Llano Estacado in New Mexico and Texas

Vs. YEC and Flood Geology

Stephen Mitchell Jan 4, 2021

Email: Jesus.inHistandS@gmail.com

Triassic and Permian strata in the Palo Duro Canyon

The geology of Palo Duro Canyon and the Llano Estacado region provides a great test for the predictions of "Young Earth Creation" and "Flood Geology". Were the rocks deposited by a great flood or were they by slower geological processes over millions of years? We find spearpoints made by Paleoindians from flints formed in the area. If Abraham used flint for weapons, could it have hardened in the time available in the Young Earth model?

Summary

The Southern High Plains, the Llano Estacado provides an opportunity to evaluate the claims by Young Earth Creationists (YEC) regarding the age of the earth and the processes by which the sedimentary rock record was formed. Using the oldest sedimentary units here, the Paleozoic rocks, we will show examples with many geologic events that took far too long to be deposited to fit the Young Earth model. These include reefs and many cycles of well-organized deposits which were changed diagenetically from lime to dolomite. Many of the units show clearly that they were laid down in desert salt-flat environments known as sabkhas. Thousands of feet of sediment formed in such environments and these do not fit as deposits from a large flood. Above the Paleozoic rocks are the Mesozoic rocks. These include ancient soils known as paleosols. The Llano Estacado region was a large shallow lake with rivers of many kinds that flowed into it. Neither paleosols, nor lakes, nor rivers fit into a flood model.

Above the Mesozoic section is the Cenozoic interval, here beginning with the Ogallala Formation. YEC have interpreted the base of this interval to have been deposited as "a blanket sand layer spread across thousands of square miles with no evidence of river channelization". We will show evidence of rivers that eroded into the unit below and deposited sand and gravel along meandering river valleys. Above the river deposits are thick caliche deposits that formed in soils that developed in semiarid environments over thousands of years. Interfingering lake, sand dune and spring-fed deposits in the Blackwater Draw formation overlie the Ogallala. These include evidence of the Clovis culture of humans that hunted mammoths and other animals in this region. They made spear points from flint that formed in the late Paleozoic and Mesozoic. This raises questions about how these could have hardened and been available for use, if the Earth is 6,000 to 10,000 years old, as interpreted by YEC. Did Abraham have flint available to use in spears or knives? If so, time was required for this to form.

This area shows that the YEC flood geology model is invalid. God used vast amounts of time to prepare this Earth as a place that could support a large population of humans in a society that would someday be able to see the reaches of the universe and appreciate the beauty and majesty of His creation.

If you were to drive westward from Dallas, Texas to Albuquerque, New Mexico, you would drive across the High Plains. The southern portion of the High Plains is separated from the northern portion by the valley of the Canadian River. South of the river is a broad, flat mesa named the Llano Estacado (L.E.). (Figure 1). Llano Estacado means "staked plains" in Spanish. With its semi-arid climate and lack of topographic features, it can make for a boring drive. The names of some of towns there tell the story. They include "Notrees", "Levelland", and "Plainview". The land is level to the point that it looks like it has been ironed. In the winter, when the wind comes from the northwest, it feels like there is not a tree between you and Canada.

Figure 1. Llano Estacado mesa shown on a Google Earth map of the eastern New Mexico, West Texas region. Notice that a series of river valleys define it.

Why do I choose to write about this area? It doesn't hurt that this area represents home for me. I grew up in eastern New Mexico in the small village of Dora. I labeled it on the map though few regional maps would show this important place. For most of the population across the Llano Estacado, agriculture is king. Most of the boys that I grew up with became farmers and ranchers like their fathers before them. The area has spectacular sunsets in part because there is "not a tree to mar the view". The flat mesa top does have undulations. There are shallow, dry arroyos that lead to shallow playa lakes. On 'wet' years, they fill with water. The water draws water fowl, antelope and occasionally deer today, but in earlier periods bison and other animals came. Hunters come for deer and crane as they have for thousands of years.

Mesas develop when softer rocks are eroded around an area, leaving a harder, more resistant bed at the top. The layers that hold up the Llano Estacado are caliche beds from the Ogallala Formation. The Ogallala formation is named for the town of Ogallala, Nebraska, where it was first described. The caliches that prove to be so hard to erode away are limestones that developed within semiarid climates as a part of the soil profile, but more about that later. In most areas, when you drive off the caliche caprock, there is a pronounced escarpment. People in the area call this "coming off the cap". (Figure 2)

Figure 2. A view of "coming off the cap", showing the escarpment north of Crosbyton, Texas. The upper layer is the Ogallala Formation composed of caliche, overlying Triassic sediments.

While the view of the upper surface may not be terribly scenic in most areas, I think that this region makes some very useful points regarding the age of the Earth and the Young Earth Creationist's (YEC) flood geology model. First, we will look at the older section, commonly considered by YEC authors to have been deposited by Noah's flood. Then we will look at the Ogallala formation that holds up the mesa and how it was deposited. YEC are divided about how this unit fits into their model. Next, we will look at the Blackwater Draw Formation, the youngest unit. It is important because it contains some of the earliest evidence of humans in the Americas. We can compare the flood geology predictions about how these units formed with current geological explanations. The two explanations cannot both be true and they are different enough that it should be clear which fits the data best.

Attempts to account for the rock record into the flood geology model typically run into two problems:

1. **Too many events and two little time or**
2. **Incompatibility issues**, essentially trying to put a square peg in a round hole.

Perhaps to understand these concepts, lets imagine three identical big boxes that have been delivered to your door. You are told that the boxes each contain a kit to make a large wall clock. You are told that the first box was filled over several years by carefully crafting each piece, arranging and designing the shipping material. For the second box, the sender explains that they just grabbed the pieces together and threw them in the box because the shipping office needed them in ten minutes. Do you think you could tell which of these boxes was which? What would you look for? It should be easy to recognize the ordered arrangement in the one that developed over time vs. the chaotic arrangement resulting from the rapid throwing of pieces in the box. One would expect to be able to recognize the packing material from the carefully packed box that took time to build. Think about characteristics that the YEC interpretation of Noah's flood demand. In this view, this was a one-year long, global catastrophe leaving vast deposits that formed over that year. Individual components had to have been deposited very quickly, both at the scale of individual beds or as units made up of many beds. In this area, with almost 16,000 feet of rock deposited, this would mean averaging over 40 feet of rock per day. A common view would be that the early flood involved more erosion than deposition. If this were the case, then the actual depositional rates for much of the section would have been much greater. If the flood interpretation is correct then we should find massive intervals of chaotic deposition hundreds or thousands of feet thick that formed over very short times. If we find any intervals within the package that took more than one year to form, then that package cannot have formed from the flood. We should be able to recognize this.

What if the third box that you believe will contain the parts of a beautiful wall clock actually contains a kitchen sink, complete with a faucet and pipes? Do you think you would be a bit suspicious that it really isn't a clock? It really doesn't matter how quickly or slowly it was packed. It will not construct a clock. We will see rocks that just were not formed by a flood, regardless of its size or duration. We will look at the deposits formed in the Llano Estacado region to see if they look more like the package filled very quickly vs. slowly, and we will look for characteristics that would not be compatible with flood environments and processes. We find examples of both problems through this area.

Pre-Ogallala Sediments: Paleozoic

The thin cover of Cenozoic sediment here overlies thick Mesozoic and Paleozoic sections. Precambrian igneous and metamorphic rocks extend through the area and are known as "basement". Above this basement are approximately 6,500 – 16,000 ft (2,000 – 5,000 m) of sediments, most of which are pre-Cenozoic in age. (Shah and Boyd, 2018). The rocks tell a long story of deposition in shallow seas and along an adjacent margin that were typically arid and reflect non-marine sabkha (salt flat) environments. Figure 3 shows the various geologic regions beneath the Llano Estacado with varying histories. Figure 4 compares the timeframes to a schematic profile from one of the basins, the Palo Duro Basin. Each unit has its own story as the area developed through time. I described this section over a somewhat larger area in my book, "A Texas-Sized Challenge to Young Earth Creation and Flood Geology". Many events, too little time. I described the Pennsylvanian reef complex called the "Horseshoe Atoll" in my post on reefs: "Ancient Reefs confirm Deep Time and sink Flood Geology". Reefs take time to form. Three thousand feet of reefal deposits in multiple phases did not take place in one year or in 6,000 years.

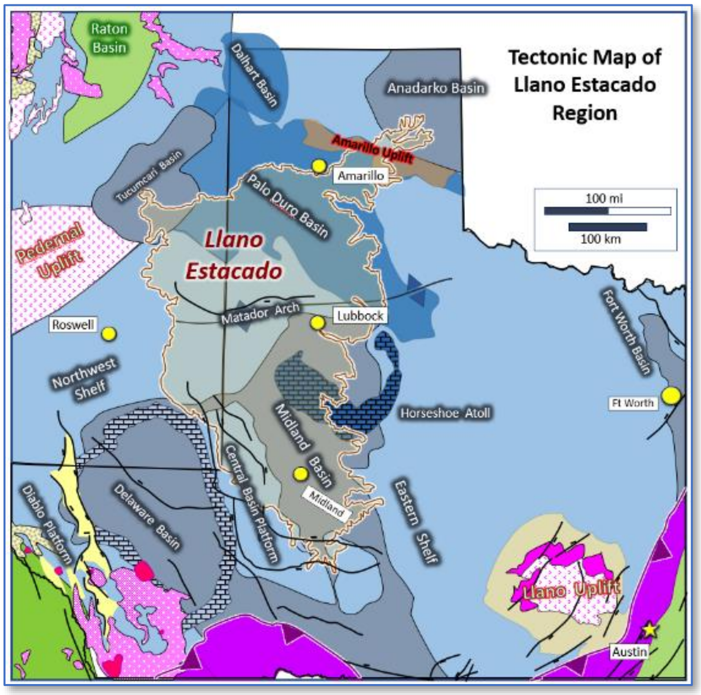


Figure 3. Paleozoic tectonic map of the Eastern New Mexico and West Texas region. Under the polygon for the Llano Estacado, you will notice the Palo Duro Basin (north and east; light blue-green area) of the Llano Estacado and the Midland Basin (south and east; light grey area) of the Llano Estacado. They are separated by shallower areas such as the Central Basin Platform (partially underlying the Llano Estacado) and the Northwest Shelf (extending west of the Llano Estacado) and in particular the Matador Arch.

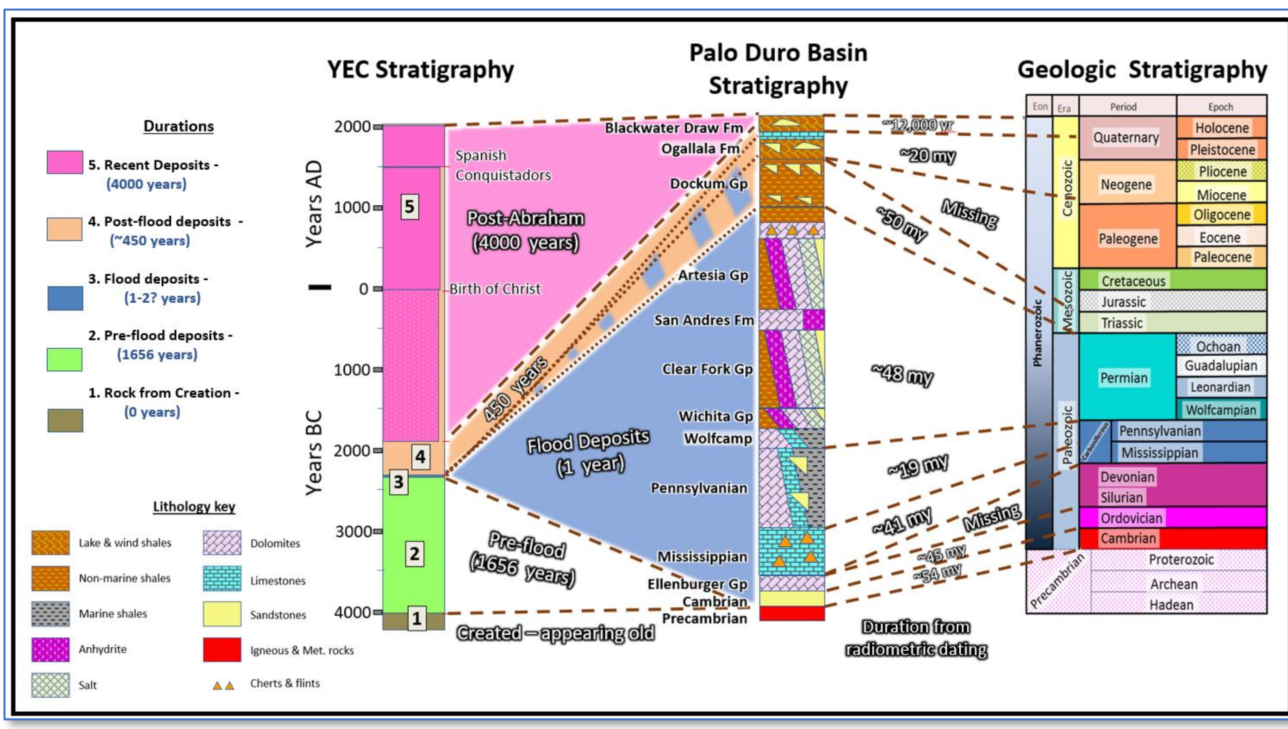


Figure 4. Schematic stratigraphy from the Palo Duro Basin showing how it is interpreted by flood geology (left) and fits into global stratigraphy (right). Notice that YEC authors have different interpretations of where flood deposits begin. The intervals for different periods and epochs represented on the right are typically also recognized by both YEC and conventional geologists because they agree on the order of rock deposition. The duration of the intervals based on radiometric dates is shown as well. Modified from Mitchell, 2019, Ruppel et al., 1984

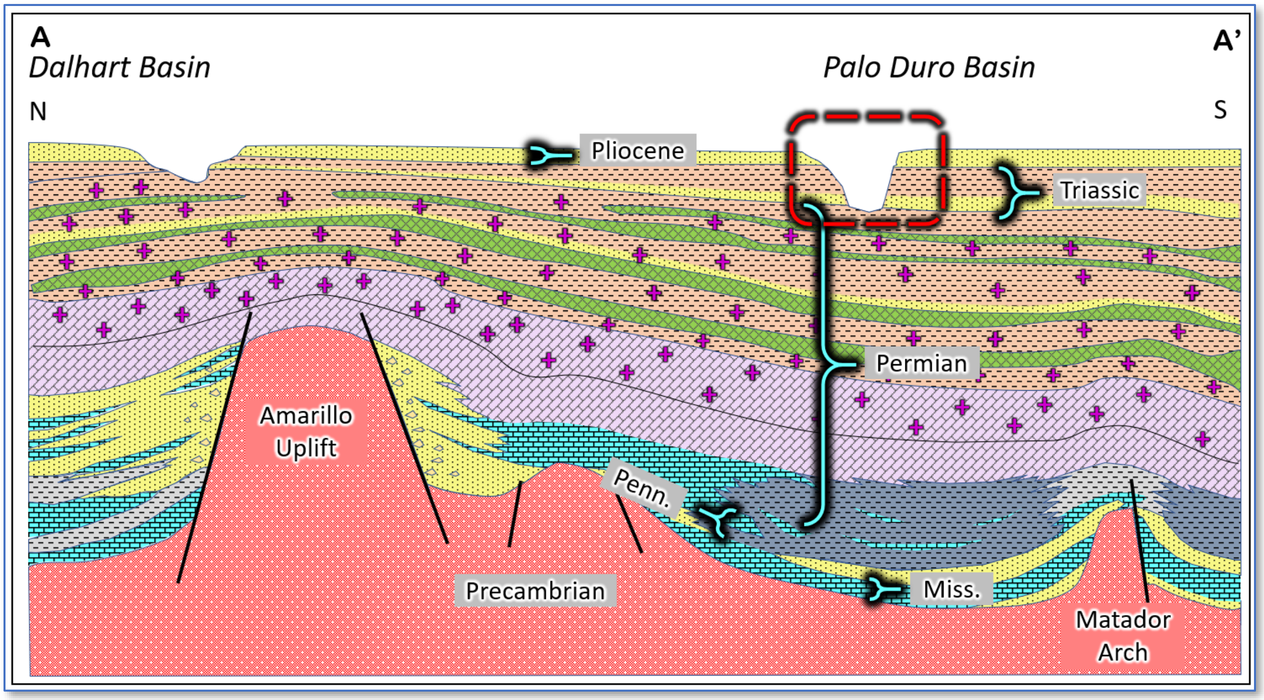


Figure 5. Schematic North-South profile A-A' across the Palo Duro Basin (modified from Dutton et al., 1979). The red dashed box shows the location for profile B-B' in Figure 6. The basin developed between two uplifted areas, the Amarillo Uplift and the Matador Arch. These granitic highs were exposed and often sands and cobbles shed off of them are referred to as "granite wash". Similar deposits are shed off of eroded granitic highs today all around the world.

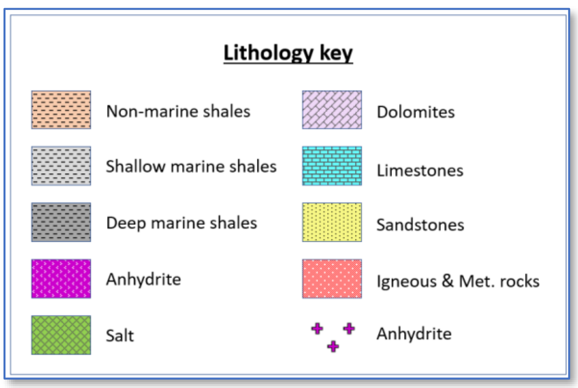


Figure 5a Lithology key for Figure 5.

The Permian deposits in the area provide a particular incompatibility issue that I want to highlight here. We can use the Permian unit named the San Andres Formation to illustrate how sediments were laid down through this period. It clearly was not a chaotic process. We find repetitive cycles of limestone or dolomite overlain by anhydrite (CaS04), then halite (salt) and topped by red shale (Hills, 1972). The same cycles that we find vertically are present in map view when we correlate strata around the basin. The red shales thicken and eventually dominate to the north, while limestone units dominate to the south. Bands of predictable lithology that repeat suggest depositional processes that took place over time and repeated over and over.

The fine-grained red shales and siltstones have sparce terrestrial fauna and are typically interpreted to have been formed mainly by wind-driven (eolian) processes, with some stream deposition. The limestones have all the characteristics of limes deposited in shallow seas with sand bars composed of fossils and oolites such as we see today in the Bahamas. (Dutton, et al, 1979, Ruppel, et al., 1984, Hiss and Williamson, 2020, Elliott and Warren, 1989) Many are heavily burrowed as we see today in subtidal deposits. Rocks are found that look like modern sediments from both shallow lagoon settings and open marine settings. The rocks between the open marine limestones and the red shales tell us much of what the region was like in the Permian. Calcium sulfate precipitates out when sea water evaporates both as the mineral anhydrite and in the hydrated mineral, gypsum. Today, we find this happening in arid settings, both in shallow marine and non-marine positions in places such as the Persian Gulf. In the San Andres formation, both anhydrite and gypsum are found as well. With sea water evaporation, salt is also precipitated out as well and salt beds are common in San Andres beneath the Llano Estacado. So far, we have an association with bands of limestone, anhydrite, salt, and red beds. This is just what we find in modern arid regions such as Persian Gulf. I cannot think of any scenarios with large floods that would produce such.

What explanations do YEC authors give for these types of deposits? I have not found reports that look at the Permian record in West Texas and New Mexico. Some do have suggestions for anhydrite and salt. These lithologies are typically characterized as evaporites by geologists because of the obvious explanations and the analogues that we see forming today. YEC authors must find alternatives. It is a fact, some local deposits of these lithologies apparently developed by supercritical water rising from volcanic vents on the seafloor and some YEC suggest that this may explain salt in flood deposits. (Snelling, 2009; Morris, 2010). This has been proposed by geologists for certain deposits such as those in the Red Sea. How would this work? Quoting from Hovland, et al., 2014,

> "*In the oceanic crust, these pressures are attained at depths of 3 km below sea surface, and sufficiently high temperatures are found near intruding magmas, which have temperatures in the range of 800˚C to 1200˚C. The physico-chemical behaviour of seawater changes dramatically when passing into the supercritical domain. A supercritical water vapour (ScriW) is formed with a density of 0.3 g/cc and a strongly reduced dipolar character. This change in polarity is causing the ScriW to lose its solubility of the common sea salts (chlorides and sulphates) and a spontaneous precipitation of sea salts takes place in the pore system."*

This is an interesting proposal that certainly has merit for some evaporites that develop over oceanic crust or in areas with volcanic activity. Let's think about it in a global flood scenario. If the flood involved large amounts of water from rain or sources from "the fountains of the deep" (Gen 7:11), this would actually make it far less likely that salt would be deposited by the expulsion of supercritical water vapour rich in chlorine. The properties of chlorine are such that the chloride ion is rapidly dispersed in the water and never precipitated (Dr Lorence Collins, 2020, personal communication and Collins, 2006).

Regardless, this proposal is not really relevant to the Permian Basin because of the lack of oceanic crust or volcanism. The general pattern of limestones, evaporites and red shales point to deposition in dry climate over time. Looking closer at the units, we find more features that tell us about their deposition and changes that took place after the initial deposition. For instance, limestone packages can be traced into units that are made of dolomite and then include anhydrite and then are totally anhydritic. A close examination of the dolomite shows that it contains fossils and other evidence to show that it started out as lime muds and shells. The units were changed by fluids that moved through the lime muds. The processes that change sediments after deposition are referred to as diagenesis. While some changes take place after deeper burial, much of this change to dolomite took place while the muds were at or near the surface. Diagenetic changes are obvious throughout the zone as we move northward. We see lime sediments that became dolomitic, often later were replaced by anhydrite and gypsum. We see beds and features that were originally formed as gypsum that were converted to anhydrite and vice versa. The forms of gypsum and halite often show crystal forms that grew up from below, some above and some below the sediment surface at the time. We see halos in the crystal from their episodic growth. (Elliott and Warren, 1989, Fracasso and Hovorka, 1986)

We also find depositional features that are diagnostic of tidal deposits such as algal stromatolites, mud cracks, small vertical burrows and possible root traces. Algal stromatolites form when cyanobacteria (blue-green algae) developed films that trapped layers of other sediment. Stromatolites such as these formed in an intertidal zone, the zone between high tide and low tide. This reflects regular tides over some period of time. How fast do such algal laminations form? Rates of growth for modern laminations have been measured and they average between 1.6 to 5.6 years per lamination (Petryshyn 2013). We find evidence that at times the stromatolitic intervals were exposed to freshwater for enough time to be partially leached away, forming "bird's eye" structures, often later filled with anhydrite or salt. All of these are indications that the sediments were deposited in arid environments, very much like those in the Persian Gulf today. Many great studies are available describing the Persian Gulf environments including two available on line: Al-Youssef, 2015 and Akili, 2004. A series of local environments that include salt encrusted flats, known as sabkhas developed that produce sediments exactly like those deposited in West Texas and Eastern New Mexico in late Permian time.

I could go on and on with many more detailed examples of these ancient depositional environments. These are not just of interest to geologists. I explained near the first of this article that agriculture is king in the area. That is certainly true in the northern part of the L.E. In the southern part of the area, since the 1930s, another king has been important to the area – oil. Miles of oil pumping units (pumpjacks) are found, often very closely packed. The San Andres formation is one of the most important. The largest field, the Slaughter-Levelland Field has produced over 1 billion barrels of oil from porous dolomite from the San Andres formation. Dolomite pinches out into anhydrite and salt as beds come up over the Matador arch (Figure 3). Some of my first experience in oil exploration involved discovering oil in deeper reservoirs in this area. This basic model of ancient sabkha evaporites interfingered with shallow marine limestones has enabled oil companies to find, develop and produce large amounts of oil.

What I have tried to show using the San Andres formation is the following:

1. The beds are organized and have predictable mappable lithology patterns (facies) that make depositional sense, inconsistent with predictions from a massive flood.

2. The progression of facies and the detailed internal features show us that the rocks were deposited under arid conditions that included sabkhas and other associated settings. This is very different from any of the conditions that might be expected in deposits from a large flood.

This is an incompatibility issue.

As the basins in this area were filled and the seas moved southward, the upper most unit in the Permian was deposited over the area, the Quartermaster Formation. Red beds, very similar to those of the earlier Permian formations covered the whole area. They include thin gypsum beds like the earlier units and a dolomite unit that extends over the northern part of the L.E. (Dutton, et al, 1979). The Quartermaster formation is the oldest formation that is exposed at the surface in the area. The L. E. is not known for scenic beauty, but a major exception to this is the Palo Duro Canyon, south of Amarillo Texas. Here the Prairie Dog Town Fork of the Red River carved down through the red beds, leaving beautiful red walls along the canyon. (Figures 6-10). While this canyon clearly is not the Grand Canyon, it is beautiful and well worth visiting. The Quartermaster Formation was largely deposited subaerially from wind-blown deposits, though the presence of wave ripples tells us some were deposited in very shallow seas. At times the environment must have included sabkhas. For instance, a dolomitic unit, named the Alibates Member is correlatable across the entire region. As with the older Permian dolomites in the area, it started as a lime mud that over many years became dolomitic due to replacement caused by the interaction with fluids from brine pools. We find the stromatolites and other diagnostic characteristics. Anhydrite deposition and replacement of dolomite is common. What makes the Alibates most interesting is the fact that some beds of the dolomite have been silicified. The silicified dolomite is variously called flint or chert or agate. (Bowers and Reaser, 1996; Quigg, et al., 2011). (Figure 10). In fact, this Alibates flint is particularly beautiful and this has been recognized for thousands of years. It has been quarried for this long period of time in the area around Lake Meredith (Figure 1). Here the Alibates Flint Quarries National Monument preserves evidence of the way this material was valued by humans long before the Europeans arrived. Later in this document, we will look at the use of the flint in more detail. When did the flint form? Bowers and Reaser, 1996 observed, "*The close proximity of most Alibates chert to opalized and calichified zones in the superjacent Miocene-Pliocene Ogallala Formation suggests that local chertification may have been a by-product of the calichification process*." If it was formed by fluids from the Ogallala, that will also be significant for the questions we are addressing here. For now, this is just another case of too many events, too little time and incompatible events for flood geology.

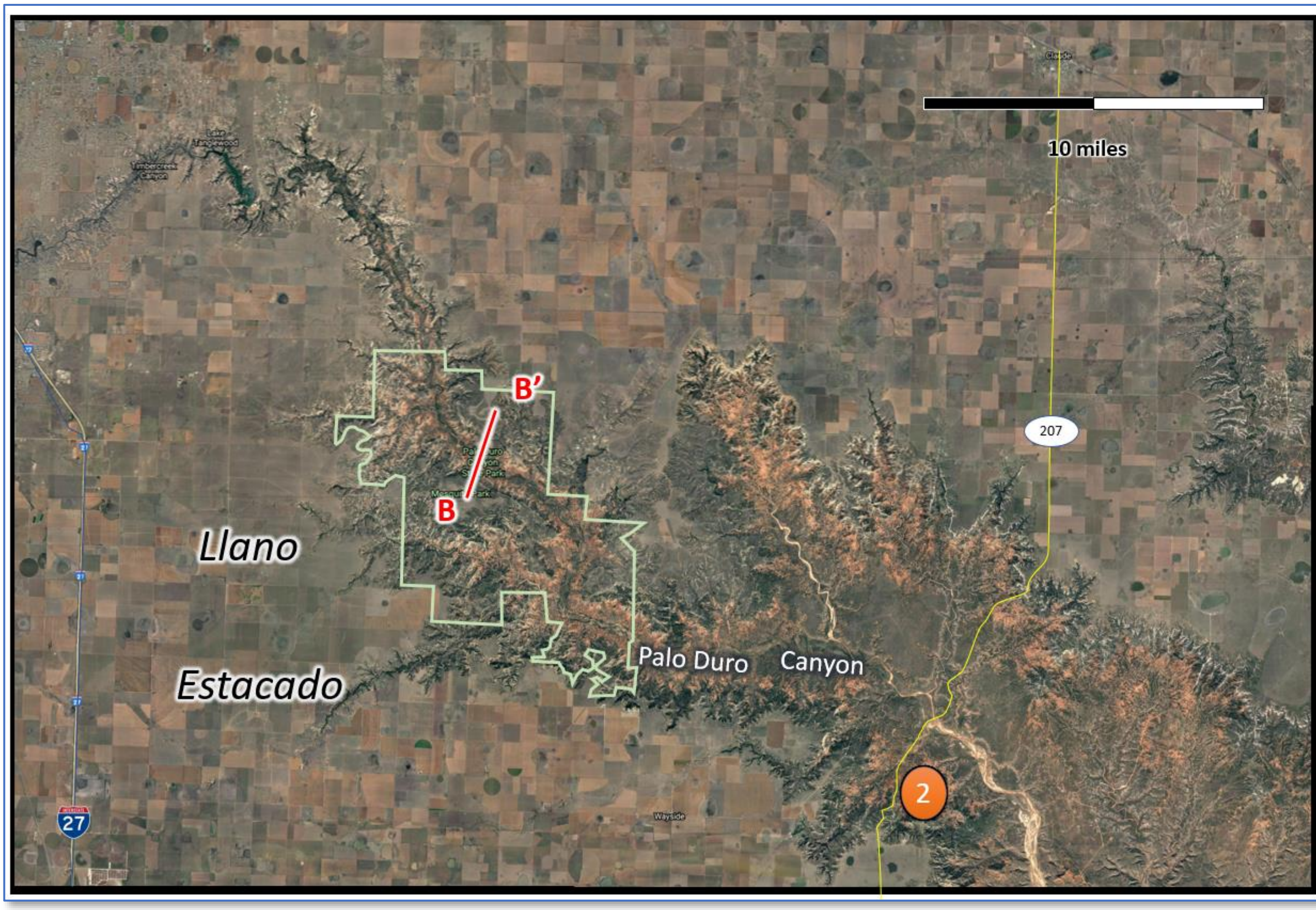


Figure 6. Google Earth view of the Palo Duro Canyon. The Palo Duro Canyon State Park is outlined in light green. The patched pattern outside of the canyon reflects the flat, highly cultivated plateau of the Llano Estacado. The canyon was carved into the Ogallala and older formation by stream erosion of the Prairie Dog Town Fork of the Red River. Much of the erosion took place during periods when the climate was wetter.

Figure 7. View of the canyon from location 2 on Figure 6.

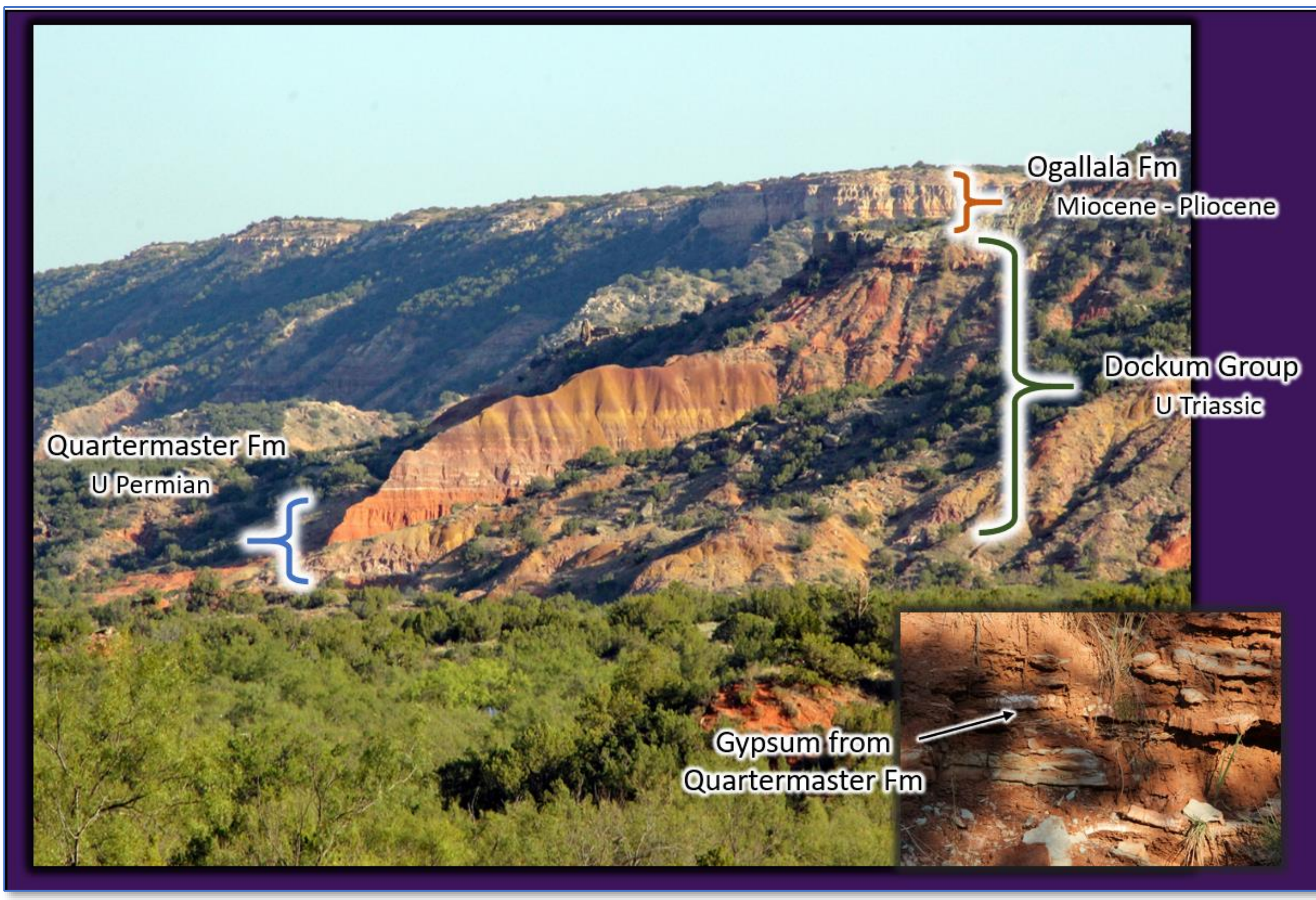


Figure 8. Photo from Palo Duro Canyon showing the Permian Quartermaster Formation and the Triassic Dockum Group

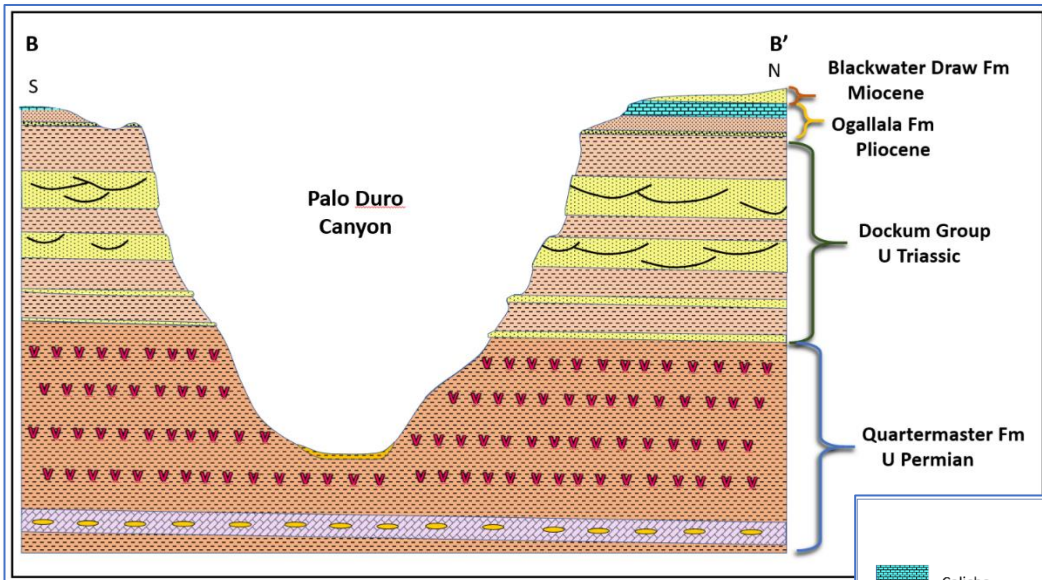
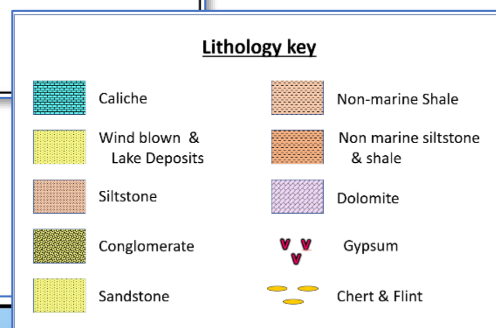


Figure 9. Profile B-B' across the Palo Duro Canyon



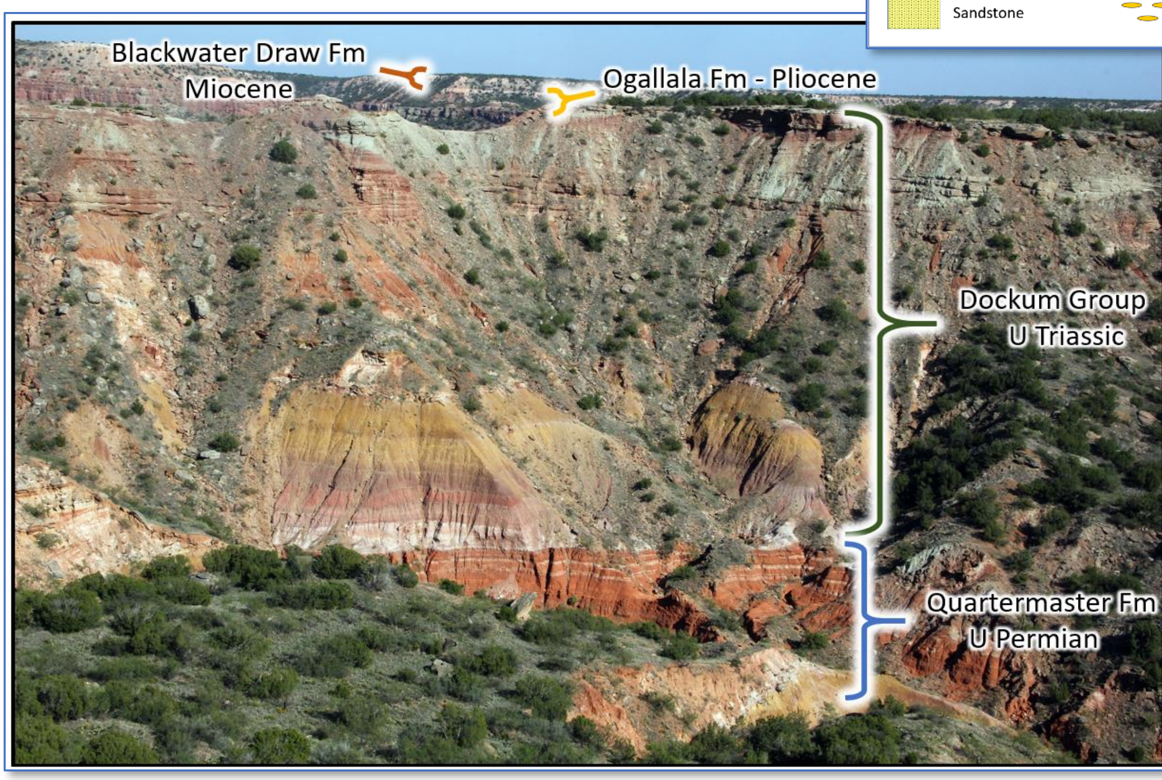


Figure 10. Photo from Palo Duro Canyon showing the stratigraphy. Both the base of the Triassic and the base of the Ogallala Formation are sharp unconformities.

Figure 11. Alibates flint. Here it is brecciated (broken into angular pieces) dolomite that was replaced by agate. In undergraduate school, one of my professors offered me the chance to cut this slab off a piece at the university that had been collected years before, when the area was not restricted. Alibates flint is quite variable in color. Often it is red from iron leached from sediments above, as silica carrying fluids moved through the sediments.

Pre-Ogallala Sediments: Mesozoic

The surface that you see in Figure 10 that separates the Upper Permian Quartermaster from the Upper Triassic Dockum Groups is known as an unconformity. In this case, it represents 25 million years of non-deposition or erosion. Non-geologists are often skeptical of wide gaps in time across such surfaces, but experienced geologists know that in other areas, thick packages of sediment were deposited that are younger than the lower units and older than the upper units. In this case, geologist recognize that over this gap, the world literally changed. All of the continents came together to form one supercontinent, Pangea. Little deposition took place on the continents because they were so high. To use an analogy from the Bible, it is like the gap between the Old Testament and the New Testament. If you want to find out what happened in that time period, you have to go outside of the Bible. Same thing here. A lot of events took place in that intertestamental period, and when Matthew begins, Judea is culturally very different. We saw that when the Permian period closed, the climate was very dry and the basin filled and the seas retreated. When the Upper Triassic sediments were deposited, the climate was humid, an unusual period for West Texas.

The flood explanation has a different kind of feature that it must explain that is located near the base of the Dockum Group over most of the L.E. At or near the base is an ancient well-developed soil, a paleosol. (Kanhalangsy, 1997). This particular soil, referred to as the "Palo Duro geosol" is 11.5 ft (3.5 m) thick with root traces, burrows and other features that we see in modern soils. It often sets directly on the Permian Quartermaster and includes pieces of the lower formation in it. The early soil developed in "well drained environments in a climate with high precipitation rates". Over time, conditions changed as the upper parts show evidence of calichification. Caliche develops as rainwater leaches carbonates from the soils but there is not enough water to move it out of the section. This will be considered in more detail later.

How long does it take to develop a paleosol? Most experts believe that it takes hundreds of years to form one inch (2.5 cm) of good soil. Kanhalangsy, 1997 said “The illuvial structures observed in the paleosol indicate that the profile required at least several thousand years to form (Birkeland, 1974).” In fact, many paleosols have been recognized through the Dockum group (May, 1988). In fact, Gratzer, 2016 recognized 15 different paleosols from the upper Dockum using a core from Andrews County, Texas. Why so many? We should expect many soils as delta plain sediments of a river system are deposited over time. How would even one soil develop during a major flood? If this was after the flood, then there is just too little time, using the YEC chronostratigraphic model.

With the Permian seas gone, the Triassic Dockum group formed as non-marine deposits. Many of the deposits are fluvial, meaning that they were formed by rivers and their associated processes. It is normally pretty simple to figure out which direction ancient rivers flowed. It is interesting that we have all of these rivers in the lower part of the Dockum flowing into the LE region from all directions (McGowen, et al, 1979). So, we have a non-marine area with sediment coming in from all directions. What kind of setting could that be? Today, we call such areas – lakes. This is interpreted to have been a large shallow lake with rivers and river deltas along the margins. The extent of the lake would have been comparable to Lake Bonneville, the large Pleistocene lake whose remnant today is the Great Salt Lake in Utah. The rivers and deltas that formed to fill the lake developed at different times and were of different types, just as we have many different types of rivers today. Such river channels continued through the top of the Dockum units. Channels are really well exposed in the sides of Palo Duro Canyon as shown in Figure 12. There we see many different channels as the stream switched back and forth across the area.

The Dockum group differs from the Permian and older sediments in another significant way. So far, we have looked at lithologies and depositional processes. The other change is in the fossils contained. Just as the people of the Old Testament had all died long before the New Testament began, so many species of animals from the Permian went extinct before the Triassic began. Wikipedia reports this regarding the Permo-Triassic extinction event, “*It is the Earth's most severe known extinction event, with around 81% of all marine species and of terrestrial vertebrate species becoming extinct. It was the largest known mass extinction of insects. Some 57% of all biological families and 83% of all genera became extinct.*” Life certainly didn’t end, but when it came back it was different.

Fossils from the Triassic Dockum Group include plants such as fern and conifer fossils, including leaves, petrified wood, spores and pollen. (Ash, 1989). The Triassic cast of animal characters include freshwater clams and snails, but also, more significantly, many larger vertebrate fossils. Bone fragments, isolated skulls and some complete skeletons have been found. The variety is impressive. For instance, Lehman and Chatterjee, 2005 report “*The Dockum tetrapod fauna represents one of the finest and most diverse Late Triassic continental assemblages found anywhere in the world*.” Fossils are found from several species of amphibians, mammal-like creatures known as cynodonts ("dog teeth"), large herbivores (Placerias), crocodile-like reptiles and other large carnivores, and primitive bird (?) (Protoavis) and of course dinosaurs. The most common dinosaurs reported are three-toed theropods. These were carnivores such as *Coelophysis.* A number of species of fish fossils are found. (Gregory, 1972). That fits well in streams and lakes. Isn’t it interesting that we don’t find any of these creatures or anything similar in the early Paleozoic rocks? We don't find them today and I hear the explanation that they just couldn't live in the post-flood environment. While that seems like special pleading to me, but regardless, it does not explain why the older rocks do not contain any of the later animals. One guppy fossil or one mammal fossil, let alone one dinosaur in those early rocks would be a major discovery. Even pollen would be a major coup. They just aren't there.

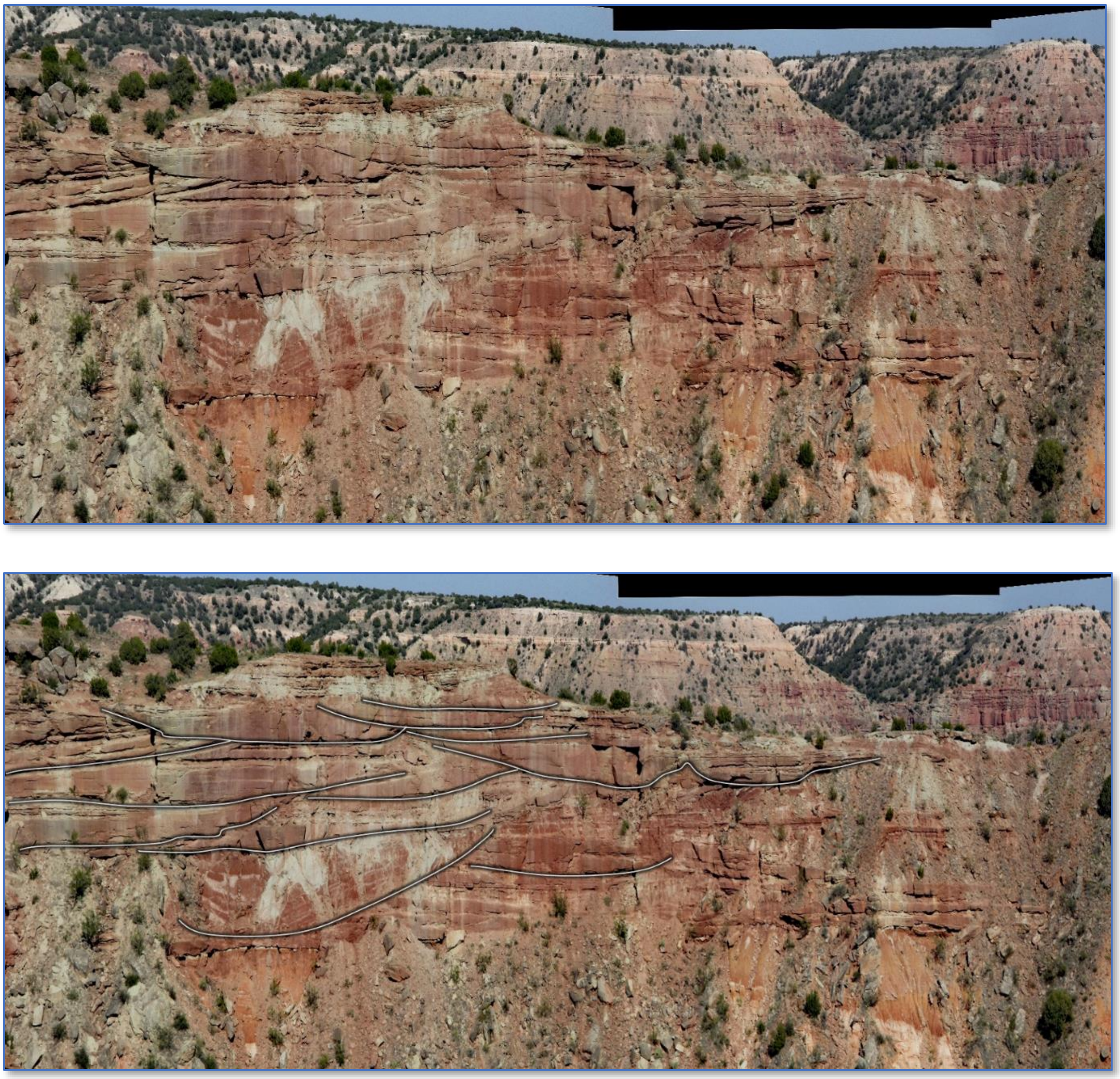


Figure 12. Triassic river channel deposits from the upper part of the Dockum Group. These photos have actually been squeezed or compressed horizontally. Depositional dips are often low, making features more difficult to see. Squeezing them or stretching them vertical makes changes in dips more obvious. (Vertical Exaggeration - 1.8:1)

Ogallala Formation: Cenozoic, Miocene - Pliocene

We have looked at the "Old Testament" – the Paleozoic Rocks. We then looked at the "New Testament", the Mesozoic rocks. Imagine a book that next included a description of the Reformation, 1500 years later. A reader unfamiliar with the history of Christianity might be pretty confused. The world would have changed and without some other source of information, the reader would miss much of the story. The same is true in L.E. region. If you want to learn about what happened after the Triassic but before the Ogallala Formation was deposited, for the most part, you will have to look somewhere else. Looking in Palo Duro Canyon, across this unconformity, modern conventional geological dating claims that the Triassic rocks are 180 million years older than the rocks sitting immediately on top of them. I have seen several YEC posts that are skeptical of this. Examples include Dr Brian Thomas (2019) in "Does Palo Duro Canyon Show Deep Time?" and Dr Tim Clarey (2018) in ""Palo Duro Canyon Rocks Showcase Genesis Flood". Dr Clarey states,

> *"The lack of any visible erosion is strong evidence that there were not millions of years between the deposition of the Triassic beds and the overlying Ogallala. Instead, we see a pattern—much like we see in the Grand Canyon—that is best explained by continuous activity. The Ogallala is conformable to the underlying Trujillo all around the canyon rim, with no tilting of the underlying units and no erosional channels carved into the boundary surface."*

Their expectations are simplifications and not valid. It is true that in many areas, the Triassic and Miocene aged sediments are essentially parallel. Apparently in the YEC mind, if this much time elapsed, the rocks should be sharply different, and maybe at very different angles. Some unconformities are like that and in fact, in places this unconformity looks more impressive, but that is often not true. The fact is that as these surfaces are carried towards the Gulf of Mexico, a thickness of over 7 miles of rock is present there that is younger than the Triassic and older than the Ogallala (Mitchell, 2018). Some material has been eroded away in the Palo Duro Canyon area, but very little deposition probably ever took place in the L.E. area over most of the early Cenozoic era. We do find outcrops with thin late Mesozoic, i.e. Cretaceous marine sediments, but even these sediments are thin. The major deposition took place in the Gulf of Mexico basin during the period missing in Palo Duro Canyon.

Fossils from the Ogallala reflect a very different set of animals than in the Mesozoic rocks. Gone are the dinosaurs and many other animal types. Probably the most common fossils are fresh water clams and terrestrial snails (gastropods) (Leonard and Frye, 1978). Among the gravels and other deposits in the Ogallala are found bones from ancient species of deer, horses, elephant relatives, rhinoceros, camels, ground sloths, cats, and peccaries (Proctor, 1980). They are typically not complete skeletons, but are still identifiable. When people think of animal tracks in rocks, they think about dinosaur tracks. In fact, animal tracks come in many, many forms. In this area, there are indeed mammal tracks. Williamson and Lucas, 1996 found a site in Chavez County, New Mexico with tracks from four species, including a split toed ungulate (presumably a grass-eating mammal), a large camel, and a small relative of dogs. The report also note mudcracks, burrows and raindrop impressions interpreted to have formed along an ancient stream. Think about why you would find these in the upper part of a major flood that wiped out all of terrestrial life. Also, why do we not find mammal tracks in any of the older units?

The oldest part of the Ogallala usually consists of sands and gravels deposited in various stream environments. The streams probably originated in what is now central New Mexico along the Rocky Mountain range that were uplifted earlier in the Cenozoic. My earliest interests in geology began with collecting interesting pebbles from the Ogallala gravels. There is an amazing variety of lithologies and forms in this unit including flints, cherts, quartzites, granite, rhyolite, gneiss, micaceous schists (that when I was young, I hoped contained gold and silver), limestone, siltstone and sandstone. (Hurst, 2009). Native American populations in the area used rocks from here for arrowheads and other uses over thousands of years.

These Miocene - Pliocene gravels demonstrate some interesting points for YEC interpretations. The rocks from which pebbles were derived were solid rocks before they were abraded and rounded into pebbles. The granites cooled and solidified. The metamorphic rocks were sedimentary beds that were subjected to heat and pressure over a long period of time. The beds were then eroded away and boulders and cobbles worn out of them. These eventually were worn down to just pebbles. Petrified wood was mentioned in the Triassic Dockum units. It also is very common in Cretaceous units. We can be sure about some of the stages in the wood's existence. We know it formed from trees that grew. We know for instance that forests grew in the Cretaceous period as particularly evidenced in Utah, (Mitchell, 2018; Dinosaur Tracks and Flood Geology (Part 2)). It spent some period of time buried while silica rich fluids moved through the sediments and replaced the original wood with siliceous minerals. At some point later, the original host rocks were worn away. The quartz made the wood more resistant to erosion and it weathered out. Over time and transport by streams, the logs and branches were worn down to small rounded fragments like the other gravel in the stream. I do not see how this can be accomplished in the YEC model. Andrew Snelling (2009) claims that "petrification by silicification" can take place very quickly. Such claims are now common online. It is true that silica can be deposited in wood quickly, but detailed cell replacement is really more complex. (Neyman, 2005). In this case, even if the wood were completely petrified in just a few years, that would still be far too long, especially for the whole chain of events that occurred. Too many events, far too little time.

Above, I described the lower part of the Ogallala as being deposited by streams or "fluvial processes". This interpretation is consistently presented in the geologic literature. YEC geologist, Dr Tim Clarey quoted above also argued that the Ogallala sandstones were not deposited by rivers in his 2018 article. He writes, "*Secular scientists claim these are deposits from rivers, but a receding mega-flood explanation better fits the broad extent of the Ogallala. How else can a blanket sand layer spread across thousands of square miles with no evidence of river channelization?*" His interpretation of the Ogallala as "blanket sand layer" does not match the observations of most observers. Locally the base of the unit does parallel the Triassic sediments below. In other areas, the base is quite erosive, as shown in Figure 14. The sands and conglomerate look very much like modern fluvial deposits from braided or low sinuosity rivers.

Figure 13. Petrified wood pebbles from the Ogallala formation. Lower left piece has been slabbed and polished.

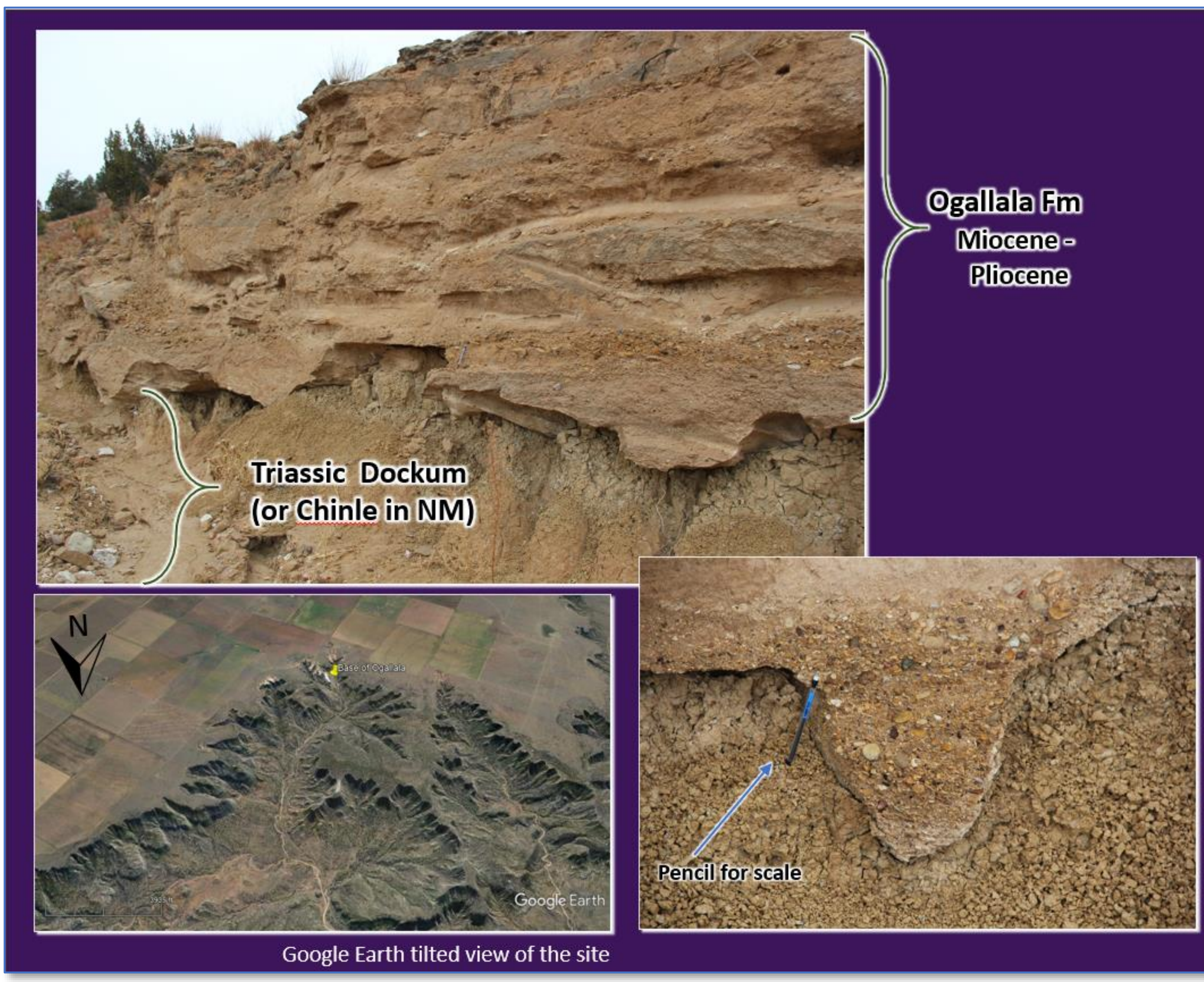


Figure 14. Fluvial sands at base of the Ogallala Formation from a location southwest of Tucumcari, New Mexico.

If we have obvious fluvial deposits at some locations, then why would they not seem evident in the Palo Duro State Park? The answer is pretty simple. Big river systems weren't located everywhere. The big rivers weren't located in the area of the state park. In this case, an ancient larger river system is well documented south of Palo Duro Canyon. The sands below the upper caliches of the Ogallala are important to this area because they are the most important fresh water aquifer. It provides vital water for drinking and irrigation. As a result, it has been delineated in detail by well control and sensing media. Figure 15 shows a map of the net feet of aquifer sand. The contours reflect the amount of sand which was controlled both by depositional processes and by the topography at the time of deposition. A well-developed sinuous river pattern is evident north of the present city of Lubbock, Texas. Dr Dale Winkler published a paper that documents the exit of this system from the L.E. (Winkler, 1990) (Figure 15). Channel geometries are well exposed and reflect an ancient river system through which an ancestral Brazos River flowed during the Miocene epoch. Figure 15 also shows the location of the Blackwater Draw site in New Mexico that we will discuss more detail later. For now, it is significant that ancient Ogallala river gravels were quarried here for many years. The Miocene river system drained from central New Mexico to the Gulf of Mexico. Sandstones from Miocene Brazos deltas have produced large amounts of gas from Offshore Texas. Thus, this particular river system could not be much better documented. Dr Carey's interpretation of a "blanket sandstone" is totally unfounded. The Palo Duro Canyon area does have far less sand thickness, as shown in Figure 15, but that is to be expected. The article, "Palo Duro Canyon Rocks Showcase Genesis Flood" has taken a small amount of data and made "blanket" statements. When more data is examined, the blanket statements turn out to be unsupportable. Every YEC argument that I have examined in any detail follow this same trend. The more you examine a claim and bring more data to bear on the question, the weaker the YEC argument becomes.

Another interesting aspect of Dr. Clarey's paper is that he interprets it as a "*receding mega-flood*" deposit. As documented in my post, "Flood Geology and the Stratigraphic Record", flood geology authors have difficulty agreeing on which rocks represent the flood. If the flood was a global event, a catastrophe as characterized by flood geologists, then it should be very evident. Apparently, that is not the case. The upper part of the Ogallala provides another "too many events, too little time" problem regardless of whether, it is interpreted as part of the flood, as per Clarey or if it is viewed as post-flood, as per Snelling (2009) and others. The top caliche (also known as calcrete, calcic soils, hardpan, or duricrust) averages at least 7 to 20 ft (2 to 6 m) thick and weathers to form a prominent ledge. (Bachman and Machette, 1977). (Figure 17). Typically, the upper 1.5 to 3 ft (0.5 to 1.0 m) is dense and well-indurated, as anyone who has ever tried to dig a posthole in it can attest.

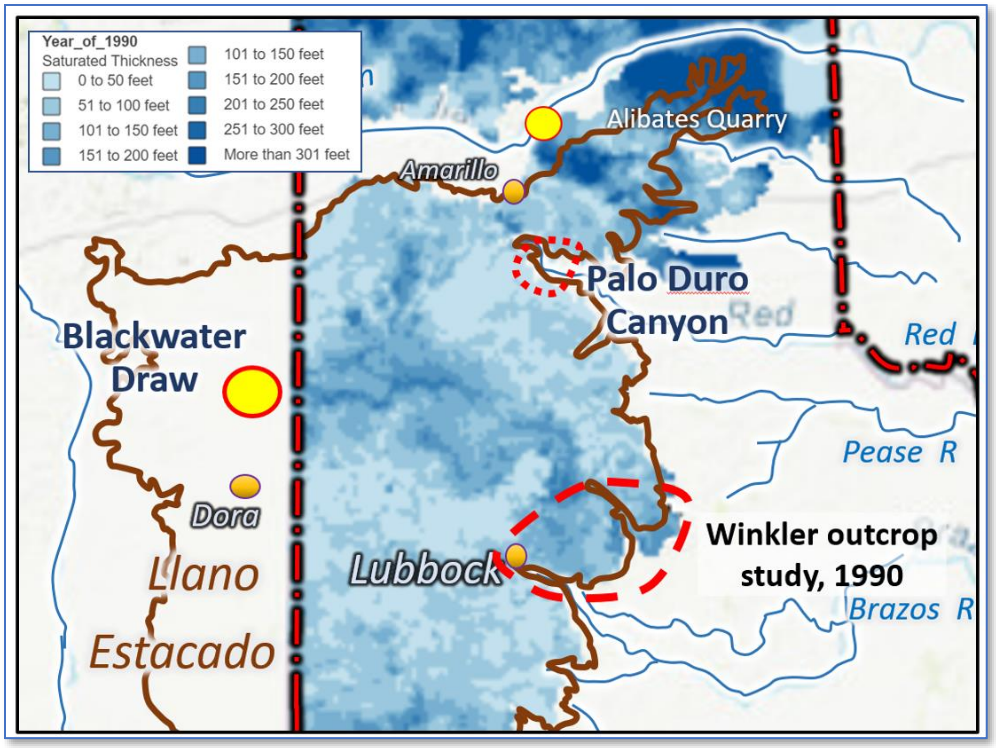


Figure 15. Saturated sand thickness map, 1990 for the Ogallala Aquifer, (Center for Spatial Technology, Texas Tech University). Darker colors represent greater thicknesses of sand. Notice the sinuous pattern of darker colors extending across the L.E. north of Lubbock Texas. Notice also the light colors in the Palo Duro Canyon area because of the thinner sands in that area as it was between the larger river systems. Another similar river system, not shown, developed south of this map.

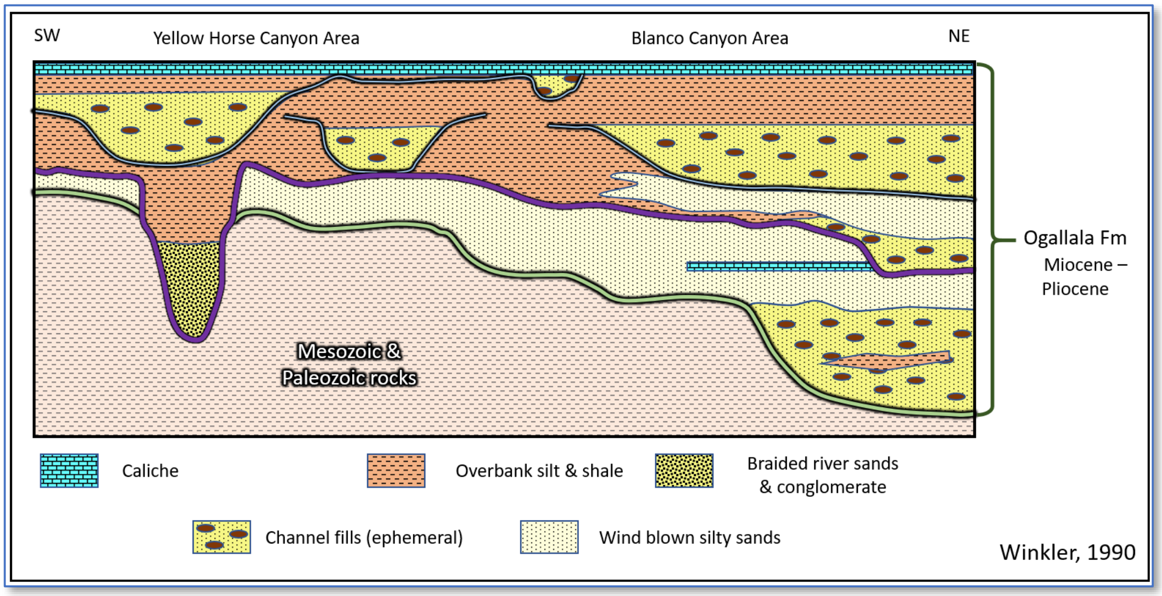


Figure 16. Schematic profile from Dale Winkler, 1990 of river channels exposed in the eastern escarpment of the L.E. in two canyons west of Lubbock, Texas.

Figure 17. Roadcut north of Crosbyton, Texas. The caliche here is very thick, indicative of a very long period of fairly stable semiarid conditions.

The development of caliche is not a mystery. Caliches develop today in soil profiles under semiarid conditions around the world. In this area, winds brought carbonate material into the area in the form of loess. Rainwater dissolved the carbonate material and moved it down through the soil. In humid climates, the carbonate would have moved down and out of the area, but in the L.E., as in many other areas, too little water was available. The carbonate moved down through the soil column and began to precipitate. Eventually the carbonate material formed blockages that develop into nodules and formed other associated features. (Figure 18)

Photos in Figure 19 show pieces of caliche that I picked up near my wife's aunt's farm, outside Elida, New Mexico. The caliche here is particularly hard and the pink coloration makes it attractive. I was surprised at how well it takes a polish. A wide range of features are found such as breccias, hardened layers that are broken up. Rounded and angular masses known as pisolites are common. They show evidence of many layers of that formed as waters percolated down through the soil many times, depositing layer after layer of calcium carbonate. All of these are consistent with a very advanced level of calichification.

Figure 18. Two views of caliche paleosols from roadcuts in Palo Duro Canyon State Park. Nodular development along soils have coalesced along layers, probably representing Bachman and Machete (1977) Stage 3 or 4.

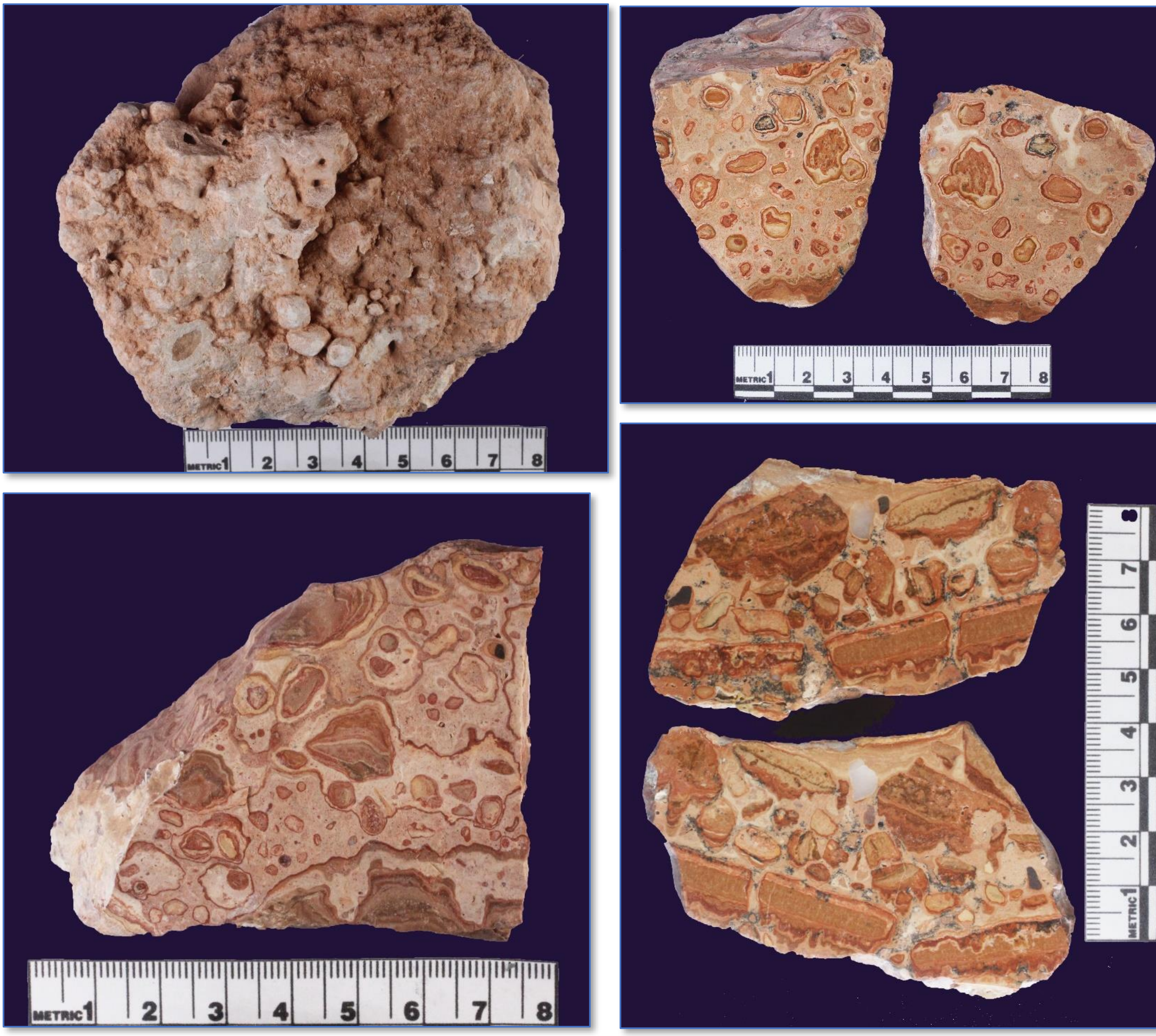


Figure 19. Caliche from Ogallala Formation, Elida, NM. Upper left sample has pisolites that have eroded out. Other samples have been cut and polished, again showing pisolitic development.

Bachman and Machete (1977) described six stages of calcrete (caliche) development showing how it advanced over time:

> *I. The first or youngest stage includes filamentous or faint coatings of carbonate on detrital grains.*
>
> *II. The second stage includes pebble coatings which are continuous; firm carbonate nodules are few to common.*
>
> *III. The third stage includes coalesced nodules which occur in a friable or disseminated carbonate matrix.*
>
> *IV. The fourth stage includes platy, firmly cemented matrix which engulfs nodules; horizon is plugged to downward moving solutions.*
>
> *V. The fifth stage includes soils which are platy to tabular, dense, strongly cemented. A well-developed laminar layer occurs on the upper surface.*
>
> *VI. The sixth and most advanced stage is massive, multilaminar, and strongly cemented calcrete with abundant pisoliths, the upper surface of which may be brecciated. Pisoliths may indicate many generations of brecciation and reformation.*

Calcium carbonate movement is the most obvious deposition from fluid movement in semiarid climates; however, silica movement also took place though at a slower pace. Chert and opal were also deposited though not as quickly and typically lower in the profile. (Reeves, 1970). Locally higher concentration of silica resulted in agatized layers in the Ogallala Formation.

It is not possible to quantify how much time each stage takes, because there are many controls involved. It is also highly likely that through time, climates changed, making the processes discontinuous. Caliches develop in so many parts of the world that much work has been done to understand what conditions were like when they formed. Reeves, 1970, described the conditions required like this:

> *"The ideal environment for caliche formation is neither arid nor humid. Too little water, as in the very arid desert regions, allows only surficial accumulations of carbonate; too much water and relief causes regional leaching of soil solubles. Therefore, the local relation between precipitation, temperature, runoff, and relief is critical."*

We find caliche deposits in many parts of the US Southwest, but many are small. The Ogallala caliche is not. It is by far the largest. Its extent and the high stage of its development demand that the High Plains were tectonically stable over a long period and that the climate remained fairly stable over such a period as well. Variations no doubt occurred. Climate change is not a new phenomenon. The variations no doubt contributed to separate calichified soils that are evident in many places.

Radiometric dating tells us that the caliches formed over several hundred thousand years (Bachman and Machete, 1977). This is consistent with all other dating evidence that we have. I have not used radiometric dating because I choose to demonstrate that the geology of regions such as this cannot be fit into the YEC flood geology model, regardless of the evidence from radiometric dating. I will discuss this more with the next unit. Regardless of the absolute dates involved or the specific duration in years over which the Caprock caliches were deposited, they just do not fit in the YEC models. If the caliches formed during the last parts of the Genesis flood, then that would mean that they formed over just days or weeks and that clearly did not happen. If they are part of the post-flood deposits, but before Abraham, then they would have formed in less than four hundred years. It is quite possible for thin calcium crusts to form quickly or for perhaps the first two stages of calcrete development as listed above, to develop over somewhat short periods, but not large regional highly indurated caliches.

Blackwater Draw Formation: Cenozoic, Pleistocene

Up to this point, one type of fossil has been absent from the discussion. We have not made any mention of evidence of human existence in any of the units. That is because none exists. All of the prior rock units were deposited before humans came to North America. The next unit sees this change. Here we see the first evidence of humans in the area. In fact, a very important site in North American anthropology is found in Eastern New Mexico. The Blackwater Draw Site, located between Portales and Clovis, New Mexico (Figure 1) proved to be key in understanding early humans across North America. It was somewhat equivalent to the Rosetta Stone in Egyptian Archaeology. The Egyptian Rosetta stone contained the same decree in three languages, Ancient Egyptian hieroglyphs, Demotic script, and Greek script. Prior to its discovery, the language of Egyptian hieroglyphics was untranslatable. The stone proved to be key in unlocking this mystery. Prior to the discovery and evaluation of the site known as "Blackwater Locality No. 1", archaeological sites were found across North America with several distinct types of arrowheads and other artifacts. Finding individual sites was important, but it was not possible to understand what was the relative age between them. Blackwater Locality No. 1 provided documentation for several different cultures in different stratigraphic positions. It was now possible to begin to place them in order.

The caliches of the Ogallala came from a very stable climate but eventually this changed. The short term (in conventional geologic time scale) glacial cycles that we experience now began in the Pleistocene. Cyclic climate changes resulted in sediment cycles. Lake sediments interfinger with dune facies across the L.E. The ancestral Brazos River extended to headwaters into the southern Rocky Mountains in the early Pleistocene just as it did in the earlier period. By the middle Pleistocene, the Pecos River extended its drainage northward to capture the headwaters of the Brazos. (Thomas, 1972). The once constant ancestral Brazos River became just an ephemeral stream known as the Blackwater Draw, extending from New Mexico to the Lubbock, Texas area.

In what is now Eastern New Mexico, Blackwater Draw formed a depression that filled with interfingered lake facies, dune facies, and spring-laid facies above the gravels of the larger river system from the Ogallala Formation. Apparently the easily available fresh water, relatively mild climate and abundant game made the area attractive for the early Americans.

The gravels from the older deposits were mined for use in construction. Reports of artifacts made it to E.B. Howard of the Philadelphia Academy of Natural Sciences and he began to work the area in 1933. (Holliday, 1997). Many seasons of work by many workers were carried out. Over much of the period, the area was actively mined for gravel. This was less than ideal in terms of the care taken, but it also meant that material was excavated much more quickly, including portions that might not have been recognized for a long time. Today the site is a national historic landmark. (Figure 20). The oldest human artifacts are assigned to a culture named for the nearby town of Clovis, New Mexico. Distinctive points are known as "Clovis Points". (Figure 21). For many years, this was considered the oldest generally accepted human culture in the Americas. Today, we see several candidates for pre-Clovis cultures that certainly existed. Afterall, the technique of making the Clovis points was developed in America by a people who were here.

Figure 20. Blackwater Draw Archaeological Site, National Historic Landmark, located between Portales and Clovis, NM.

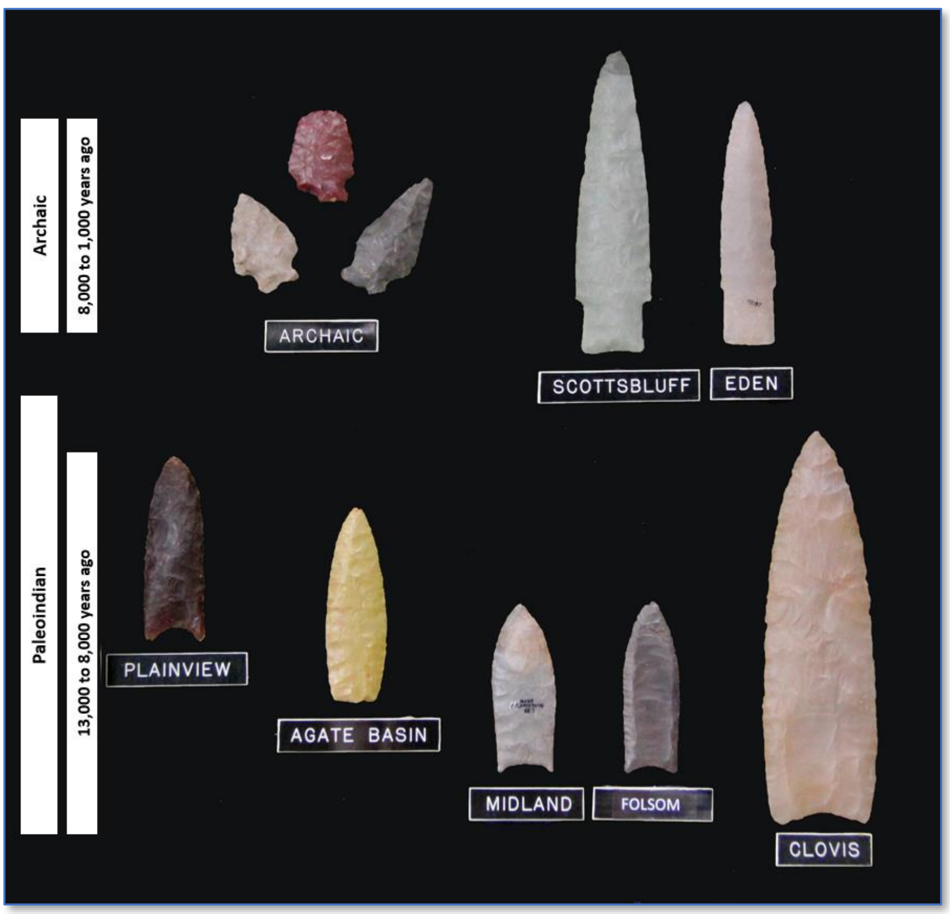


Figure 21. Arrowheads from Blackwater Draw representing different cultures. Blackwater Draw Museum, Eastern New Mexico University, Portales, NM.

Most of the artifacts are associated with hunting sites for a variety of ancient animals. "The *Clovis-age artifacts are in association with the remains of extinct Late Pleistocene megafauna, including mammoth, camel, horse, bison, saber-toothed cat, sloths, and dire wolf that were hunted by the early peoples who visited the site*." (Wikipedia). Modern big game hunters should be envious. We don't know that much about the culture, in terms of how they lived or what their spiritual ideas were.

When did all of this take place? These are the oldest units in this area that carbon-14 (^{14}C) radiometric dating is available for. Older units have been dated using other radiometric elements. Over forty different measurement techniques are used. Are dates based on radioactivity method to be believed? Validating radiometric dating in general, involves two basic considerations.

1. Is the physics that form the basis solid and well understood?
2. Is the technology and methodology adequate to give meaningful data?

Regarding the first, the decay of unstable elements is well documented and understood. The parent elements break down through a well-documented series of daughter products. The rate of this decay doesn't change regardless of extremes in temperature, pressure, electromagnetic field or gravity field. It has been suggested that it may have been much more rapid in the distant past. The decay produces heat and if it really were more rapid in the past, much more heat would have been generated. Changing the rate of decay enough to fit the YEC ages would have generated tremendous amounts of heat. It would be hard to miss this effect.

Regarding the second consideration, modern equipment allows very accurate measurements of the concentration of the elements involved. We can measure ratios in individual grains that are very stable and unlikely to have been altered by natural processes. We can often use multiple element measurements in a single rock as a cross-check and some of the methods eliminate the need to know the original concentrations. Most potential losses of the original elements would make them measure as younger than the actual age.

How about ^{14}C dating? Is it to be believed? Many nonscientists think of this method as the only form of radiometric dating, when in fact, it was not even discovered until 1949 and not used for dating until the 1960s. The method recognizes that living plants and animals have nearly constant ratios of ^{14}C and ^{12}C and that ratio is fixed at death. At that point, the radioactive ^{14}C begins to decay and the ratio begins to change. With a half-life of 5,730 years, ^{14}C dating does not help much for most of the geologic column. It can be used only for samples with ages less than fifty to sixty thousand years. While that is old enough to be a significant problem for YEC position, it does not hit much of the geologic record by the conventional timeline. This method has a well-known set of possible problems that can invalidate it, but it offers opportunities for validating it with material of known dates. While not every analysis has proven to be correct, even YEC geologist, Andrew Snelling admits that "radiocarbon 'dates' for the last 2,000 years seem to show a generally good correlation with historically verified artifacts and specimens" (Snelling 2009). It seems a bit convenient to me for a technique to be valid until it begins to give problems for the YEC position. Snelling again appeals to accelerated decay during creation and the flood. (Adapted from the Radiometric Dating Appendix in Mitchell, 2018)

The development of ^{14}C dating was timed well for investigations at Blackwater Draw. Six well developed paleosols are found at the Blackwater Draw site and this permitted use of the new dating methods. (Gustavson and Holliday, 1985). (Figures 22 and 23). Carbonaceous material was present at multiple levels, allowing the stratigraphy to be dated. The material for dating often consisted of organic rich sediments and soil samples, which are not as ideal as wood or charcoal samples, but then, as now, trees were rare. Dates range from 11,000 to 11,500 years BP for the Clovis level. Similar dates are also found for Clovis artifact levels near

Figure 22. Exhibit at Blackwater Draw Site, showing different soil levels, many of which are quite fossil rich. Clovis artifacts are found along the lowest level. The grey levels shown here have many bones preserved in them. The animals changed over time. For instance, mammoth bones were found only in the lowest levels.

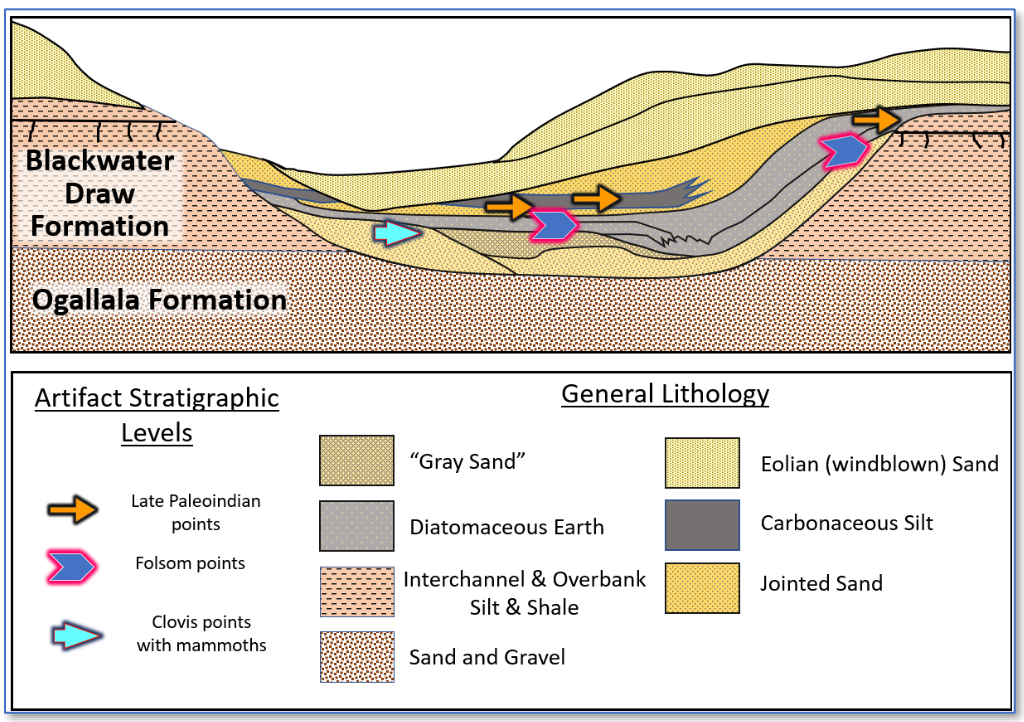


Figure 23. Schematic profile across Blackwater Draw site showing the location of some of the artifacts from early Paleoindians. Despite the complex fill, it was possible to clearly identify the age relationships between the different cultures represented. (Haynes, 1995; Holliday, 1997).

Lubbock, Texas. (Holliday, 1997). Materials have been dated for each of the levels, allowing age ranges to be estimated for each of the different cultures. In addition, other means of dating Paleoindian sites are also available. For instance, dendrochronology (tree-ring dating) is available at some sites, as reported below.

> *"A tree-ring calibrated chronology for Paleoindian occupations throughout the Plains shows that the "absolute" ages are ca. 2000 years older than the uncalibrated ages (Eighmy and LaBelle 1996). The calibration does not significantly alter the sequence of Paleoindian traditions, with one exception. The revised chronology suggests a substantial overlap in Clovis and Folsom ages. The overlap may be real, but stratigraphic data repeatedly show that Folsom followed Clovis. The calibration chronology is based on radiocarbon ages from throughout the Plains. Geographically defined subsets of the data might illuminate chronological subtleties."* (Holliday, 1996)

Tree rings provide an independent method of dating that demonstrate that the radiometric ages are generally correct. In fact, where available, tree data are considered the best data. Christian geologists, Gregg Davidson and Ken Wolgemuth's article "Testing and Verifying Old Age Evidence: Lake Suigetsu Varves, Tree Rings, and Carbon-14" shows that ^{14}C dating technology can be validated using both tree rings and seasonal lake deposits known as varves. A 2020 article provides a new attempt to reconcile all of the available Clovis site data (Waters, et al., 2020). They propose that the best Clovis data can all be reconciled to fit within a 300-year period from 13,050 to 12,750 years ago.

YEC authors all agree in considering the Pleistocene interval as post-flood deposits. In the most common model, the 6000-year-old Earth, this means that the period between the flood and the time of Abraham (~1900-2000 BC) was about 450 years (Figure 4). Modern archaeologists and anthropologists recognize many human cultures that lived before Abraham's time, including the Paleoindian cultures of North America such as Clovis and Folsom (Figure 24). In the L.E., like most of the world, only very thin deposits have been formed since 2000 BC. If there is anyone who wants to make the case that more of the section should be dated to this younger period, then the onus is on them to make that case.

Can we find a scenario that would fit the observations from this area, if we placed the top of the flood deposits at the Pliocene – Pleistocene boundary in the L.E. area? Such a scenario would require that some explanation could be found for the radiocarbon and tree ring data. Recognizing that human artifacts are near the base of the Blackwater Draw Formation, one would also have to explain how man got to the L.E. so quickly after a global flood. If Noah left the ark in the Middle East, and if man remained in that area until the Tower of Babel, then how long would it have taken for humans to migrate to this area? Evidence suggest that man migrated from the Middle East, across Asia, down from Alaska and eventually to what is now New Mexico and Texas. Perhaps a faster route could have been used. We cannot quantify how long it took, especially without ^{14}C data, but it seems reasonable that it would have taken thousands of years.

What if we were to hypothesize that somehow the scientific dating is very wrong and man moved very, very rapidly? Would the data now fit? If the first Paleoindian cultures lived 5-6000 years ago, and this was not long after Noah's flood, would we be able to account for all we find? What about points such as those in Figure 21? The spearheads and other stone artifacts were made from

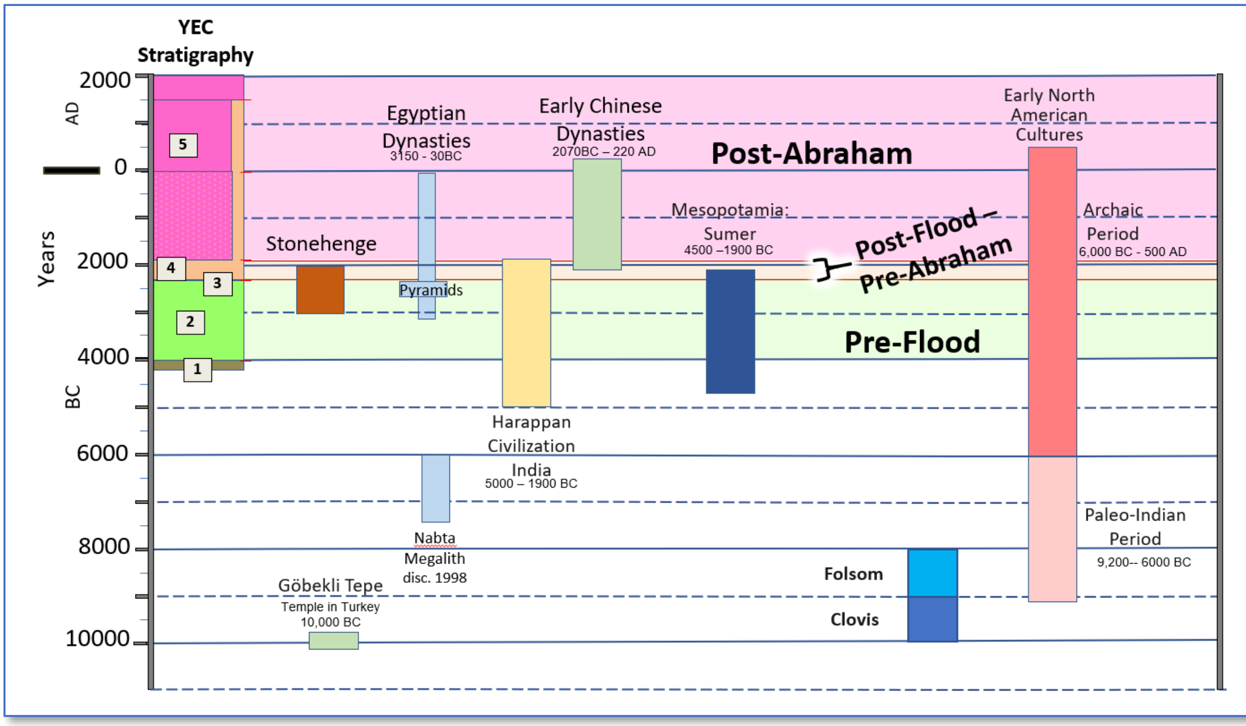


Figure 24. YEC chronology vs. various cultures around the world. Some of the dates are debated but regardless, the dating of many cultures all around the world are problematic for the YEC age model.

material that was just as hard as we find it today. When we looked at the Permian Quartermaster formation, we described the Alibates flint. Alibates flint was used by the Clovis culture for points. Beautiful material was available at the surface but it was often fractured by freezing and so the better material required digging. It was quarried in pits at the Alibates Flint Quarries over a long period of time. Alibates tools have been found as far away as Central Mexico and Montana. The flint was certainly beautiful and hard when the Paleoindians made scrapers and spear points with it. If Bowers and Reaser, 1996 are correct that the silicification of the dolomite took place during the calichification of the Ogallala, then, using the YEC chronology, even less time is available for the flint to form before man began to work it.

At the Blackwater Draw site, some of the Clovis points come from an even younger unit, the Tecovas Jasper of the Triassic Dockum Group (Quigg, et al., 2011). Even siliceous portions of the Miocene-Pliocene Ogallala are knappable (breaking in such a way as to make good points). It seems that all of the lower units below the level of the Clovis culture were lithified before this culture came into the area. What do we find in other parts of the world? We know that the earliest Egyptian and Mesopotamian cultures made use of flint. (Stevens and Hunt, 2020). The book of Exodus records that flint was used for knives in circumcision (Exodus 4:25). It is reasonable to assume that Abraham did as well.

Think about what the YEC flood model describes. It proposes that about 4,500 years ago, the Earth was covered with massive unconsolidated and unlithified flood deposits. The only hardened materials that seem likely to have been available for making tools or building would have been rocks that remained consolidated from before the flood. It really makes no sense to claim that flat-lying beds were deposited by the flood and then instantly lithified so that people could use them for building with. The flints formed as silica replaced previous materials. It would have initially been amorphous opaline sediment that had to go through several stages of chemical changes before that final agate or flint form. This had to dewater and harden over the course of time. We have no way of quantifying exactly how long this took, but it is difficult to imagine it occurring in less than many thousands of years.

Summary and Conclusions

The rocks in the L.E. tell a story of changing conditions and many different processes over a very long time. They tell us that the deposition took place far too slowly to fit the flood geology model and under conditions that would not have existed during a flood. Here are presented a few examples though many more could be given, even in this one area. Sometimes proponents of flood geology argue that the rates of geological processes were much faster than today, particularly during the period following the flood. When faced with the challenges of too many events for the time available in the post-flood period, the proponent of flood geology must do one of two things.

1. Propose a continual state of miracles, at least to the time of Abraham, that seem to serve little purpose but to confuse modern scientists.
2. Provide explanations for fast processes that would have dominated pre-Abrahamic history, but apparently ceased today.

I have not seen any YEC writings that argue for the first option. Attempts at the second option, at best, explain a few special local situations and fail overall. The units interpreted as part of Noah's flood formed by many different processes, but even a miraculous explanation would be unbelievable, not because miracles could not happen, but because if God had chosen to work through such a flood, the deposits would reflect a giant flood and its processes. That simply is not the case.

Alternative

If God chose to create the universe and life over what is often called "*deep time*", would that have been unreasonable for the God of the Bible? The idea of the universe developing over deep time means thinking of processes acting over expanses of time that are vastly different than what we experience and are difficult to grasp. Most characteristics of God, as the Bible reveals Him, are like that. We have difficulty comprehending the power of God or the love of God. Daniel gave the name of God as the "*Ancient of Days*" (Daniel 7:9). It should not be surprising that this involves more than we can easily comprehend.

Why would God have used so much time before creating man? Sometimes we act as if the only reason that God created the universe was for us. There is really no basis for this idea. God undoubtedly had many reasons, in addition to ourselves. These might even include other intelligent beings. Why not? God does not create as a minimalist. He creates with beauty and majesty that is extravagant and magnificent. The universe is that! He certainly owes us no explanation for why He chose to spend the time that He did. God may have had many purposes through geologic time, but that does not mean that mankind was an afterthought.

> *For this is what the Lord says— the Creator of the heavens, the God who formed the earth and made it, the one who established it (he did not create it to be a wasteland, but formed it to be inhabited)— he says, "I am the Lord, and there is no other.*
>
> Isaiah 45:18 (CSBBible)

Earth is finely tuned for life, but not just for simple life. More is required for advanced life and Earth was designed for it. Just as we see now, many of God's actions were not miracles in the sense of God setting aside the laws of physics in order to act. In a sense, it could be compared to the making of a movie. God serves as producer and director. He determined the overall plot and directed the actions but is normally off camera. In certain scenes, He chose to take a more active role, arranging for those in the movie to be aware of Him. At times He performed miraculous acts that demonstrated His presence. Two thousand years ago, He physically entered his production, taking the lead role, though physically on earth only for a short time. Afterward, He resumed His position, largely off camera, but active in every scene. God acting through deep time is consistent with this God who reveals Himself in creation but often in ways that only those of faith recognize.

At the start of this document, I asked you to compare the record in the rocks in the Llano Estacado region to three big boxes delivered at your door, each to contain a kit to make a large wooden clock. One box was filled through a process of careful crafting, with even precision shipping material. The second was thrown together over a few minutes. I suggested that you would be able to recognize which was which. I suggested that the deposits of a global flood would have been like the second box, while deposits over deep time might be more like the first. After considering the evidence that I have given, what do you think? I suggested that if rocks were deposited in settings and by processes that are incompatible with rapid water deposition, this would be more like the third box, containing a kitchen sink, complete with a faucet and pipes instead of clock parts. I suggest that, for example, thousands of feet of rock deposited in desert sabkha settings or as thick deposits in soil profiles would be more like the kitchen sink scenario than the wooden clock. While kitchen sink parts may not help with building a clock, they can be very useful. In the same way, while the slowly accumulating deposits from deserts or reefs or rivers did not form from a flood, they can be very useful. If there is a creator who placed people here, then He was the one who provided the means that we have utilized to develop the technology to learn about the universe that He created. We have used the stones that slowly formed, in buildings and roads. We have used the flint to serve functions for thousands of years. It also can truly be said that the technological revolution that has allowed us to explore the universe was fueled by easily recovered fossil fuels such as oil and gas. The burial of reefs and desert environments have provided reservoir rocks that held billions of barrels of such fuel. The petroleum has also enabled us to produce many other articles that are used by technology. The "staked plains", with the Ogallala aquifer beneath produce much food that helps to feed the nations – God's provision for man. Early scientists such as Isaac Newton were awed that God created a universe where the movements of the planets could be described by elegant mathematical expressions. We can also be awed that God has placed us here and provided for our needs and far beyond.

I understand that YEC and flood geologists come to their views of geology based on their desire to support their interpretation of scripture. I suggest that an interpretation of scripture that honors it and also fits the natural revelation is more likely to be valid. Elsewhere, I have presented my interpretation of Genesis, integrating scientific data. Some will not be persuaded by it, but I hope this paper will help Christians to understand that models presented by YEC to date are just not viable.

References

Akili, W, 2004, "Foundations over Salt-Encrusted Flats (Sabkha): Profiles, Properties, and Design Guidelines", *Proceedings: Fifth International Conference on Case Histories of Histories in Geotechnical Engineering, New York, NY, April 13-17, 2004.* https://core.ac.uk/download/pdf/229076171.pdf

Al-Youssef, A, 2015, "Gypsum Crystals Formation and Habits, Dukhan Sabkha, Qatar", *J Earth Sci Clim Change*, Gypsum Crystals Formation and Habits, Dukhan Sabkha, Qatar (omicsonline.org)

Ash, SR, 1989, The upper Triassic Chinle flora of the Zuni Mountains, New Mexico, in: Southeastern Colorado Plateau, Anderson, Orin J.; Lucas, Spencer G.; Love, David W.; Cather, Steven M., ed(s), New Mexico Geological Society, Guidebook, 40th Field Conference. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.587.5937&rep=rep1&type=pdf

Bachman, G0, Machette, MN, 1977, *Calcic soils and calcretes in the southwestern United States,* US Department of the Interior Geological Survey, *Open-File Report 77-794.*

Bein, A, Hovorka, SD, Fisher, RS, Roedder, E, 1991, "Fluid Inclusions in Bedded Permian Halite, Palo Duro Basin, Texas: Evidence for Modification of Seawater in Evaporite Brine-pools and Subsequent Early Diagenesis", *Journal of Sedimentary Petrology.*

Birkeland, P.W., 1974. *Pedology, Weathering, and Geomorphological Research*. Oxford University Press, New York, N.Y.

Bowers, RL, Reaser, DF, 1996, "Replacement chert in the Alibates Dolomite (Permian) of the Texas Panhandle", *The Texas Journal of Science Publisher*: Texas Academy of Science.

Center for Spatial Technology, Texas Tech University, "Geography of the Ogallala Aquifer in Texas". https://www.depts.ttu.edu/geospatial/center/Ogallala/Storymap/Index.html

Clarey, T, 2018, "Palo Duro Canyon Rocks Showcase Genesis Flood", from *Institute for Creation Research* website https://www.icr.org/article/palo-duro-rocks-showcase-flood

Collins, LG, 2006, Time to Accumulate Chloride ions in the World's Oceans – More Than 3.6 Billion Years, *Reports of the NCSE,* http://www.csun.edu/~vcgeo005/collins.pdf

Davidson, G, Wolgemuth, K, 2018, "Testing and Verifying Old Age Evidence: Lake Suigetsu Varves, Tree Rings, and Carbon-14", from *Perspectives on Science and Christian Faith*, retrieved from: https://www.asa3.org/ASA/PSCF/2018/PSCF6-18Davidson.pdf

Dutton, SP, Finley, RJ, Galloway, WE, Gustavson, TC, Handford, CR, Presley, MW, 1979, *Geology and Geohydrology of the Palo Duro Basin, Texas Panhandle*; *Geologic Circular 79-1*, Austin: Bureau of Economic Geology, UT Austin.

Elliott, LA, Warren, JK, 1989, "Stratigraphy and Depositional Environment of Lower San Andres Formation in Subsurface and Equivalent Outcrops: Chaves, Lincoln, and Roosevelt Counties, New Mexico". *AAPG Bulletin*

Fracasso, MA and Hovorka, SA, 1986, Cyclicity in the Middle Permian San Andres Formation, Palo Duro Basin, Texas Panhandle, The University of Texas at Austin, Bureau of Economic Geology, *Report of Investigations No. 156.*

Gratzer, MC, 2016, Paleosol Development and Trace Fossils in the Upper Triassic Cooper Canyon Formation of the Dockum Group in Andrews County, Texas, Sally McDonnell Barksdale Honors College, University of Mississippi. https://egrove.olemiss.edu/hon_thesis/703/

Gregory, JP, 1972, Vertebrate fauna of the Dockum Group, Triassic, eastern New Mexico and West Texas East-Central New Mexico, Kelley, V. C.; Trauger, F. D.; [eds.], New Mexico Geological Society 23rd Annual Fall Field Conference Guidebook.

Gustavson, TC, Holliday, VC, 1985, Depositional Architecture of the Quaternary Blackwater Draw and Tertiary Ogallala Formations, Texas Panhandle and Eastern New Mexico, report for US Dept. of Energy by Bureau of Economic Geology, University of Texas at Austin, OF-WTWI-1985-23

Haynes, CV Jr, 1995, Geochronology of Paleoenvironmental Change, Clovis Type Site, Blackwater Draw, New Mexico, *Geoarchaeology: An International Journal.*

Hills, JM, 1972, "Late Paleozoic Sedimentation in West Texas Permian Basin." *AAPG Bulletin.*

Hiss, KA, Williamson, DB, 2020 "Facies and Stratigraphy of the San Andres Formation (Mid-Permian) Petroleum Province, Northwest Shelf of the Permian Basin, West Texas: A Resurgent Play", presentation, GSA South-Central Section, March 9, 2020, https://labs.utdallas.edu/app/uploads/sites/39/2020/05/SC-GSA-San-Andres-presentation-PBRL-WEB-VERSION.pdf

Holliday, VT, 1997, Paleoindian Geoarchaeology of the Southern High Plains, University of Texas Press, Austin.

Hovland, Martin, Håkon Rueslåtten, and Hans Konrad Johnsen. 2014. "Buried Hydrothermal Systems: The Potential Role of Supercritical Water, 'ScriW,' In Various Geological Processes And Occurrences In the Sub-Surface." *American Journal of Analytical Chemistry.*

Hurst, S, Johnson, E, McCoy, ZM, Cunningham, D, 2009, "The Lithology of Ogallala Gravels and Hunter-Gatherer Procurement Strategies along the Southern High Plains Eastern Escarpment of Texas, USA", *Geoarchaeology: An International Journal.*

Kanhalangsy, K., 1997, Petrography, Geochemistry, and Clay Mineralogy of a Paleosol in the Dockum Group (Triassic), Texas Panhandle, MS Thesis, Texas Tech University, https://ttu-ir.tdl.org/handle/2346/22560?locale-attribute=de

Lehman, T, Chatterjee, S, 2005, "Depositional setting and vertebrate biostratigraphy of the Triassic Dockum Group of Texas", *Indian Journal of Earth System Science.*

Leonard, AB, Frye, JC, 1978, Paleontology of Ogallala Formation, northeastern New Mexico, New Mexico Bureau of Mines & Mineral Resources, *Circular 161*.

May, BA, 1988, Depositional Environments and Sedimentology and Stratigraphy of the Dockum Group (Triassic) in the Texas Panhandle, MS Thesis, Texas Tech University.

McCoy, ZL, 2011, The Distribution and Origin of Silcrete in the Ogallala Formation, Garza County, Texas, MS Thesis, Texas Tech University.

McGowan, JH, Granata, GE, and Seni, SJ, 1979, Depositional Framework of the Lower Dockum Group (Triassic) Texas Panhandle, The University of Texas at Austin, Bureau of Economic Geology, *Report of Investigations No. 97*.

Mitchell, SM, 2019, *A Texas-Sized Challenge to Young Earth Creation and Flood Geology*, Meadville, PA, Christian Faith Publishing, Inc.

Morris, JD, 2010, Evaporites and the Flood, from *Institute for Creation Research* website, https://www.icr.org/article/evaporites-flood

Neyman, G, 2005, "More Petrified Young Earth Claims" from *Old Earth Ministries* website, Creation Science Rebuttals, https://www.oldearth.org/rebuttal/icr/impact/petrified2.htm

Petryshyn, V. 2013. Stromatolites in the ancient and modern; New methods for solving old problems. Dissertation, University of Southern California.

Proctor, DD, 1980, Paleontology and Paleoenvironment of the Janes Gravel Quarry, Crosby county, Texas, MS Thesis, Texas Tech University.

Quigg, JM, Boulanger, MT, Glascock MD, 2011, Geochemical Characterization of Tecovas and Alibates Source Samples, *Plains Anthropologist.*

Reeves, CC Jr, 1970, Origin, Classification and Geologic History of Caliche on the Southern High Plains, Texas and Eastern New Mexico, *Journal of Geology*.

Ruppel, SC, Conti, RD, Dutton, SP, Fracasso, MA, Herron, MJ, Hovorka, SD, Johns, DA, Kolker, A, 1984, Stratigraphy of the Palo Duro Basin – A Status Report, The University of Texas at Austin, Bureau of Economic Geology, *Open-File Report OF-WTWI-1984-30*.

Shah and Boyd, 2018, Depth to Basement and Thickness of Unconsolidated Sediments for the Western United States, https://pubs.usgs.gov/of/2018/1115/ofr20181115.pdf

Snelling, A. 2009, Earth's Catastrophic Past, Vol. 2. Dallas: Institute for Creation Research.

Stevens, T Hunt, BV, 2020 Flint Industries at Ancient Giza, from Ancient Egypt Research Associates (AERA, http://www.aeraweb.org/news/flint-industries-giza/

Thomas, B, 2019, "Does Palo Duro Canyon Show Deep Time?" from *Institute for Creation Research* website, Does Palo Duro Canyon Show Deep Time? | The Institute for Creation Research (icr.org)

Thomas, RG, 1972, The Geomorphic Evolution of the Pecos River System, *Baylor Geologic Studies*, Waco, Texas.

Waters, MR, Stafford, TW, Carlson, DL., 2020, "The age of Clovis—13,050 to 12,750 cal yr B.P." Science Advances, https://advances.sciencemag.org/content/6/43/eaaz0455#:~:text=Thirty%2Dtwo%20radiocarbon%20ages%20on,to%20~12%2C750%20cal%20yr%20B.P.

Williamson, TE, Lucas, SG, 1996, Mammal footprints from the Miocene-Pliocene Ogallala Formation, eastern New Mexico, New Mexico Geology. https://geoinfo.nmt.edu/publications/periodicals/nmg/18/n1/nmg_v18_n1_p1.pdf

Winkler, DA, 1990, Sedimentary Facies and Biochronology of the Upper Tertiary Ogallala Group, Blanco and Yellow House Canyons, Texas Panhandle, Jn: Gustavson, T. C. (ed.*), Geologic framework and regional hydrology: Upper Cenozoic Blackwater Draw and Ogallala Formations, Great Plains*, The University of Texas at Austin, Bureau of Economic Geology.