this massive sand unit? Whitmore (2013) has made the assertion that "enormous quantities of sediment should be found resting on the post-Flood unconformity." However, the size and scale of the Whopper Sand is beyond any deposit like it in the world. The erosive power to produce this much sand and to transport it so far would have likely affected most of the contiguous USA, as shown in Figure 3 (Blum and Pecha, 2014), making it nearly impossible for animal and human survival. As described above, the best explanation for the Whopper Sand is at the onset of the receding-water phase of the Flood.

2. The Extent and Volume of Cenozoic Sediment

Holt (1996) and Oard (2016b) have previously pointed out the tremendous amount of Cenozoic (post K-Pg) sediment found globally. This is also confirmed by our research. Holt (1996) showed there is more Cenozoic sediment, by volume, than at any other time interval in Phanerozoic history. Admittedly, he also included the ocean sediments in his totals, but his point is verified by the three continents included in this study. Our totals for the sediments on the continents and on the offshore shelves show the volume

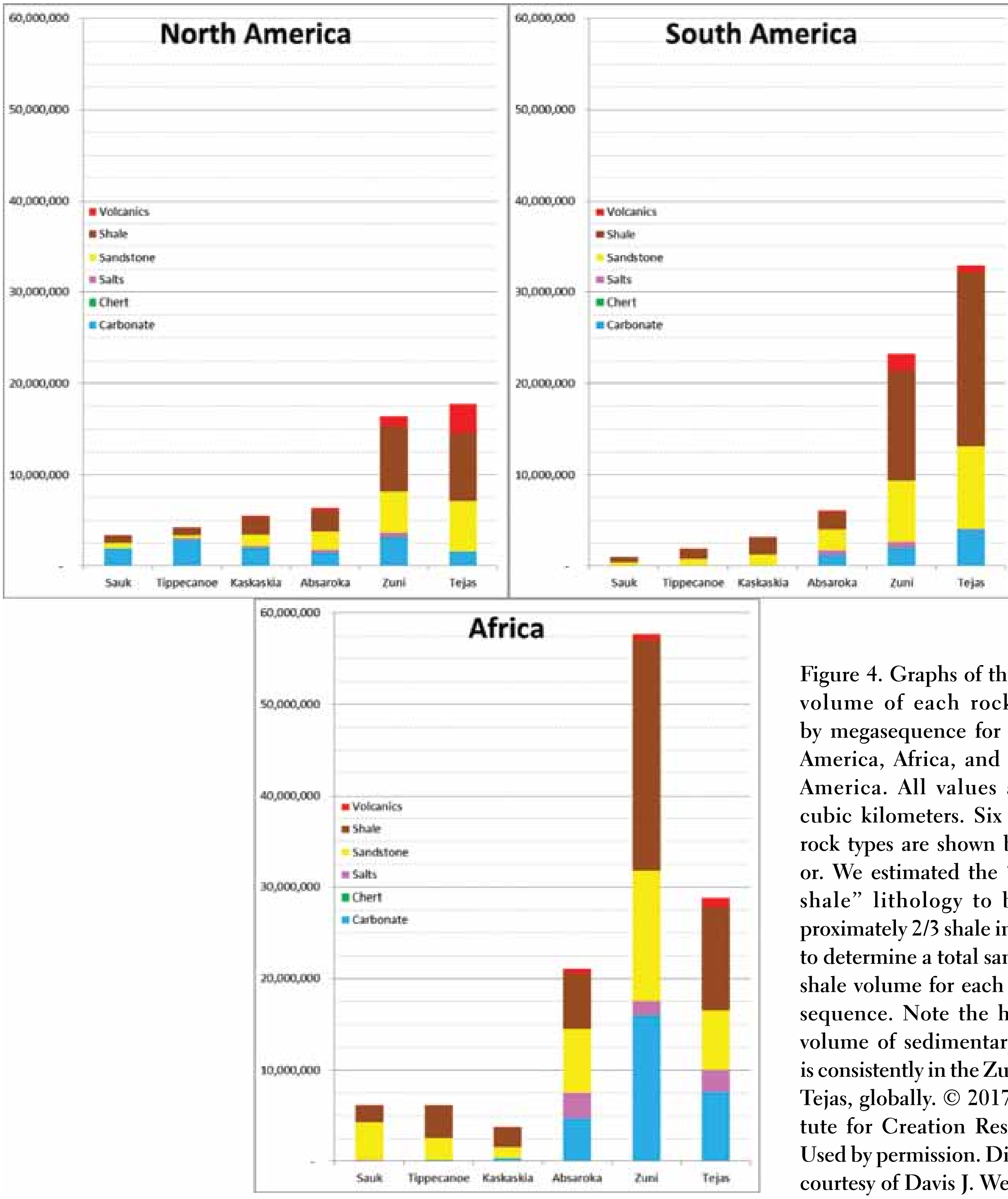


Figure 4. Graphs of the total volume of each rock type by megasequence for North America, Africa, and South America. All values are in cubic kilometers. Six major rock types are shown by color. We estimated the "sand/shale" lithology to be approximately 2/3 shale in order to determine a total sand and shale volume for each megasequence. Note the highest volume of sedimentary rock is consistently in the Zuni and Tejas, globally. © 2017 Institute for Creation Research. Used by permission. Diagram courtesy of Davis J. Werner.

of sediment deposited during the Tejas megasequence to be second only to the Zuni megasequence in terms of global volume (Figure 4).

The advocates of a K-Pg Flood/post-Flood boundary have yet to produce a viable explanation for the vast amount of Cenozoic sediment observed. Although Whitmore (2013) did acknowledge that post-Flood erosion should produce large deposits on the post-Flood boundary, he failed to explain how organisms could have survived while this continental-scale erosion was occurring. The sheer volume of sediment transport would likely have prevented the establishment of any plant and/or animal populations (Figure 4).

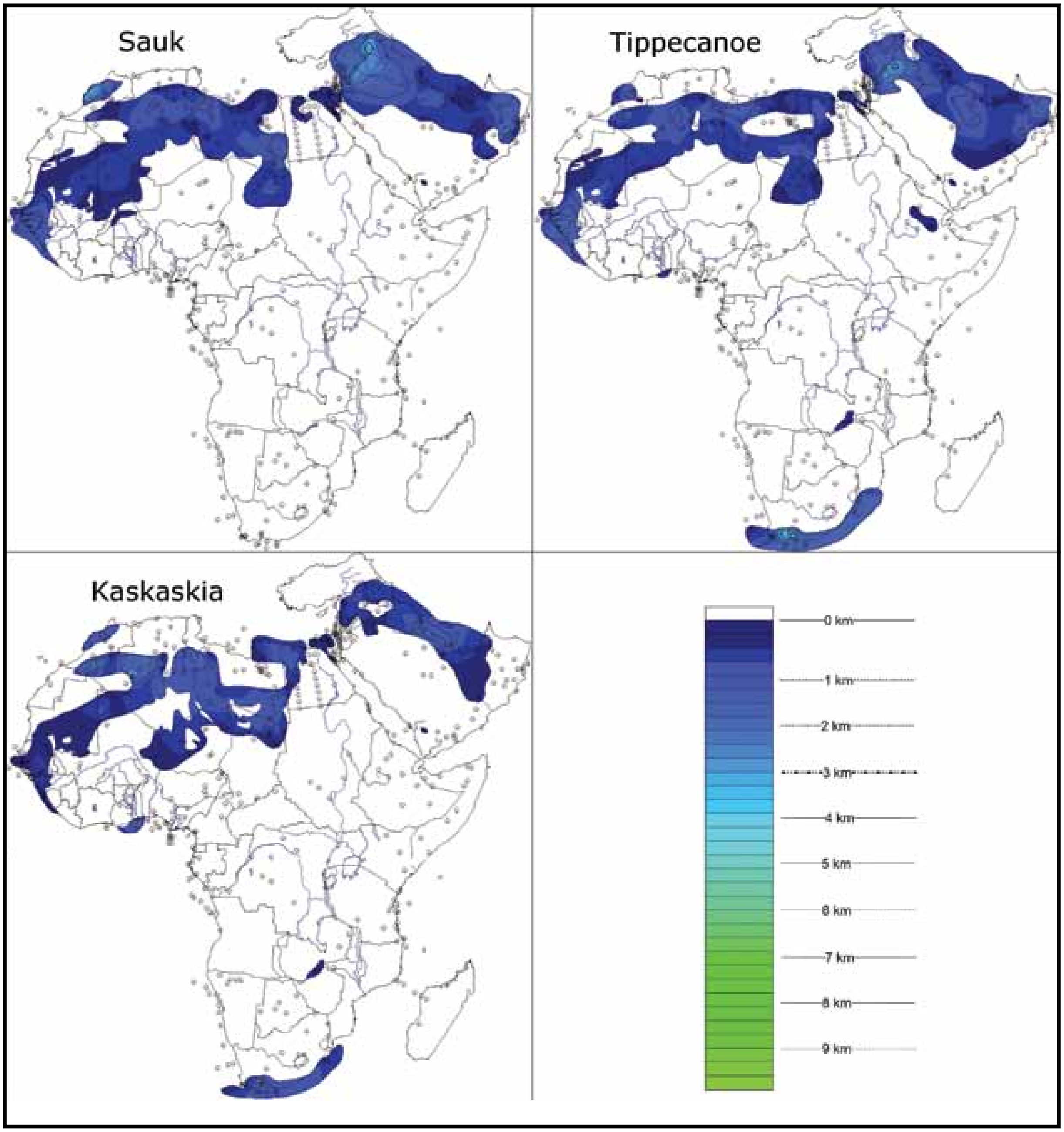


Figure 5. Isopach maps of the Sauk, Tippecanoe, and Kaskaskia megasequences of Africa. Scale is in kilometers. © 2017 Institute for Creation Research. Used by permission. Diagram courtesy of Davis J. Werner.

Another way advocates of a K-Pg Flood/post-Flood boundary have tried to explain the huge volume of Cenozoic (mostly Tejas) sediment is to argue that much of the Cenozoic is the result of erosion of earlier megasequences, thus reducing their relative volumes and increasing the amount of Cenozoic sediment. Snelling (2014a), discussing the paper by Holt (1996), acknowledged that there is a disproportionate amount of Cretaceous (Zuni) and Tertiary (Tejas) sediment preserved in the rock record globally compared to earlier deposits (Sauk through Absaroka, Figure 1). Snelling reasoned that it is impossible to know how much of the earlier megasequences have been eroded and then redeposited as Cretaceous and Tertiary strata. As a consequence, he concluded that the disproportionate amount of later sedimentary strata should not be used as evidence against a K-Pg Flood/post-Flood boundary.

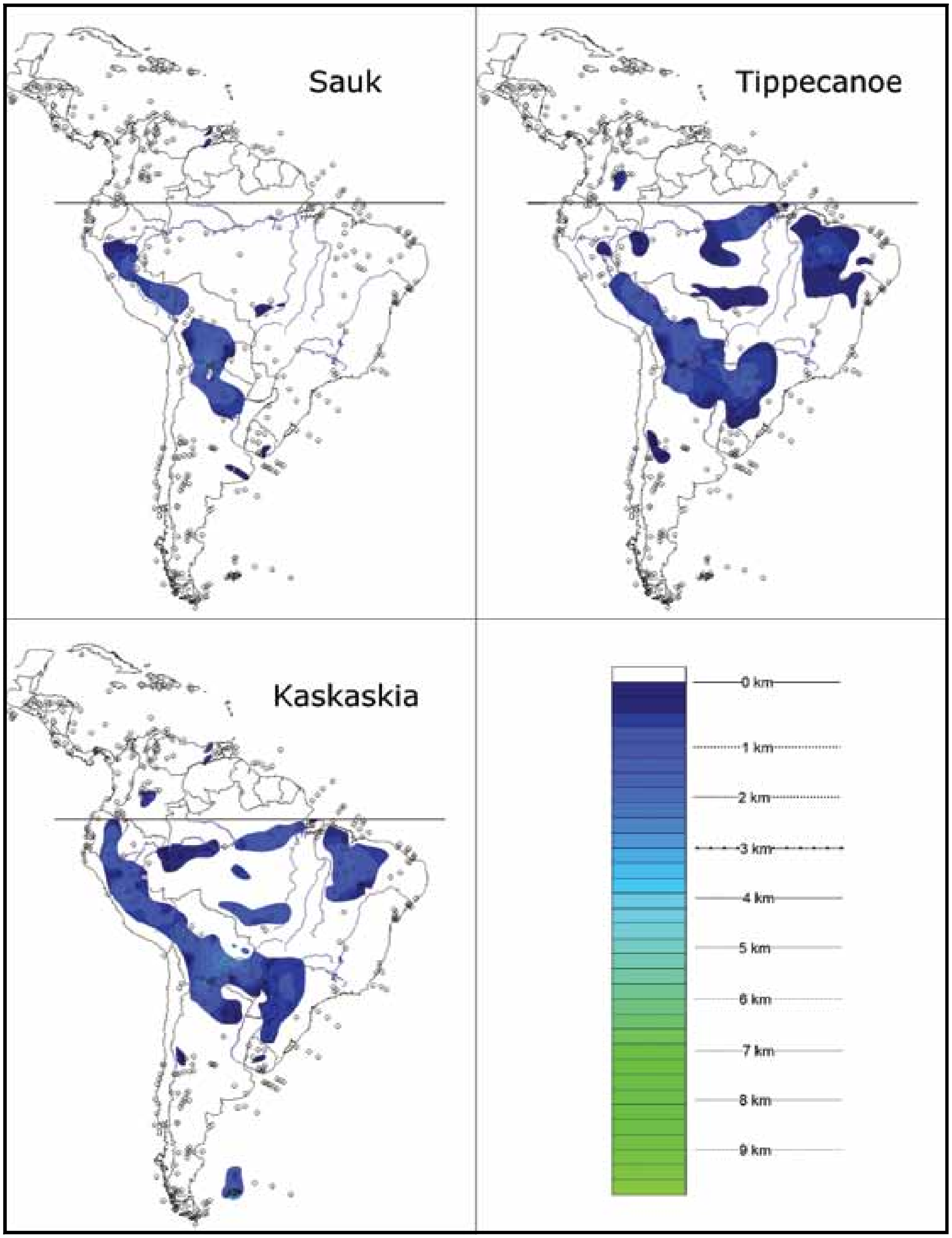


Figure 6. Isopach maps of the Sauk, Tippecanoe, and Kaskaskia megasequences of South America. Scale is in kilometers. © 2017 Institute for Creation Research. Used by permission. Diagram courtesy of Davis J. Werner.

Estimating the exact volume of erosion is difficult to determine if the material is now missing or scattered elsewhere. But if there were lots of earlier erosion that significantly reduced the volume of all pre-Cretaceous strata, there should still be much evidence preserved. Clarey and Werner (2017) have shown that the vast volume of Cenozoic sediment identified by Holt (1996) is also observed across North America, South America, and Africa. All three of

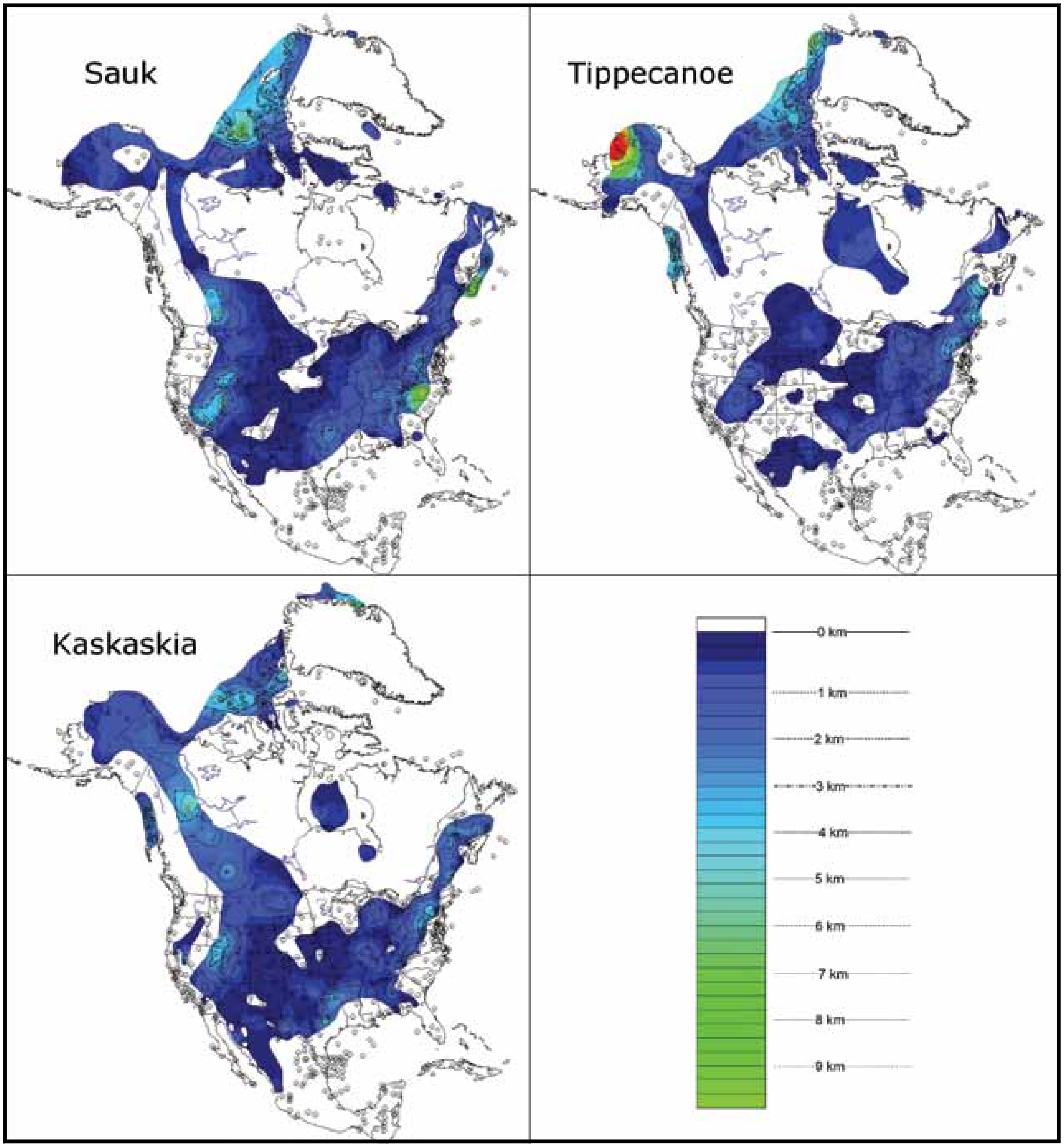
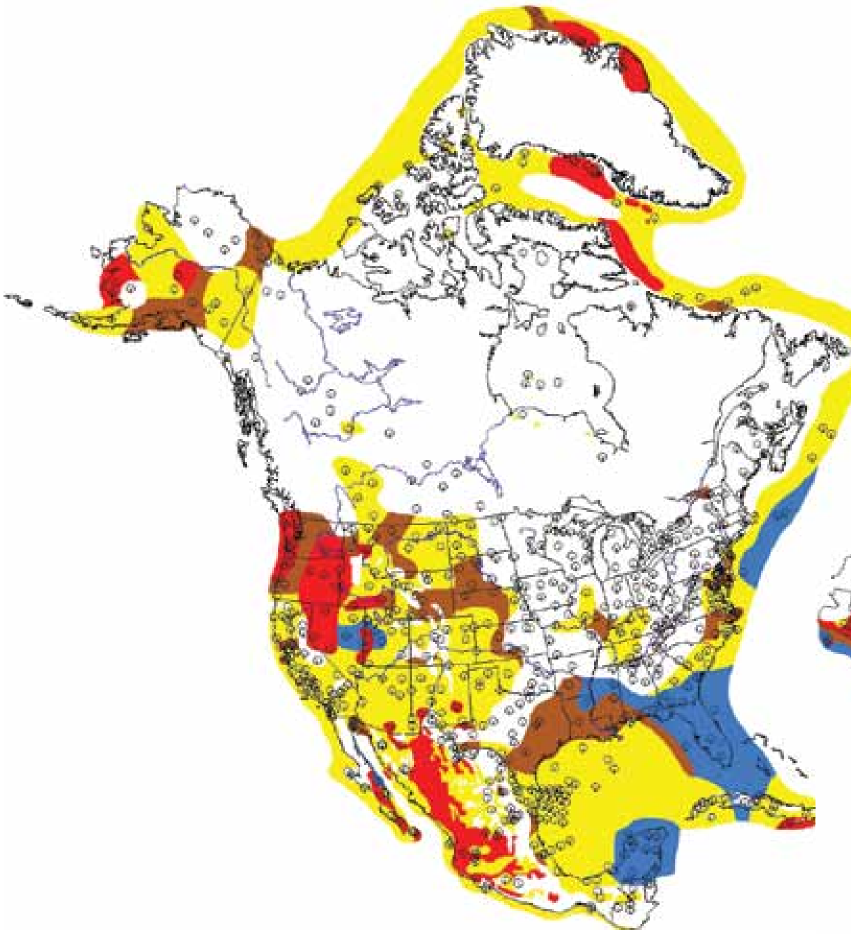


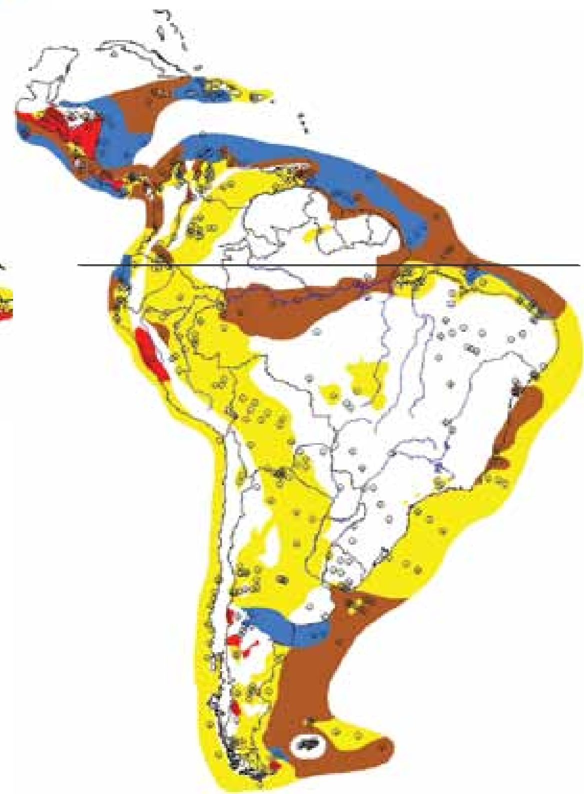
Figure 7. Isopach maps of the Sauk, Tippecanoe, and Kaskaskia megasequences of North America. Scale is in kilometers. © 2017 Institute for Creation Research. Used by permission. Diagram courtesy of Davis J. Werner.

these continents show limited volumes of sediment in the Sauk, Tippecanoe, and Kaskaskia megasequences (Cambrian through Lower Jurassic systems, Fig. 1), and greatly increased amounts of sediment in the latter megasequences (Fig. 4).

Furthermore, Snelling's (2014a) argument that the earlier megasequences were significantly reduced by erosion caused by mountain building near the end of the Flood can be voided by the following observations:

1. There is a consistent internal stratigraphy of each megasequence, where most start out with sandstone followed by shale and then carbonate. For example, the Sauk megasequence still exhibits a complete cycle of basal sandstone (Tapeats equivalent), followed by shale (Bright





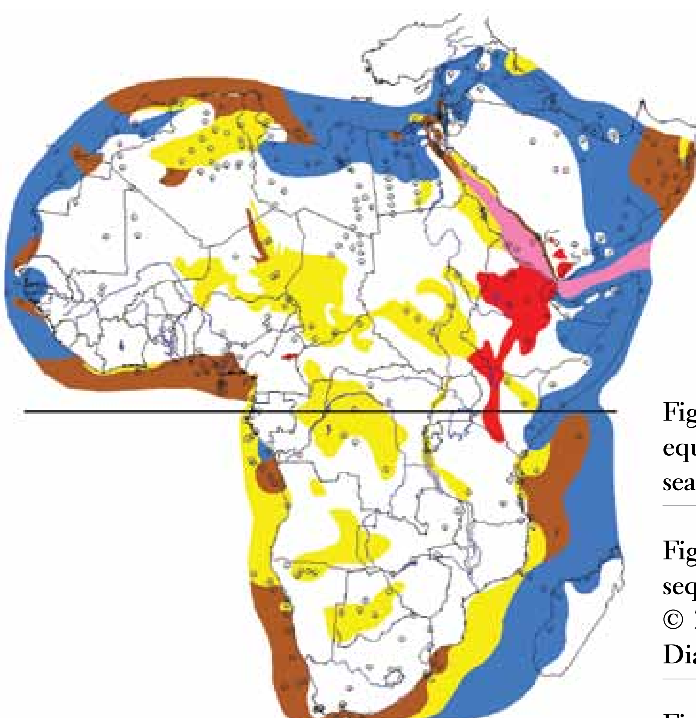


Figure 8 ***(upper left)*****. Basal lithology map for the Tejas megasequence for North America. © 2017 Institute for Creation Research. Used by permission. Diagram courtesy of Davis J. Werner.**

Figure 9 ***(lower left)*****. Basal lithology map for the Tejas megasequence for Africa. © 2017 Institute for Creation Research. © 2017 Institute for Creation Research. Used by permission. Diagram courtesy of Davis J. Werner.**

Figure 10 ***(upper right)*****. Basal lithology map for the Tejas megasequence for South America. © 2017 Institute for Creation Research. Used by permission. Diagram courtesy of Davis J. Werner.**

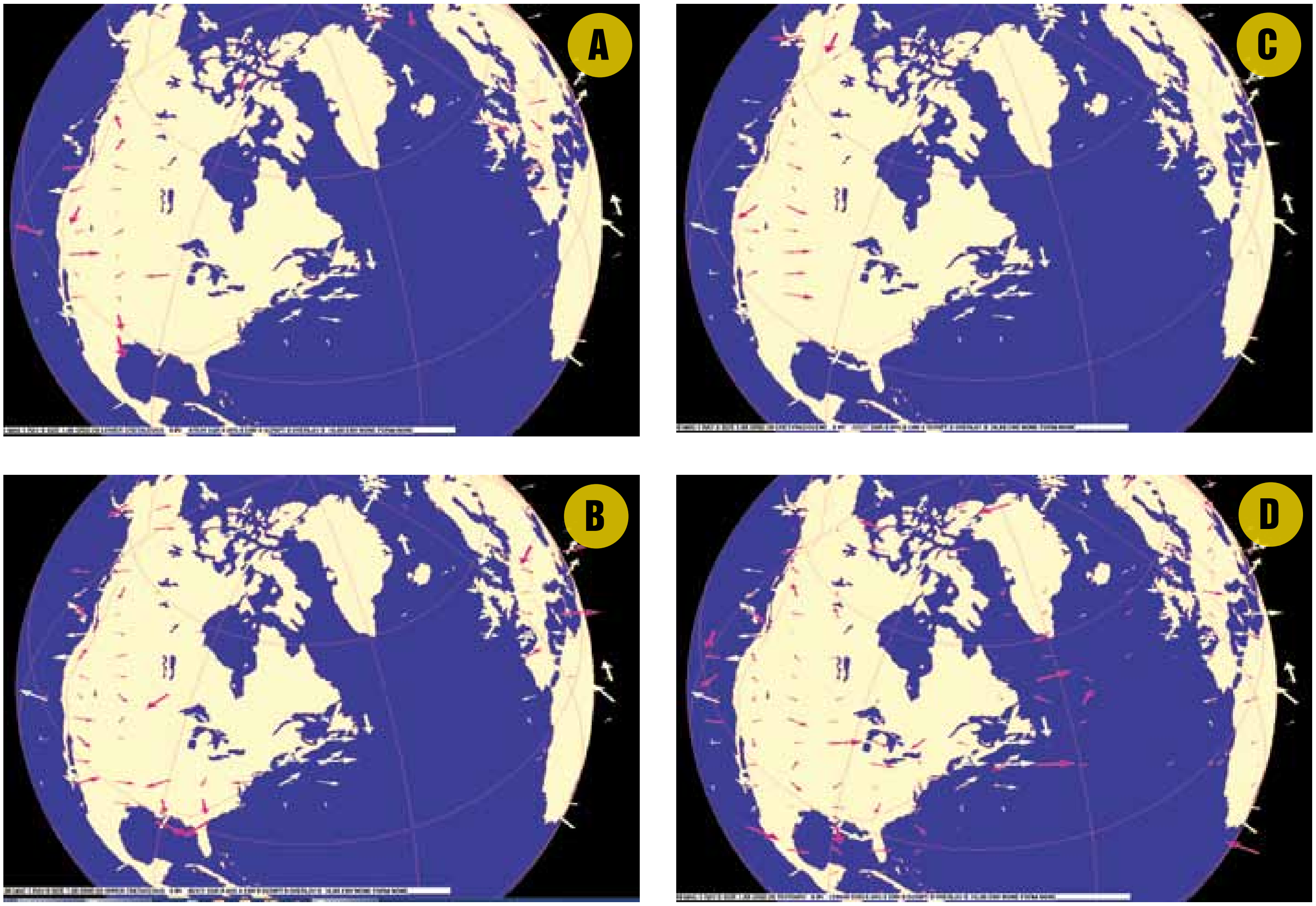


Figure 11. North American current data as mapped by Chadwick (2001). (A) Currents in Lower Cretaceous rocks, (B) Currents in Upper Cretaceous rocks, (C) Currents in Upper Cretaceous-Paleocene (K-Pg boundary) rocks, (D) Currents in Cenozoic rocks. Used by permission of A. Chadwick.

Angel equivalent) and topped by a carbonate (Muav equivalent). This pattern is preserved in most of the earlier megasequences and in the Zuni and Tejas too. Vast erosion, as Snelling (2014a) envisions, would have likely destroyed this systematic signature in many locations, if not totally.

2. There are no reworked fossils and fossil debris in younger Cretaceous and Cenozoic strata. Erosion should have transported vast amounts of fossil material and microfossils from the earlier megasequences and incorporated them into the younger sediments so that no fossil pattern would be discernable in the later megasequences. This is not what is observed. The pattern of sudden appearance, stasis, and sudden disappearance of fossils is prevalent throughout the entire Phanerozoic sedimentological record, Sauk through Tejas (Wise, 2017). Reworking significant amounts of fossils would have obliterated this pattern.
3. There is no significant mountain-building event in Africa like there was in North and South America late in the Flood (Andes and Rockies). And yet, we see the same megasequence pattern of very small volumes of Sauk through Kaskaskia and tremendous amounts of Zuni and Tejas across Africa like we see on the other two continents.
4. The areal extent of the early megasequences matches closely with the pattern of small volumes preserved in the earliest megasequences. This

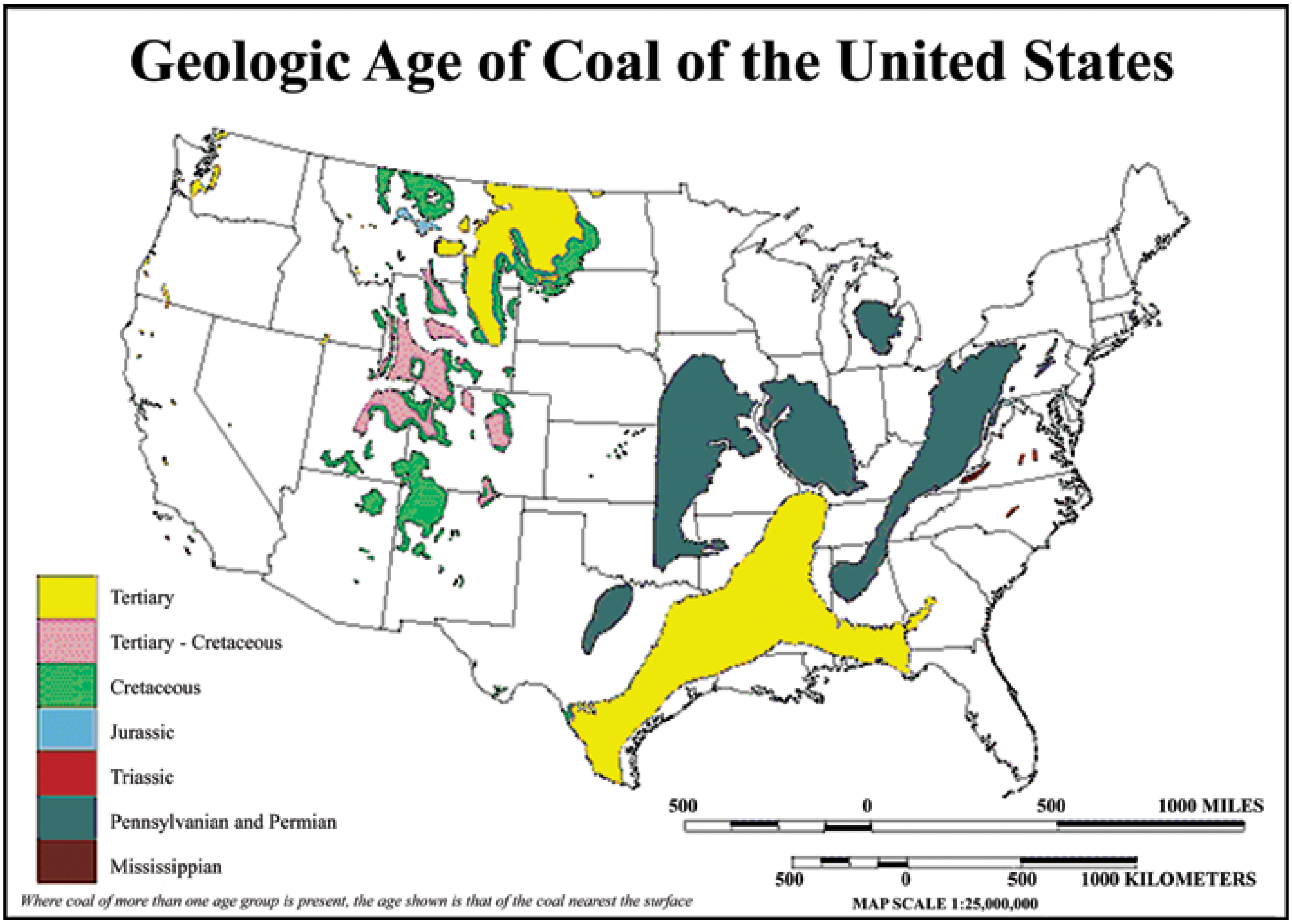


Figure 12. Map of the coal beds in the USA by age. Note the coals in the Western USA are primarily found within Cretaceous and Paleogene rocks. The Pennsylvanian (U. Carboniferous) coals in Eastern USA are thin and discontinuous. The map merely outlines the extent of all coal beds, not individual beds. Modified from USGS map, www.ems.psu.edu/~pisupati/ACSOutreach/Coal2.html, accessed May 15, 2017.

is particularly noticeable in Africa and South America (Figures 5 and 6). If erosion did significantly reduce the volume of earlier sediments, there should still be many small remnants of the Sauk through Kaskaskia scattered across these two continents, and in a random distribution. We do not see this pattern. The early megasequences are confined to the same part of the same continents and stack uniformly one on top of the other. This pattern is particularly consistent across North Africa (Figure 5). And even the more extensive coverage shown by the early megasequences across North America consists of extremely thin deposits across the central USA (Clarey, 2015) (Figure 7).

As Clarey and Werner (2017, p. 279) stated:

> The above patterns observed for each of the first three megasequences are not explainable as mere erosional coincidence. Instead, they are best explained by similar patterns of deposition across the same areas of the same continents. Erosion would not leave this consistent of a megasequence pattern on each of the three continents.

The Tejas megasequence extends from near the base of the Paleogene System to the top of the Neogene (Figure 1). The top of this megasequence coincides with the newly identified sixth great extinction (Pimiento et al., 2017). Cenozoic uplift of the Rocky Moun-

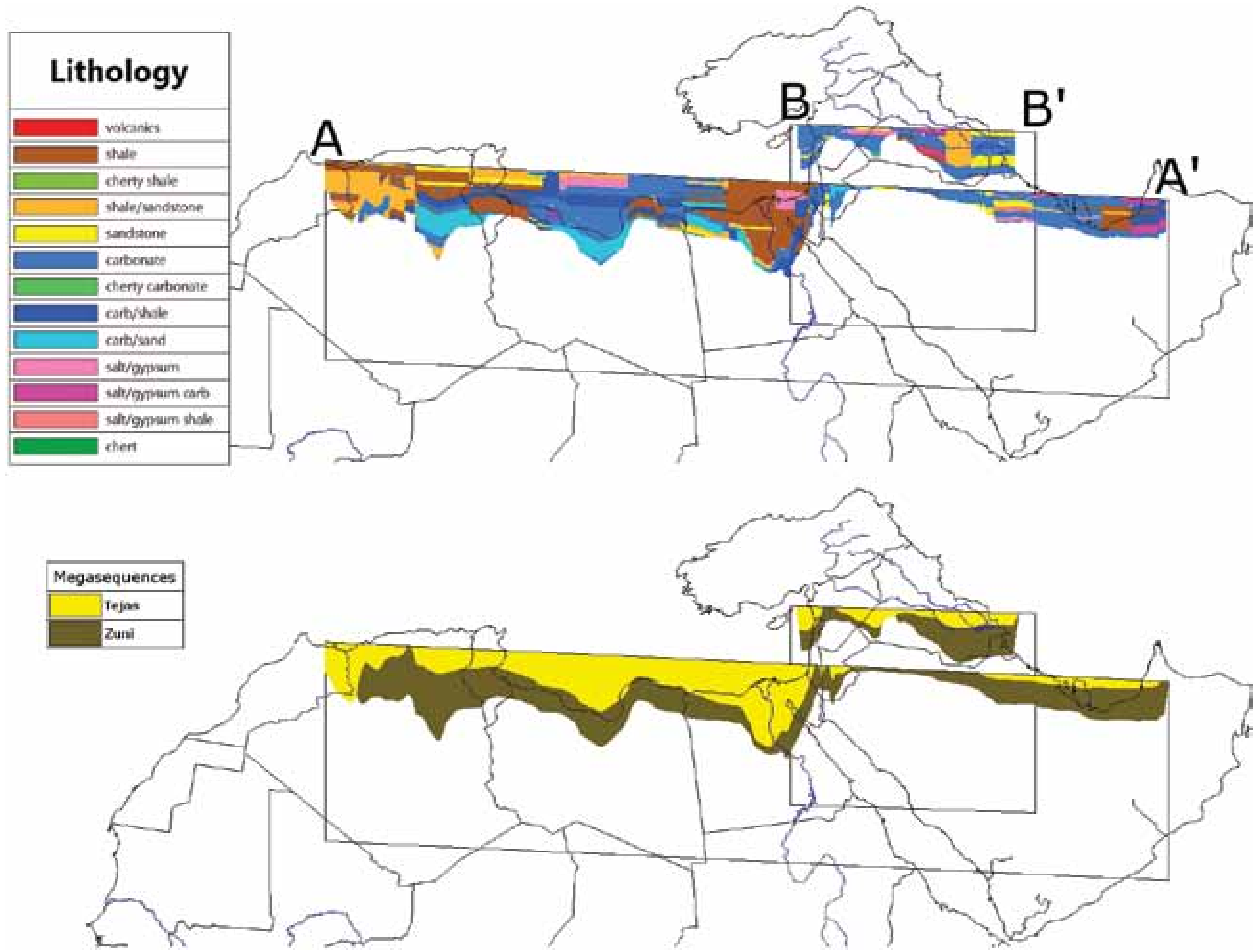


Figure 13. Stratigraphic sections A-A' and B-B' showing the lithology (upper) and the megasequences (lower) across North Africa and the Middle East. Note the carbonate rocks (in blue) in the Zuni megasequence extend upward continually to the top of the Tejas in many locations on the section. The uppermost Tejas in this area is primarily Miocene and commonly contains salt (in pink) deposits associated with the Mediterranean region. © 2017 Institute for Creation Research. Used by permission. Diagram courtesy of Davis J. Werner.

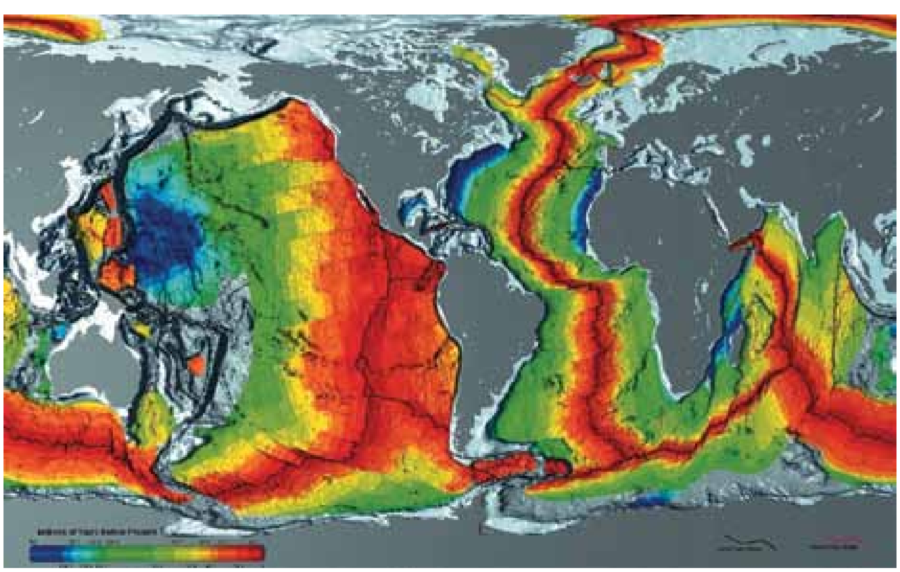


Figure 14. Map showing the age of the ocean crust from «Earth seafloor crust age 1996 - 2». The Cenozoic seafloor is shown in yellow, orange and red. Note how much of the ocean crust formed during the Cenozoic. The presumed secular ages are shown in the scale on the bottom left. Licensed under Public Domain via Wikimedia Commons (https://commons.wikimedia.org/wiki/File:Earth_seafloor_crust_age_1996_-_2.png#/media/File:Earth_seafloor_crust_age_1996_-_2.png. Accessed Aug. 5, 2015).

tains shed millions of cubic kilometers of clay and sand across the Western States. Many of the basins in between the uplifted Rocky Mountains are filled with over 3000 m of Tejas sediment. The Bighorn Basin has 3500 m, the Wind River Basin has 2875 m, the Washakie Basin has 3600 m, the Shirley Basin 3500 m, and the Green River Basin has 3000 m of Tejas sediment to name a few. This volume of sediment, laid down in a 100-year time frame (about 30 m/year), is nearly unimaginable if humans and animals were living in these areas post-Flood.

A notable shift in drainage near the base of the Tejas (Blum and Pecha, 2014) across North America poured tremendous amounts of siliciclastics into the Gulf of Mexico (GOM), including the basal Tejas Whopper Sand (discussed above), which covers the deep, central GOM with a blanket of sand exceeding 300 m in thickness (Clarey and Werner, 2018) (Figure 2). Siliciclastic deposition continued to spread across the continental shelf along much of the Atlantic seaboard, offshore northern Canada, and Greenland. Few deposits were preserved in the eastern USA and across Canada, other than offshore (Figure 8).

The basal Tejas in Africa again shows a fairly extensive sandstone deposit across the center of the continent (Figure 9). Simultaneously, a blanket of continuous carbonate deposition still dominated North Africa and offshore East Africa during the early Tejas. Figure 9 shows the carbonate deposition across major portions of North Africa never ceased throughout the entire Zuni and through much of the entire record of the Tejas. This continuous deposition of carbonate rock continued all the way up from the Cretaceous system to the top or middle of the Miocene in many countries like Libya, Iraq, Iran, southeast Turkey, Qatar and Oman (Figure 9 and Kendall et al., 2014). A more thorough discussion on this is below.

Interestingly, the stratigraphic columns in the Red Sea record upwards of 3000 m of continual salt deposition starting at the base of the Tejas (Figure 9). Oil geologists from Aramco claim there are areas with even thicker salt (up to 5000 m) in the Red Sea (personal communication, 2016). This extensive salt deposit also documented the split of the Saudi Arabian Peninsula from the Horn of Africa during the Tejas megasequence. This splitting would likely have caused tremendous earthquakes to have occurred in the Middle East region at that time. These earthquakes would have wreaked havoc on anyone living in the region at the time, if this was indeed, after the Flood.

The basal Tejas megasequence across South America shows an extensive sandstone layer running the length of the continent and east of the Andes Mountains (Figure 10). It is likely this deposit was from sediment eroded off the uplifting mountains and shed eastward, similar to the deposits in the basal Tejas east of the Rocky Mountains in North America at the same time. Extensive sandstones are also found along large segments of the offshore shelf regions of South America. Areas of extensive shale and/or carbonate deposition also dominated the basal Tejas in the Amazon Basin and along the northeast and extreme southeast parts of the offshore, including the Caribbean.

Using the paper by Snelling and Matthews (2013), Clarey (2016a) has calculated that the time between the end of the Flood and the onset of the Ice Age was about 100 years. Advocates for a K-Pg end of the Flood must assume all Paleogene and Neogene (Tejas) deposition occurred in this time frame. For this reason, Wise (2017) has proposed evolutionary saltation to explain the mammal fossil record in the Cenozoic. Essentially, Wise is suggesting evolutionary changes at the species level and above, from one generation to the next. Surprisingly, this is more rapid evolution that that being proposed by most secular scientists. Wise (2009, p. 143) has even proposed whales may have evolved after the Flood, and that "vestigial legs and hips in modern whales confirm legged ancestors of the whales existed only a short time ago."

Wise (2009, p. 144) has concluded that "mammal taxa which lack a fossil record from the Lower Eocene or before can be understood to have arisen after the Flood as subtaxa of ark kinds." Wise (2009, p. 136) has also pointed out that "44% of living mammal genera have no fossil record at all." However, just because the fossils of living mammals do not appear until later in the Cenozoic does not prove they "evolved" after the Flood. Alternatively, this same mammalian pattern could be explained by ecological zonation, where many of the living mammal genera may have been living at the highest pre-Flood elevations and therefore were buried later. The Bible states that the Flood waters prevailed 15 cubits upward of the highest hills (Gen. 7:20) and buried the cattle also, along with everything that creeped upon the earth, including mankind (Gen. 7:21–23). Fifteen cubits (about 22–30 feet) likely did not provide sufficient depth for sediment to accumulate and make fossils on the highest elevations. The result would be a bleak to nonexistent fossil record, similar to that of humans. This may help explain why so many living mammal genera are nonexistent in the fossil record and/or appear later in the Cenozoic only.

Furthermore, advocates for a K-Pg Flood/post-Flood boundary have claimed the areal distribution of sedimentary rocks shifts from a more continental scale to a more regional scale at the end of the Cretaceous (Austin et al., 1994). And they have argued that water current directions, recorded in ripple directions, support this shift in pattern, going from large-scale continental flow to scattered, local-scale flow (Wise, 2009). However, the claim of a more localized distribution of the sedimentary rocks above the K-Pg (Tejas) primarily applies to the American West (Figure 8), where disruptions in flow in and around the Rocky Mountains are to be expected, and is not observable on other continents like Africa and South America (Figures 9 and 10).

Likewise, the claimed discontinuous nature of the current data above the K-Pg boundary also primarily applies to western North America where the Rocky Mountains were being actively uplifted in the early Cenozoic. The Rocky Mountains are also unusual in their wide swath across the North American continent. Other continents, like Africa and South America have narrower (Andes Mountains) and/or more limited post-Cretaceous uplifts.

Finally, and in contrast to the claim of Wise (2009, p. 130), an examination of Art Chadwick's (2001) current data does not show a clear shift in pattern "from consistent basin-ignoring transcontinental direction to scattered, basin-centering directions" below and above the K-Pg boundary, respectively. Figure 11 shows the current data across North America from the Lower Cretaceous through the Cenozoic as provided by Chadwick (2001). These data show a fairly scattered, nonuniform pattern existed from the Lower Cretaceous right on through the Cenozoic. Indeed, Chadwick (2001) himself noted that the trends in Paleocene rocks were consistent with the trends in the Upper Cretaceous rocks. The change from a more transcontinental flow pattern across North America to a more scattered pattern occurs much earlier in the Flood record, closer to the Mesozoic/Paleozoic boundary (Chadwick, 2001). However, as noted above (Figure 3), there does appear to be some evidence of a major shift in drainage direction across the USA near the base of the Tejas megasequence.

The tremendous amount of Cenozoic sediment cannot be easily dismissed as the product of local catastrophes as previously suggested. There is too much volume globally, and the time frame of 100 years precludes a post-Flood explanation. These sediments, and the fossils they contain, are better explained by the receding-water phase of the Flood. Maintaining they are post-Flood as some creationists claim, and deposited by some as-of-yet poorly described and unknown types of catastrophes, leads to evolutionary hypotheses beyond that of most secularist scientists.

3. The Extent and Thickness of Cenozoic Coal Seams

Cenozoic coal beds are some of the most neglected strata in the creation literature. Only Holt (1996), Oard (2017a), and Clarey (2017) seem to have published on their extent and significance. Previously, Wise (2002, p. 202) claimed:

> Most of the world's coals are made of the large trees of the antediluvian floating forest [lycopod trees] described in Chapter 12 [of his book]. This provided the sheer mass of plant material necessary to produce most of the earth's coals.

However, this is not accurate today. As discussed below, most of the world's coal is found concentrated in Tertiary (Cenozoic) strata and are not composed of lycopod trees (Clarey, 2017).

Most Flood geologists are in favor of an allochthonous origin for coal, resulting from transport of vegetation by the high energy of the Flood. Creation scientists point to the tree mat that formed on Spirit Lake from the eruption of Mt. St. Helens in 1980 as verification of this process. Allochthonous coal is not the issue that is being criticized by Clarey (2015, 2017) and Clarey and Tomkins (2016). These papers only question the viability of a pre-Flood floating forest biome and the presumption that this environment covered much of the pre-Flood ocean surface. As these papers demonstrated, there are serious geological problems with the floating forest hypothesis. Clarey and Tomkins (2016, p. 120) concluded:

> All available geologic and fossilized anatomical data support the existence of pre-Flood lycopod forests rooted in soil. These forests were likely located in wetlands and/or coastal lowland areas as suggested by Clarey (2015). Detailed analysis further demonstrates the trunks and the roots were not hollow as previously claimed. Based on these data, and that of Clarey (2015), we strongly recommend abandoning the floating forest model.

Furthermore, lycopod-rich coal beds are confined primarily to Upper Carboniferous rock layers (Clarey, 2015). Coal deposits found in later Flood rocks show steadily decreasing numbers of lycopod trees and more and more conifers and many angiosperms. In fact, the thickest and most extensive coals in the USA are from Cretaceous and Paleogene rock layers and are almost exclusively composed of conifer-dominant plants, like the metasequoia, and very few, if any, lycopods (Carroll, 2017b).

Most of the coals in the USA Great Plains states are found within Cretaceous and/or Paleogene strata and contain virtually zero lycopod tree remnants (Figure 12) (Tully, 1996). In contrast, the coal beds in the eastern USA, which are composed primarily of lycopod trees, are found almost exclusively within Carboniferous rock layers (Fig. 12). These include the Pennsylvanian (Upper Carboniferous) coals in Illinois, Michigan, and the Appalachian region. The Carboniferous coal beds in the eastern USA are usually 3.0 m or less in thickness. Whereas, the non-lycopod-rich coal beds in the Colorado Plateau and Northern Rockies usually exceed 3.0 m, especially in the Powder River Basin of Wyoming, where beds are often thicker than 15 m over significant areal distances (Luppens et al., 2009).

Indeed, the Powder River Basin (PRB) coals, which are all within Paleogene system rock layers, contain the largest reserves of low-sulfur subbituminous coal in the world (Luppens et al., 2013). Approximately 42% of the present coal production in the USA comes from the Powder River Basin (Luppens et al., 2013). At least six or more coal beds in the PRB exceed 30 m in thickness and some individual beds have been shown to extend for over 120 km (Luppens et al., 2013). Some of these coal beds can exceed 70 m thick in places, such as the Big George coal layer (Scott et al., 2010). The United States Geological Survey (USGS) has estimated that the total in-place coal resources of the PRB is approximately 971 billion metric tons, with just ten individual beds making up about 80% of that value (Luppens et al., 2013). The vast majority of the PRB coals are found in Cenozoic rocks such as the Tongue River Member of the Paleocene Fort Union Formation (Luppens et al., 2013).

It is quite clear that the Cenozoic coal seams in the PRB were not deposited by post-Flood river systems as they are not even remotely sinuous or river-shaped. Using nearly 30,000 drill holes, Luppens et al. (2013) mapped 13 separate coal seams, stacked one on top of the other, through the center of the PRB. They found that several of the seams extended over 100 km north-south and also 100 km east-west. No known river systems and/or local landslides could deposit vegetation (coal) of this extent and thickness, over and over, giving the stacked coal seams found in the PRB today.

The massive Cenozoic coal beds are not exclusive to the USA. Cenozoic coal beds in South America (SA) are also the thickest and most areally extensive across that continent too (Weaver and Wood, 1994). It is estimated that the Cenozoic coal beds make up about one-half of all coal in SA, and the tonnage is estimated to be greater than any other geologic system or combination of systems (Weaver and Wood, 1994). And interestingly, Germany, one of the largest lignite coal producers in Europe, has approximately 65% of its reserves in Cenozoic rocks (Sheldon, 2005). The Rhenish Basin in Germany has lignite coal seams up to 90 m thick within Cenozoic (Tertiary) sediments (Thomas, 2002).

How can coals as extensive and thick as noted above be deposited in a post-Flood scenario? What local catastrophe could deposit continuous coal seams exceeding 100 km in extent and upwards of 50 m thick and lignite beds up to 90 m thick? And it is not just one layer, but multiple layers. Coal deposits this large are unexplainable within the uniformitarian worldview (Snelling, 2009) and equally unexplainable within the creationist worldview if they are deemed post-Flood. Only a global Flood event could produce these coal seams.

How did these massive coal seams form? Evidence for the allochthonous origin of coal is abundant (Snelling, 2009), even down to the sharp contacts of the coal beds with the sediments above and below. There is no evidence of rooting extending downward below the coal bed base into the substrate below, as would be expected if buried in place as uniformitarian scientists contend. Instead, it is likely that the receding water of the Flood transported massive, floating vegetation mats that were torn loose from the pre-Flood land surfaces. For the Powder River Basin coals, these vegetation mats likely became trapped up against the rapidly rising uplifts like the Bighorn Mountains and subsequently buried repeatedly in a succession of waves. Thus, a global Flood scenario better explains the extent and repetitive nature of these thick coal seams.

4. The Continuum of Cretaceous and Cenozoic Carbonates Across North Africa and the Middle East

The lowermost unit in the Tejas megasequence in Africa again shows a fairly extensive sandstone deposit across the center of the continent (Figure 9). Simultaneously, a blanket of continuous marine carbonate deposition dominated North Africa, the Middle East, and offshore East Africa. Figure 13 shows carbonate deposition across major portions of North Africa never ceased throughout the entire Zuni megasequence and throughout most of the entire record of the Tejas. This continuous deposition of carbonate rock continued all the way up from the Cretaceous system to the top or middle of the Miocene in many countries like Libya, Iraq, Iran, southeast Turkey, Qatar and Oman (Figure 13 and Kendall et al., 2014).

One of the arguments made by Whitmore (2006) and Snelling (2009) is the claim that the K-Pg boundary marks a shift in sedimentation pattern and environment. They have claimed that Mesozoic strata are dominantly marine deposits while the Cenozoic strata are dominantly continental deposits. However, this argument seems to be based solely on the American West, where Cenozoic sediments in great amounts were shed locally as the Rocky Mountains were rapidly uplifted in the Early Cenozoic (Paleogene). However, it also ignores the presence of marine fossils in deposits like the Green River Formation, such as herring and rays (Clarey, 2016b). Second, this view too readily accepts the secular depositional interpretations for the Cenozoic deposits in North America, even to the point of accepting that fossil herring were freshwater herring in the past.

Globally, however, there is little evidence of a sudden shift from marine to continental at the K-Pg boundary. The aforementioned African megasequence data illustrate this point. Indeed, there is no change in sedimentation at the K-Pg across North Africa or the Middle East, including Iraq. The geology simply shows continuous marine carbonate deposition from the Cretaceous, uninterrupted, all the way through the Miocene.

Furthermore, Vandenberghe et

al. (2014) noted that there was still considerable marine influence across northern Europe through the Miocene (with ample glauconitic sands) and even into the lowermost Pliocene. And it is not until the Pliocene that the marine sedimentation pattern is broken in the Lower Rhine Valley.

Of all the countries in this study however, perhaps Iraq is of most interest. This is where the Bible tells us the Tower of Babel was most likely located. This is where the Tigris and Euphrates Rivers flow. This is where civilization initially settled after Noah and his family came out of the ark. And yet, this country shows continuous deposition of carbonate sediment, up to several kilometers thick across much of the nation (Figure 13). These carbonate rocks begin in the Cretaceous and continue, uninterrupted, all the way through the Middle Miocene (Grabowski, 2014).

There are several oil fields in the valley of the Tigris and Euphrates Rivers, or along their source areas north of Baghdad, that produce from Miocene carbonates and are sealed by Miocene salt/gypsum layers, like Ajil, Chia Surka, and Jambur (Grabowski, 2014). How can the Tower of Babel be built in an area still dominated by widespread carbonate and salt/gypsum deposition? These are marine deposits that only form under seawater! And these deposits are not trivial but up to thousands of meters thick! The geology of Iraq is the closest thing to "proof" that the Flood was not over in the North Africa and Middle East region until at least the post-Miocene.

5. The Tremendous Volume of Cenozoic-age Ocean Crust

Finally, the process of seafloor spreading did not, in any way, cease at the end of the Cretaceous. There is no evidence of a change in seafloor spreading rate that coincides with the K-Pg boundary. In fact, the rocks support just the opposite scenario. Indeed, the runaway subduction described by Baumgardner (1994) caused the creation of approximately one-third to one-half of the world's ocean crust to form in the Cenozoic, and in particular, during the deposition of the Tejas megasequence (Paleocene through Pliocene). Figure 14 shows the age of the ocean crust, based on secular age dates. However, these dates also are verified by the sedimentary strata, at least in a relative sense. Although we do not advocate millions of years, we do recognize the consistent sedimentological pattern of deposition that shows the youngest sediments deposited nearest the ridges and the progressively older sediment found farther from the ridges. This sedimentary pattern verifies the relative ages of the ocean crust beneath, finding the youngest crust at the ridges and the oldest crust farthest away in both directions (Hess, 1962).

Those who advocate the K-Pg as the Flood/post-Flood boundary must explain how the plates could still be moving at rates of kilometers per hour (Baumgardner, 1994) while claiming the Flood was over. Snelling (2014b) has used the onset of catastrophic plate tectonics (CPT) to start the Floodwater's encroachment onto the land in a series of tsunami-like waves, but he has failed to explain how the Flood could be over while the plates were still moving as rapidly as the seafloor geology indicates. The earthquakes associated with this continued plate motion would have continued to send tsunami waves crashing across the continents. Baumgardner (2016) has modeled the height of tsunami waves generated by rapid plate motion and suggests they could have exceeded hundreds of meters on the continents. In addition, the huge earthquakes would have been devastating for any type of human civilization after the Flood, if the Flood/post-Flood boundary is located at the K-Pg.

Furthermore, to create the new seafloor, the old, original Creation Week seafloor was presumably consumed by subduction. It was this density contrast, of the cold, old original oceanic lithosphere, that allowed the runaway subduction process to begin and continue. This density difference served essentially as the "fuel." Baumgardner (2016, p. 16) describes it as "gravitational energy driving the motion" of the plates. Indeed, this "runaway" process would continue to run its course until all the original oceanic lithosphere was consumed. There was no geophysical means or reason to stop the rapid plate motion until the density contrast was fully alleviated. At that moment, the lithosphere would cease the runaway subduction process, slowing dramatically and also slowing down the production of new lithosphere at the ridges. As a consequence, we witness only small, residual plate motion of cm/yr today. This "slowing" was likely about the time of deposition of the Pliocene rocks, based on the age of the ocean floor (Figure 14). This "slowing" also coincides with the first of the major Hawaiian Islands (Kauai) appearing above the surface.

Others have tried to claim that seafloor spreading had slowed sufficiently during the onset of the Tejas, even using the Hawaiian Islands as evidence (Whitmore, 2013). But all of the Hawaiian Islands are Pliocene and younger. Even the advocates of a Pliocene Flood/post-Flood boundary would agree the plates were slowing at that point.

Further Discussion

The purpose of this paper is not to analyze all the criteria proposed by Whitmore and Garner (2008) for identifying pre-Flood, Flood, and post-Flood boundaries. However, this paper has addressed three of the criteria they deemed were of highest importance; namely (1) marine deposits on the continents, (2) deposits of unparalleled extent, and (3) global and regional unconformities. Whitmore and Garner (2008) applied these and other criteria to a single location in the Rocky Mountains of western Wyoming, concluding that the post-Flood began somewhere near the top of the Cretaceous section (Lance Formation).

Unlike Whitmore and Garner (2008), who applied these criteria only to western Wyoming, the present study has examined the rock record across three entire continental masses, furthermore recognizing marine vs. continental deposits is sometimes ambiguous and arbitrary. Rock formations like the Coconino Sandstone are thought to be continental deposits by most secular geologists and yet contain ample evidence of marine deposition (Whitmore et al., 2014). Regardless, it seems likely that Cenozoic uplifts like the Rocky Mountains and the Andes Mountains rose rapidly above the receding Floodwaters before most of the continents had fully drained. Therefore, it should be expected that the mountainous regions would appear to be more heavily influenced by continental-looking deposits. In this regard, the conclusion of Whitmore and Garner (2008) for western Wyoming does appear to be correct. However, when examining this criterion on a global scale, extensive deposits of marine sediments are observed across northern Europe (Vandenberghe et al. 2014), North Africa, and the Middle East (Figure 13). We conclude that marine deposition continued across large expanses of the continents well above the K-Pg boundary and continued to the top of the Miocene or higher.

Whitmore and Garner (2008) have further asserted, as have Austin et al. (1994), that deposits of unparalleled extent cease near the top of the K-Pg boundary and that Cenozoic deposits are more "localized" in extent. However, this interpretation also seems influenced by primarily studying rocks within the Rocky Mountain region. It seems obvious that the numerous uplifts and adjacent basins within mountainous regions would tend to localize deposition on a basin-by-basin basis as the uplifts blocked and divided the depositional pathways. However, when viewing the sedimentological data on a global scale, as in this paper, a completely different picture is revealed, as described above. Figures 8, 9, and 10 show extensive deposits of Tejas (Cenozoic) strata spread across great expanses of the continents, including the continental shelves. And the volume of Tejas sediment globally is second only to the Zuni megasequence (Clarey and Werner, 2017). Applying the criterion of "deposits of unparalleled extent" leads to a post-Flood boundary interpretation that is much higher than the K-Pg.

Finally, this paper also touched on the "global and regional unconformities" criterion. Whitmore and Garner (2008) have stated that they expected widespread erosional surfaces to mark the end of the Flood's recession off the continents. At the time of their publication, a global stratigraphic discontinuity had yet to be identified above the K-Pg boundary. However, a major "biostratigraphic break" has recently been located near the top of the Pliocene. Pimiento et al. (2017) determined that 36% of the Pliocene genera failed to cross the Pliocene/Pleistocene boundary. Furthermore, they calculated extinction rates to be three times higher in the Late Pliocene relative to the rest of the Cenozoic (Pimiento et al., 2017). Although many creation scientists do not accept that these represent true extinction events, they do acknowledge that these extinctions mark the last appearance of these particular fossils in the rock record. Therefore, there appears to be fossil evidence of a global "break," or disconformity, at or near the top of the Pliocene. This so-called sixth extinction may coincide with the end of the receding-phase of the Flood.

Conclusions

This paper presents empirical evidence that challenges many of the arguments for a Flood/post-Flood boundary at the top of the Cretaceous. Indeed, these data establish that the Flood/post-Flood boundary had to have been much higher in the Cenozoic rock record. Five major arguments are put forth challenging the K-Pg boundary as the Flood/post-Flood boundary and against any explanation involving local catastrophes to explain the Cenozoic record: (1) the presence of the Whopper Sand in the Gulf of Mexico; (2) the tremendous amount of Tejas sediment deposited globally; (3) the fact that the thickest and most extensive coal seams are found globally in Tejas sediments; (4) the identification of uninterrupted carbonate deposition across the K-Pg boundary and continuing upward through Miocene strata across the whole of North Africa and the Middle East, areas just to the south of the landing site for the ark in Turkey. The geology of Iraq, in itself, suggests it is nearly impossible to try to pick a Flood/post-Flood boundary any lower than the Miocene. A final challenge (5) is the tremendous amount of rapid ocean crust/seafloor spreading that continued right across the K-Pg boundary and up to the Pliocene, with no indication of a significant change in velocity. Collectively, these data suggest that much of the Cenozoic was likely the receding phase of the great Flood.

In addition, the advocates for a K-Pg boundary end to the Flood have backed themselves into a corner by giving themselves only about 100 years of time for the entire Tertiary system to be deposited in a series of local catastrophes (Snelling and Matthews, 2013; Clarey, 2016a). This is why Wise (2017) is advocating evolutionary saltation to explain the mammal record in the Tertiary. He has to. How else do you explain the mammalian fossil record of the Tertiary? And it is extremely unlikely that large mammals could bear sufficient generations of offspring in the time allotted (about 100 years). Many of these mammals take upwards of 10–20 years to reach sexual maturity (around 15 years for Indian elephants) (Plowee, 1943). "Doing the math" makes the claims of mammal evolution in the Cenozoic even more absurd if they are all post-Flood animals.

The results of this paper also call into question much of the claimed paleontological evidence for a K-Pg Flood /post-Flood boundary. Have these studies been too local? Have they been too focused on just one continent? Paleontological data is ambiguous by nature due to inherent biases. It is doubtful the fossil record is truly representative of the number and diversity of organisms in any given community. So much has happened between life, Flood transport and the burial and preservation of the fossils. It's what we don't find, or what hasn't been preserved that we can never recover. Most everyone accepts there are biases to the fossil record. Even Ross's (2012) study of mammals across North America is explainable by simple probability bias (Clarey, 2016a). We need to expand our studies to more global patterns.

And rather ironically, the advocates for a K-Pg boundary have never adequately addressed the question posed by Clarey (2016a) about post-Flood dispersal of the large mammals to the separated continents. How do you move large animals across vast open seas without Ice Age land bridges?

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