**Digging for fossils: Publishable scientific research in paleontology by creationists**

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PhD in evolutionary biology, from Cornell University, 1970. I later retrained in geology, and have been teaching at LLU since 1969. I have taught classes in mammalogy, vertebrate paleontology, animal behavior, and Philosophy of science and origins, I have published 8 books, and conducted research resulting in over 45 published research papers.

Key words: Coconino Sandstone; fossil whales; fossil turtles; creationist research

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Abstract:

It is commonly argued that a Bible-believer could not do objective paleontological research. Is this true? Is it necessary to accept the materialistic assumptions underlying this field, in order to correctly understand the subject? Some of us have been following a different approach for several decades of successful paleontological research and publication in peer-reviewed research journals. When we approach research on a fossil deposit, we do not follow the assumptions underlying materialistic, uniformitarian theory, but simply ask: How did this happen? How did these become fossilized? How long did it take? What does the physical evidence say? This approach has consistently led to improved understanding of the fossils and their relationship to the sediments enclosing them. When the research is done with careful, quality work, answering the questions with accepted scientific procedures, while allowing the Bible to provide new insights, it results in new insights and publishable papers.

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## Introduction

In the scientific community there has been, and still is, much skepticism as to whether a creationist can be an effective researcher.

> *No creationist "has contributed a single article to any reputable scientific journal."* *Eldredge*

By the end of this paper we will see if such statements by critics of creationists are correct.

Mainline scientists, in the science that is accepted by most people today, deny that the Bible gives us true information about origins and earth history. Philosophical choices in recent centuries have brought us to this age of skepticism of God as a creator, and doubt that the Bible gives us scientifically reliable information. Even many Christians don't know what to do with this issue. Do they "deny science" and believe the Bible? Or do they accept what the scientific culture tells us, and give up their confidence in God and His Word? Neither of these is necessary.

This is a major challenge for our students and other church members. But there are answers that can encourage us to know God and trust the Bible, while we conduct careful, quality paleontology research.

## Evidence and scientific research

A basic description of how a scientist does research can be summarized as follows:

1. Observations raise interest in a particular topic

2. The initial observations suggest hypotheses to be tested, or questions to be answered
3. More observations follow, producing evidence, data, that are helpful in testing hypotheses or answering questions
4. Conclusions

Not all science follows the same thinking process. I will compare two variations of our approach to scientific study. Apples will illustrate what I will call science, type one. If I wish to know what season of the year the apples in my orchard are ripe, I begin sampling them at weekly intervals. As they grow larger, finally the taste and texture reach the state that indicates ripeness. I have collected the needed evidence, and my research is complete. This is type one science - the conclusion is based on *physical evidence*.

Here is another example of type one research; before retraining in geology I spent several years in research on the biology of squirrels, especially chipmunks (Fig. 1). An important feature of this work was that the chipmunks and other squirrels were alive, living right in front of me, and I could observe them and keep a record of their activities. My limitations in this research resulted from practical issues like my inability to follow them as they ran through the dense bushes, or climbed trees. However, the evidence was potentially all available. With persistence I could gather the *evidence* I needed to make this a solid research project.

**Figure 1**

Figure 1. Examples of squirrels. From left, a chipmunk, a Chickaree or red squirrel, and a Golden mantled ground squirrel. Photos by the author.

Compare this project with another example of research – study of ancient history, and I will call this type two research. The ancient history I am referring to goes before any human scientists were taking notes. Note the elegant sandstone arch in Fig. 2, or the columns in Monument Valley.  Do you know anyone who saw these structures form?  Do you know anyone who has seen trilobites first come into existence?

As serious Bible believers we think there were humans here when most of these events occurred.  But no one was taking notes or photographs.  Thus, we don't have a record of the processes that were occurring.  I don't have a working time machine that will take me into the distant past, and none of my friends have one.  We were not there, and we can only study the rocks and fossils *as they are now*, and try to understand what was going on long ago, when they formed.  Since we cannot observe, and gather evidence when the events occurred, this is the limitation that is characteristic of type two research.

**Figure 2**

Figure 2.  Left - Natural Arch in Rainbow Bridge National Monument, at Lake Powell.  Middle – a trilobite.  Right – Monument Valley.  Photos and drawing by the author.

Someone may respond that the difference between study of the ancient past and research on current processes is not a real difference.  We can study rivers today, and understand how they deposit the sediments that make up the ancient rocks.  Yes, we can study these processes in the modern world.  The more interesting and significant question is whether, for example, the ancient rock layers in places like Monument Valley were formed by the same processes we can observe today.   Certainly, the laws of nature functioned the same in the past as they do today.  Water no doubt never ran uphill in the past, and flowing water always had power to move surprisingly large rocks.  But that is only the beginning.

An ancient rock layer may have evidence convincing us it was deposited by flowing water, rather than in a lake, but what were the circumstances?  Was it deep water, or shallow water, and how fast was it flowing?  What was the source of sand or mud (sediment) it was carrying, and how extensive was that source? Did these processes function at a rapid, catastrophic rate, or more slowly and gradually as a normal river flows today? We do observe floods today, but in the ancient past were there floods vastly more catastrophic than what occurs today? The Bible says yes, there was a very catastrophic event with serious, global geological significance, but conventional science says no. However, no geologist was there at that time, so does science know what happened? We can gather indirect evidence about the ancient past, but direct evidence of what happened is not available to us. We can only study how things happen today, and make *assumptions* or guesses about whether they happened in the same way in the ancient past, when the circumstances were very different. Since we cannot directly observe these events, opinions and assumptions will inevitably be involved in the thinking process about ancient history. We are wanting to look beyond opinions, and know what the physical evidence actually can tell us about rocks and fossils. We do find evidence, and it may be very helpful.

I hope to convince you that an experienced scientist, guided by biblical insights into ancient history, can accomplish successful, even better, research, because of this guidance. There are actually a number of creationist scientists who are active in research, and publishing papers in mainline research journals, in biology and chemistry, and even in geology and paleontology, where the doubts are strongest about whether creationists can do valid research. I will focus on the work that I know best - research done by myself, my graduate students, and colleagues, and review three of our primary projects: study of fossil animal trackways in the Permian Coconino Sandstone in Arizona (USA), fossil whales in the Pliocene Pisco Formation in Peru, and study of fossil turtles in the Eocene Bridger Formation in Wyoming (USA).

## Fossil animal trackways in the Permian Coconino Sandstone

The Coconino Sandstone (Coconino SS) in Arizona is most prominent near the top of the walls of the Grand Canyon (Fig. 3, left). In other places it is commonly not well exposed, but it can be studied in flagstone quarries and in some eroded valleys.

**Figure 3**

Figure 3. Left - the Coconino SS in the Grand Canyon. Middle - an example of cross-bedded sandstone, from the Navajo SS (also see Fig. 8). Right – a modern eolian dune field in a California desert. Photos by the author.

The sandstone in the Coconino SS occurs as sloping layers of sand, similar to sloping sand layers in desert sand deposits (Fig. 3, right), or in some types of subaqueous sand deposits, such as in rivers or oceans. This is called cross-bedded sandstone (Fig. 3, middle). In the latter half of the twentieth century there was much discussion of whether cross-bedded sandstones originated as wind-blown sand dunes formed in deserts (known as eolian deposits), or whether they were deposited by water. The discussion finally settled on the firm conclusion that cross-bedded sandstones, like the Coconino SS, were desert, eolian deposits. This conclusion was based mainly on two considerations. The first consideration consisted of some fairly minor geological features, that can still be argued today. The other factor, I believe, was philosophical – a wind deposited accumulation of desert sand dunes would take many thousands of years to form. This fits well with the standard commitment to an earth history of many millions of years. Water deposited sand waves do commonly exist, but they can form more rapidly.

The common fossilized trackways of animals in the Coconino SS have been known for well over a hundred years. The tracks I studied were made by vertebrate animals – amphibians or reptiles (Fig. 4). Early in the twentieth century the Coconino SS was often interpreted as formed subaqueously, so the trackways were described as tracks of amphibians. Later, when the eolian origin of the Coconino SS became firmly accepted, the tracks were reassigned to reptiles, not because of convincing evidence, but because salamanders do not generally live in deserts.

**Figure 4**

Figure 4. Two examples of vertebrate trackways from the Coconino SS. Photos by the author.

In the 1970's I was introduced to these fossil trackways by Dr. Harold Coffin. I read the published papers he gave me, and was not convinced the evidence was adequate to support the hypothesis of a desert sand dune origin of these often-well-defined trackways. It seemed that some additional research was called for. My research approach is called multiple working hypotheses. Rather than choosing what I thought would be the best hypothesis, I defined several hypotheses, covering the range of possibilities. The list included some hypotheses I didn't think would be likely, but such a broad list improved my chances of thinking of how to test between these options. The Bible doesn't say anything about the Coconino Sandstone, and my goal was not to prove my favorite hypothesis (my hypothesis could be wrong), but to maximize the chances of finding the explanation that best fits the evidence; in other words, I did not begin with assumptions, which are beliefs that don't have evidence to prove them. I considered the options of tracks originating on dry sand, wet sand, damp sand, dry sand that was dampened the morning after they were made, and underwater (subaqueous) sand.

I spent many days studying tracks in the sandstone itself, in the field and in museums. The next task was to find out what vertebrate tracks of living animals were like when made on all those different substrates. Fine sand, as similar as possible to the fine Coconino SS, was used to make artificial dune surfaces at the average slope of the Coconino SS cross-beds, which was about 25 degrees. One artificial dune was dry sand, in a wooden box (Fig. 5, left), and another was in an aquarium filled with water. We used lizards and salamanders for these experiments, but salamanders were best, because they would readily walk on dry sand and underwater (Fig. 5, right). Also salamander feet produce tracks more similar to the fossil tracks than lizard feet do.

**Figure 5**

Figure 5. Left - experimental sand dune. Right: top - *Uma notata*, a desert lizard in his normal running mode. Bottom - A western newt (salamander). Photos by the author.

Many hours of such experiments indicated that tracks on dry, approximately 25-degree slopes, had very little detail preserved, because the dry sand slid downslope and covered those details. For some unknown reason, almost all of the fossil trackways go upward on the sloping sandstone layers. Underwater the sand was more stable and did not obscure the details, but left tracks with preserved features, such as toe marks, similar to the fossil tracks. Subaqueous tracks were the best comparison to the fossil tracks (Fig. 6) (Brand 1983). Does this prove the fossil tracks were made underwater? These data definitely favor the subaqueous hypothesis, but since we don't know all the conditions when the fossil tracks were made, it is risky to talk about proof.

**Figure 6**

Figure 6. Experimental tracks on fine sand. Left - underwater tracks. Right - tracks on dry desert sand. Compare these with fossil tracks in Fig. 4. Photos by the author.

There also were other types of relevant evidence. There were, in many cases, trackways that moved sideways. All toes pointed up the slope, but the trackway went across the slope, sometimes at almost a right angle to the direction the toes were pointing (Fig. 7, top). There is apparently no vertebrate animal that walks sideways like that. My suggestion is that if the animal is walking up a "dune" underwater, partly supported by the buoyancy of the water, gentle lateral currents could move the animal sideways as they attempt to walk up the dune, leaving a sideways trackway. There does not seem to be any way this could happen on a dry desert dune, as a wind strong enough to move the animal would certainly destroy any trackway evidence.

A set of experiments tested this hypothesis, in a six-foot-long flume (like an elongated aquarium) with water current moving along the flume. Salamanders in the flume walked on a bed of fine sand. A video camera recorded their movements and the position and orientation of each foot fall, and the video was analyzed one frame at a time. If the salamander moved with the current it produced a normal trackway. However, if they tried to move across the current their feet were pointed in the direction they were trying to go, while the animal drifted sideways, with the current, making a trackway that matched the sideways fossil trackways.

**Figure 7**

Fig 7. Top - A normal Coconino SS trackway (right) going upward and another track (middle, going horizontal) moving sideways across the middle of the photo. Photos by the author. Bottom – A trackway that moves to the right, then stops. Above that, another track, or continuation of the same track begins and also goes to the right.

One other type of fossil trackway was very significant. Picture animals walking across a desert. If the animals were birds, a trackway could suddenly begin as the bird landed and began to walk. Then if the bird took off, flying away, the trackway would suddenly end. This is normal behavior for flying birds, but terrestrial, non-flying animals could not defy gravity and leave the ground, ending its trackway. But it could happen if the animal was underwater. They could swim up into the water and end the trackway. We found several fossil trackways that clearly did suddenly end, or begin, with no evidence that could explain how a four-footed animal could move in this way unless it was underwater (Fig. 7, bottom). We published a paper in a prestigious geology journal, describing all these results (Brand and Tang 1991).

Several papers have been published by others, attempting to explain how these sideways trackways could occur on a desert dune that was not underwater, but they did not give any supporting evidence for their explanation. So far, I have not seen any published attempts to show how to explain the trackways that suddenly began or ended. Perhaps that is because there is no way to explain those except with animals underwater.

In study of ancient history, when we have no way to go back and observe what actually happened, it is fairly common for a model or theory, like the theory of eolian, desert sand deposits, to become deeply entrenched, and very difficult to be challenged. This is especially true if an alternate explanation, like underwater cross-bedded sand, is not compatible with the prevailing worldview. If these trackways formed under water, they do not fit into a worldview of millions of years of desert environments. On the other hand, those presumed desert environments do not fit in a global flood. Some secular geologists are clearly aware of this issue. I have heard prominent geologists, at geology annual meetings, say that ancient eolian, desert deposits, like the Coconino SS and Navajo SS are the biggest embarrassment for flood geologists.

I will mention one other, very significant, type of evidence relevant to this issue. Cross-bedded sandstones like the Coconino SS, the Navajo SS, and the De Chelly SS, occur as vertically stacked sets of cross-beds, as seen here in Fig. 8. The sets of cross-beds are separated by extensive, roughly horizontal, divisions called bounding surfaces. These repeated sets of cross-beds, separated by bounding surfaces, can easily be experimentally produced underwater, but those nearly horizontal bounding surfaces have never been seen in any of the many extensive, modern deserts. There is a published hypothesis of how such bounding surfaces form in a desert, but there is *no modern example* of this process. This ad-hoc hypothesis does not come from evidence, but is a requirement of the overall theory. The theory has to have that explanation, but there is no evidence to support it.

**Figure 8**

Figure 8. Cross-bedded sandstone in the De Chelly Sandstone formation, with sets of cross-beds separated by bounding surfaces indicated by arrows. Photo by the author.

The Coconino SS research by myself and my students has resulted in nine published research papers, even though many geologists do not like our data and interpretations.

**Fossil whales in the desert: The Pliocene Pisco Formation in Peru**

While on a visit to Peru, someone asked "do you want to see some fossil whales?" Of course, we said yes. A group of us were taken south to a range of hills, in the Atacama Desert of coastal Peru, which did indeed have many large, well preserved and articulated whale skeletons (Fig. 9). Paleontologists had been studying the systematics (identity and naming) of the whales for at least 20 years, but nobody had seriously investigated why they were so well preserved. They were buried in marine deposits of sand and diatom skeletons, and in the modern world this type of sediment accumulates on the ocean floor a few centimeters thick in one thousand years. It was assumed that the Pisco sediments were deposited in the same way. This assumption is the standard application of uniformitarian geology theory, in which ancient geological deposits are believed to have formed by the same processes, and at roughly the same rate as seen in the modern world.

No one had asked, it seems, how large fossil whales and many other well-preserved animals could have been so marvelously preserved, if buried so slowly. A few centimeters per thousand years (~ 0.005 mm/year; perhaps 10,000 years to bury a whale) – is that sufficient to prevent decay and scavenging, and preserve a whale – a whole whale skeleton? My colleagues and I do not assume uniformitarianism, or catastrophe, but just ask – how did this happen? We prefer to let the data speak for itself. Our thinking was not controlled by assumptions, so the incongruity of that slow burial and the great fossil preservation struck us right in the face.

**Figure 9**

Figure 9. A complete fossil whale in the Pisco Formation. Photo by the author.

The study of how and why animals get fossilized, and why some were not fossilized, is called taphonomy, and here was a prime subject for study of taphonomy of ancient whales. Such a research project was facilitated by recent research on taphonomy of whales that die today in the ocean. These whales are attacked by an army of scavengers, in addition to bacterial decay. Their flesh is gone in perhaps half a year, and the bones are destroyed in a few years.

This highlights an inconsistency in the uniformitarian thinking that had been involved in interpretation of this whale deposit in Peru, and other similar deposits in other places. Uniformitarian understanding will assume that the diatomaceous sediment accumulated in the ancient past, as slowly as it accumulates today. But is that compatible with the evidence of how fast a whale skeleton in the ocean today, disappears? If one of those factors contradicts the other, we can't take the one we like, and ignore the other. Did the ancient diatomaceous sediment really accumulate as slowly as it does today, or was something very different going on back then?

Thus began a decade-long study of whale taphonomy and of the sediments enclosing the whales, by myself, graduate students, and other colleagues. We recorded details of the skeleton, and its preservation, for each whale, and used high-precision GPS to document the position of each whale. This allowed accurate mapping of the location of whales. There are many thousands of well-preserved, articulated or mostly articulated fossil whales in the Pisco Formation. In our first study area there were over 400 whales in about two square kilometers. That is phenomenal! The abundant whales continue for several hundred kilometers to the south, and many kilometers west to the ocean.

Most of these fossils are baleen whales. Baleen is not bone, but is more similar to fingernails, and is essentially glued to the bones. When modern whales die, the baleen is likely to separate from the skeleton in days. Yet we found fossil baleen in many of our whales (Fig. 10). One sample of baleen was analyzed in detail, and it contained preserved protein, even though its accepted age is at about 12 million years.

**Figure 10**

Figure 10. The research team and a complete whale with a mouthful of baleen. Photo by the author.

We wrote research manuscripts and published them in quality research journals (Brand et al. 2004; Esperante et al. 2008; Esperante et al. 2015). Some of the reviewers of these manuscripts were among the most prominent of taphonomy researchers. They agreed that the excellent preservation of the whales required that the whales and the sediment enclosing them had to be formed rapidly.

Did we demonstrate that the entire Pisco Formation was deposited in a short time? Since there were well-preserved whales all through the formation, it looked suspiciously like it all accumulated rapidly, but it would take many more years of research to demonstrate that. Some evidence suggested that it wasn't all formed so rapidly. It seems likely that this formation is not from in the biblical flood, but formed soon afterward, in a still somewhat catastrophic phase as geological activity began to slow down toward the slow geological processes we observe today.

## Taphonomy of Eocene fossil turtles in the Bridger Formation, in Wyoming

In southwestern Wyoming the Bridger Formation accumulated as flood-plain sediments, adjacent to the lake sediments of the Green River Formation. The Bridger Formation is a rich deposit of vertebrate fossils, and has been studied since 1869.

Because the paleontologists are so focused on mammal evolution, the turtles have been mostly ignored. The Bridger sediments are of volcanic origin, in contrast to the diatomaceous sediment in the Pisco Formation. But there is one similarity – the Bridger Formation contains many thousands of fossils, including turtles with well-preserved, nearly complete shells (Fig. 11). There had been little study of the turtles, and essentially no taphonomic research.

**Figure 11**

Figure 11. Two fossils turtles from the Bridger Formation. Photos by the author.

My colleagues and I, and our students, began our research with questions like; were the turtles buried and fossilized slowly? Or was it a catastrophic process? Where the turtles scattered from top to bottom of the Bridger Formation, or more concentrated in only some sediment layers? Geographically, were the abundant turtles in local, concentrated accumulations, as was assumed by previous researchers, or were they deposited in more of a basin-wide process, covering hundreds of square kilometers? The available paleontological literature did not address most of these questions, so we had plenty of unanswered questions to pursue.

One question was answered fairly soon: the turtles are concentrated, vertically (stratigraphically) in a few layers, with no turtles between these layers (Fig. 12). Turtles that have not already been exposed by erosion have complete shells. This indicates they were intact when buried, so they were rapidly buried. Experimental studies of turtle disarticulation indicated that each concentrated layer of turtles was buried within a maximum of 5 months after death (probably sooner). Each turtle layer was indeed a catastrophic concentration of turtles, with up to several hundred turtles per hectare.

**Figure 12**

Figure 12. The Devils Playground, a research site with several catastrophic turtle layers, above limestones. Photo by the author.

The Bridger sediments came from a volcanic source to the north, in the area of Yellowstone National Park. Some sediment came south as wind-carried volcanic ash (tuff), but most sediment was also carried by water flow, while it was altered to clay, silt or sand. The turtles were always in a few meters of mostly clay sediment, right above a limestone layer deposited in a water body. The limestone layers were separated, vertically, by about 10-30 meters of water-deposited sandstone or other sediment, with no turtles. This indicates a repeating sequence of events. By the time we finished the project an explanation of this sequence seemed clear. A large number of turtles were in a water body, and an episode of volcanic eruptions to the north killed the turtles and buried them rapidly. The volcanic episode continued as a large amount of volcanic sediment was carried by water flow to the south. This episode finally ended and a water body again accumulated in the basin, and more turtles again moved in. During this process, many mammals, other reptiles, and some birds were also buried and fossilized. These included articulated skeletons and isolated bones. There are many unanswered questions about the taphonomy of these other fossils.

During our research, Dr. Paul Buchheim, a Loma Linda University geologist spent time aiding us with detailed analysis of the sediments. One of the reviewers of our manuscripts, a world expert on vertebrate taphonomy, commented in her review that our papers were a good example of the benefits of a taphonomist and a sedimentologist working together (Brand et al. 2000).

A summary of our taphonomic conclusions so far, is that with each volcanic episode, thousands of turtles were killed and buried fairly rapidly, but not immediately, in the sediments above a limestone. If they had been buried immediately they should have had skulls and limbs fossilized with the shell, which was not the case. Turtles and other vertebrates in the nearby Green River Formation, were all buried as complete, articulated skeletons. Why these two formations, of the same age, are so different taphonomically, is a fascinating puzzle.

It is important for paleontological research, for the sediments to be geologically mapped. This means to trace each rock layer and map its location. Only if this is done, is it possible to know if fossils in a particular layer are the same age (were deposited at the same time) as fossils in another layer miles away. This information is of critical importance for those seeking to understand the history of the animals. Even though the Bridger Formation is a rich source of vertebrate fossils, and should be an excellent subject for those who study evolution, the Bridger sediments had not been mapped, even after a century and a half of study. The limestones are useful stratigraphic marker beds, and are the logical layers to map. I suspect they were not mapped because in the literature it is claimed that the concentrations of fossil turtles represented local ponds and marshes, and if so, it would not be possible to map them over a large area.

We also needed to know if the limestones could be followed, and mapped, over a large area. We did not assume the concentrations of turtles were local water bodies, and began following limestones across the landscape. It became evident that if we don't make assumptions, and diligently follow the limestones, even through difficult terrain, each limestone can be followed and mapped over essentially the entire basin of several hundred square kilometers. These were not local water bodies, but a very large lake..

One other question we would like to answer, if possible. In addition to the rapidly formed turtle layers, was the rest of the Bridger Formation formed rapidly and catastrophically? To address this would be a very major task, and if the data indicated all rapid deposition, that paper would never be accepted for publication, because it would contradict deeply held scientific beliefs and assumptions about earth history.

There are a few bits of evidence that we find intriguing. Radiometric dating points to an average of 200,000 years between limestones. If that were true, why are there no turtles in the layers covering those 200,000 year periods? The types of sediment between the limestone layers represent habitats very suitable for the Bridger pond and river turtles. Why are they not there? The most likely answer, I suggest, is that there was very little time, not 200,000 years, between the successive limestones, with their accompanying turtle mass mortalities.

## Conclusion

The examples described above, and the list of published papers in the appendix, show how false are the claims that creationists can't be effective scientists. Those of us who do this research, find that when we allow the biblical account to open our eyes, to look beyond accepted assumptions (with no proof), we see significant things that others have overlooked. As described above, in the study of the Coconino Sandstone, we don't close our eyes to the explanations accepted by other researchers. Rather, we openly compare all the options – those that seem most consistent with the Bible, and other explanations. The Bible does not close our minds – it is the opposite.

Most scientists only accept, and actually are only aware of, explanations consistent with accepted long-age assumptions. We don't have to be afraid of evidence. We contrast our biblical viewpoint and the mainline scientific viewpoints, and this gives us a broader perspective, comparing different interpretations. That is what opens our eyes to see what others have often overlooked. When we do this, it becomes evident that the biblical view of earth history is the most accurate one. We offer this as an encouragement to believe that God – the greatest geologist of all time – has told us about the history of life and history of the earth.

There is a lot of written material, videos, and other helps that we can use to give church members a more accurate and encouraging understanding of these controversial and challenging issues. The written papers in this published series are a beginning, and there is a wealth of additional material, described in the separate document called *Origins Resources*.

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## APPENDIX 1, PUBLICATIONS BY CREATIONIST GEOLOGY-PALEO RESEARCHERS, IN MAINLINE RESEARCH JOURNALS

The names of journals are in italics

*BENCHMARK PAPERS IN GEOLOGY*

Brand, L. R. 1983. Field and laboratory studies on the Coconino Sandstone (Permian) fossil vertebrate footprints and their paleoecological implications. W. A. S. Sarjeant, ed., *Benchmark Papers in Geology*, 76:126-139.

*CURRENT TOPICS ON TAPHONOMY AND FOSSILIZATION*

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**Appendix 2.  Figures**

Figure 1

Figure 2

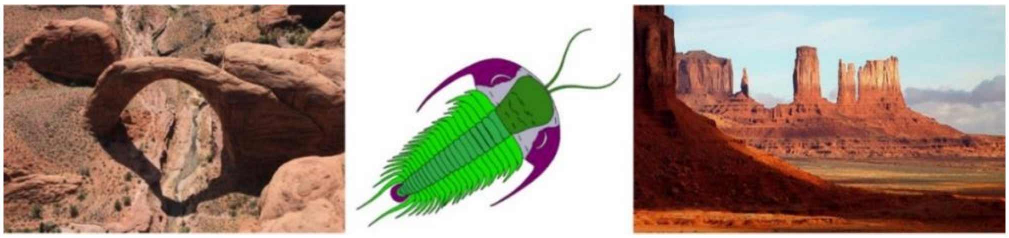


Figure 3

Figure 4

Figure 5

Figure 6

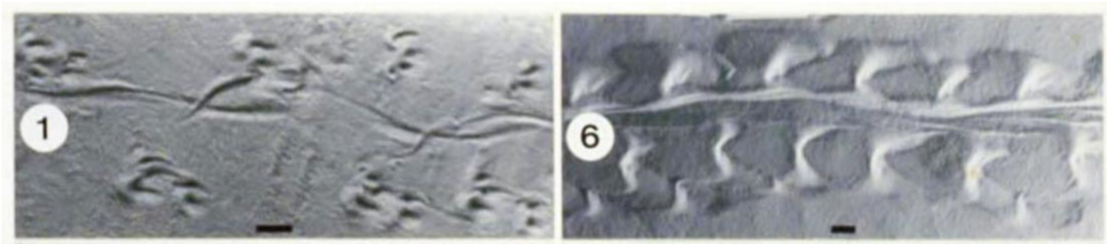


Figure 7

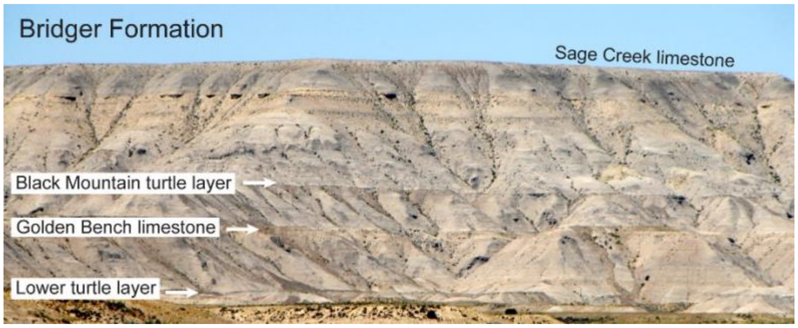
Figure 8

Figure 9

Figure 10

Figure 11

Figure 12


Bridger Formation
Sage Creek limestone
Black Mountain turtle layer
Golden Bench limestone
Lower turtle layer