Is the K/T the post-Flood boundary?—part 2: paleoclimates and fossils

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Three further evidences commonly presented for the Cretaceous/Tertiary (K/T) boundary being the location of the Flood/post-Flood boundary are: (1) the Tertiary cooling trend, (2) Tertiary mammals of the western United States, and (3) Tertiary bird and mammal tracks and the Devils corkscrews. However, a close analysis of these suggests that they raise more questions than they answer, supporting the idea that the end of the Flood corresponds to the Late Cenozoic.

In part 1,[1] I documented that among creationists there are several major Flood models with variable ideas. For the time being and in face of many geological and geophysical unknowns, such a situation is healthy, according to the principle of multiple working hypotheses.[2] Such differences are no more apparent than in the different ideas on the location of the Flood/post-Flood boundary and the extent of post-Flood catastrophism. This boundary is an important boundary and much research should be expended to locate it, assuming the geological column for sake of discussion.

I have developed eleven criteria with which to determine the boundary[3] and I have about two dozen more to add—all saying the same thing: that the boundary is in the late Cenozoic. These criteria are based on an assortment of field studies, literature research, and geological deductions. Of the three main boundary positions proposed within the geological column, the Carboniferous boundary in the recolonization model[4] has been analyzed and found to have many problems.[5] The K/T boundary hypothesis, which states that the Flood/post-Flood boundary is at or a little above the Cretaceous/Tertiary boundary in the geological column, is much more popular than the Carboniferous boundary.

How well is the K/T boundary model supported? Six main evidences are used to support the hypothesis and these are listed in table 1. In part 1, I analyzed the first main evidence used to justify this hypothesis, a change from global/continental to regional/local sedimentation and showed that it has many problems as a boundary defining criterion. In part 2 here, I will analyze the next three evidences that are sometimes claimed as support for the K/T boundary hypothesis.

The Tertiary cooling trend

Those who support the K/T as the Flood/post-Flood boundary point to published paleoclimate reconstructions of a cooling trend during the Tertiary. They argue that such trends would not have occurred during the Flood but only afterwards.

Uniformitarian scientists 'know' so much about the climates of the past that they can "postdict" a warm Cretaceous and early Tertiary followed by a gradual cooling to the cool Pleistocene. Cooling led to about 30 late glacial/interglacial oscillations in the late Pliocene and Pleistocene,[6] or Quaternary. On land, temperature trends are based mainly on fossils, but in the oceans, oxygen isotopes are correlated to temperature (figure 1).[7]

On land within the continental interiors, Cretaceous and Tertiary subtropical and tropical plants and animals have been found at high latitude.[8,9] The best known are the early Tertiary subtropical trees found on Axel Heiberg Island in the Queen Elizabeth Islands, Canada, at 80°N,[10] and the alligators and lemurs on adjacent Ellesmere Island.[11] Because the leaf layers are relatively undecayed at both the *bottom* and top,[12] they cannot be a soil profile, but are better explained by deposition from floating vegetation mats during the Flood.[13–15]

Moving south, we find warm-climate flora and fauna in the interior of North America. Early to mid-Tertiary fossil crocodiles are found as far north as southern Saskatchewan.[16–18] A tropical cycad fossil was found in the early Tertiary of northeast Washington,[19] and other tropical and subtropical plants are found in the mid and late Tertiary of eastern Washington and western Idaho, associated with the Columbia River Basalts.[14,20,21] Other examples have been documented.[18,22]

Heating during the Flood makes it reasonable for creationists to conclude that after the Flood the oceans were warm from top to bottom and pole-to-pole, but cooled with time.[23–26] This transition from the post-Flood to modern ocean temperature distribution is the basis for a rapid post-Flood Ice Age.[23,24]

However, the opposite would have been true of the continents after the Flood. Their interiors, especially at mid and high latitudes, would have experienced cold winters, even if the altitude was low and the ocean surface temperatures were warm.[27] The reason for such cold winter temperatures in these areas is because temperature depends mainly upon the *angle* of the sun and presumably this has not changed since the time of the Flood. Winters with low sun angles would have been cold. Sloan and Barron stated:

> "Eocene and Cretaceous climate-model experiments demonstrate that regardless of conditions of warm polar oceans, differences in pole-to-equator surface-temperature gradient,

> or topography, above freezing temperatures in winter for continental interiors at middle to high latitudes cannot be maintained."[28]

Those are the facts, despite efforts by some geologists to solve the 'problem'.[29–33]

In a post-Flood Ice Age, winters would have been warmer than today due to onshore flow of warm air, heated by a warm ocean, and the release of latent heat from condensation after copious oceanic evaporation. However, summers over continents would have been cooler because ash and aerosols would have blocked sunlight. Given these constraints, how could post-Flood tropical and subtropical animals live in the interior of mid latitude continents and at high latitude after the Flood? It is more reasonable to see these as Flood deposits and place the boundary in the late Cenozoic.[12,34,35]

What about the Tertiary cooling trend in the oceans? Since ocean-bottom sediments are mostly dated by microfossils, especially foraminifera, it is possible that the inferred temperature is too warm, since recent discoveries of foraminifera recrystallization have been reported.[36–38] The recrystallization in question does not show up under a binocular microscope, and SEM analysis of these forams is not routine. Results suggest a temperature up to 15°C cooler for foraminifera that inhabit the surface water since recrystallization occurred deep in the ocean, which is much cooler than the surface. At present, we do not know how much of the Tertiary cooling trend is a result of misinterpreting foraminifera data.

Table 1. Evidence used to support the K/T boundary proposal.

1. Change from worldwide/continental to local/regional sedimentation
2. The Tertiary cooling trend
3. Tertiary mammals of the western United States
4. Tertiary bird and mammal tracks and the Devils corkscrews
5. Tertiary volcanism in the northwest United States
6. The cooling of ocean basalt while the continents rise

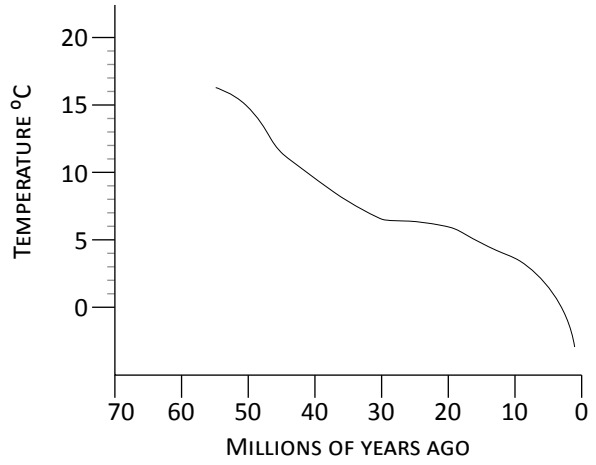

Figure 1. Inferred Tertiary cooling curve for the bottom of the ocean off Antarctica based on oxygen isotopes of benthic foraminifera from Deep Sea Drilling Project sites 277, 279, and 281 (drawn by Melanie Richard).

Even if the foraminifera temperature data turn out to be correct, they can still be explained by the misdating of the deep ocean sediments. In other words, 'Tertiary' sediments in the deep ocean might be later than 'Tertiary' sediments on the continents and continental shelves.[39] Terrestrial 'Tertiary' mammal fossils may be relics of the Flood and continental shelf sediments deposited by the Retreating Stage of the Flood.[40] But deep-sea sediment microfossils, especially foraminifera, may be post-Flood fauna. The presence of ice-rafted debris (if this interpretation is correct) as old as the middle Tertiary in deep ocean sediments suggests that they are younger than commonly assumed.[41]

Tertiary cooling trend partly based on circular reasoning

There is an element of circular reasoning in the oceanic and continental cooling trend during the Tertiary. This is because, if the date of the strata can be changed or is poorly known, geologists will sometimes date a Tertiary paleoflora or paleofauna based on its probable temperature preferences. For example, fossil plants in the western Sierra Nevada were at first dated as Pliocene in the late Tertiary (a cool period), but were later dated as early Tertiary based on the subtropical Chalk Bluffs fossil plants.[42] This change in dates was obviously due to the warm climate aspect of the fossils.

Another example is the redating of the sediments containing the Axel Heiberg fossil 'forests'. Because of abundant spruce cones found in the formation, the sediments were at first 'clearly' dated as late Tertiary, since spruce implies a cool climate:

> "The occurrence of abundant cones of *Picea banksii* [a spruce], together with the microflora in these deposits, however, clearly indicates they are correlative with the upper member of the Beaufort Formation on northern Banks Island and on Meighen Island and are of Miocene (?) early Pliocene age [late Tertiary]."[43]

This type of spruce dated the Beaufort Formation of the western Queen Elizabeth Islands as late Tertiary.[44] But the discovery of the warm-climate, mummified trees in the eastern Queen Elizabeth Islands changed the date to early Tertiary, although there are spruce cones that look like *Picea banksii* in the leaf litters.[45]

If, on the other hand, the date of the strata is considered 'solid', and they find cool aspect fossils in the warm early Tertiary, these fossils are placed in a cool oscillation during that period. More commonly, if warm-climate fossils are found in the cool late Tertiary, they are attributed to a "warm oscillation". For instance, there are many areas that have subtropical to tropical fossil plants at mid and high latitude during the late Tertiary.[22,46–49] Ralph Chaney dated the

Mascall Formation, which is above the John Day Formation, as upper Miocene during a warm oscillation, based on the warmer aspect of the plants in the Mascall Formation than in the Bridge Creek fossil plants of the stratigraphically lower John Day Formation.[50]

Circular reasoning can be shown by the analysis of the many fossil-plant sites in Oregon and Washington. For instance, the age of the Lyons fossil plants of northwest Oregon was simply pigeonholed into the mid-Tertiary (Oligocene) by its mix of subtropical and temperate varieties when compared to the fossil plants at other sites:

> "The Tertiary of western North America experienced a climatic cooling trend as this period progressed … The age of the Lyons flora is based upon *comparisons* made with the distribution of the same plant species in other Tertiary floras, as shown in the correlation charts (Tables 4 and 5). It is most probable that the age of the Lyons flora is equivalent to the age of those floras which contain the largest number of species in common with it [emphasis added]."[51]

The circular reasoning in the dating of the Lyons fossil plants is evident.

In the John Day Country of north central Oregon, the Clarno Formation was dated as early Tertiary because of its tropical elements. Chaney wrote:

> "The Clarno formation, an eruptive series of tufaceous lenses, is referred to the Eocene [early Tertiary] on the *basis* of its large-leafed evergreen [tropical] plants [emphasis mine]."[50]

He goes on to say that the John Day Formation is dated as upper Oligocene to Lower Miocene:

> "… as judged by the Bridge Creek flora and associated mammalian faunas. This temperate assemblage has been recorded from many other localities in western American and in Eurasia."[50]

The circular reasoning is especially evident when they then look back and state that the fossil plants support the Tertiary cooling trend. For instance, Chaney stated:

> "Miocene and Pliocene [late Tertiary] floras of California and Oregon are made up predominantly of genera still living in the United States; those of the earlier Oligocene and Eocene [early Tertiary] are now restricted largely to low latitudes. A change from subtropical to temperate climate is indicated in western America during the Tertiary, a change which may be noted in other parts of the Northern Hemisphere as well."[52]

In summary, the climatic aspect of a fossil plant is used as a major criterion by which to date the fossil and hence the rock formation in the Tertiary. But if the rock is already 'well dated' a 'short cool period' is introduced into the warm early Tertiary and a 'short warm period' is introduced into the cooler late Tertiary. Then they turn around and teach us that the Tertiary was a time of cooling.

Tertiary mammals of the western United States

A third evidence used to support the K/T boundary hypothesis is the presence of Tertiary mammal fossils, found mainly in Rocky Mountain basins and on the High Plains of the western United States. Since Tertiary sediments are considered much later than marine Paleozoic and Mesozoic sediments, advocates reason that the mammals must be the progeny of those animals that survived on the Ark, and thus, post-Flood.[53]

Tertiary mammals are found in the high intermountain basins in the western United States and in High Plains strata. That is not in question. The problem instead is the basis for dating the rocks as Tertiary. Since 'Tertiary' sedimentary rocks are marked by 'Tertiary' fossils, there is an element of circular reasoning, similar to that used in any evolution-based dating scheme. It is of some interest that 'complex' mammals are now being found in the mid to late Mesozoic.[54]

There are many unknowns. One is the geography before and during the Flood. The assumption seems to be that it was largely similar to today's in order to deny any refuge early in the Flood before death and fossilization. But the reality is that we do not know exactly what the region was like before the Flood or early in the Flood. The tremendous work of the Flood is the wild card. It is even possible that the present ocean basins may have been the pre-Flood continents and the current continents the pre-Flood oceans—a view espoused by the late Roy Holt and other creationists.

Another possibility to explain the mammal fossils would be the existence of high areas on the current continents during the first 150 days of the Flood until the Bible says that all the land was covered by water. Ongoing tectonics would cause rapid elevation changes of which we are not yet certain, resulting in land appearing as well as disappearing. Animals surviving in the water for a short time, possibly on vegetation mats, could then have disembarked onto these newly-emerged refuges, only to be killed and buried later in the Flood.

The same problem exists in regard to Mesozoic dinosaurs. Proponents of the K/T Flood boundary assume that these terrestrial animals were buried late in the Flood, based on their acceptance of the geological time scale. (This view is a problem since the Mesozoic has billions of dinosaur tracks and millions of dinosaur eggs, which imply live dinosaurs that must have perished by Day 150.[55,56]) But this becomes a double standard. It is all right for dinosaurs to survive inundation for a period of time and not be buried until the 'Mesozoic', but the same explanation for mammals is not valid.

Another logical difficulty presents itself to the K/T position. If mammalian fossils indicate post-Flood deposition, then where are the mammals that should have been buried in the Flood? It is true that more and more mammals are being documented in Mesozoic rocks, some quite complex,[54] but the number of mammals is still relatively small. Thus, mammals are mostly missing from the Flood fossil record (according to the K/T boundary view).

Table 2. Summary of evidence against mammals from the western United States being from the post-Flood period.

1. Cannot say that there were no mammal refuges early in the Flood
2. Vertical uplift could cause temporary refuges on the current continents early Flood
3. There is a similar problem with the dinosaurs of the Mesozoic
4. There would be very few mammal fossils buried in the Flood while a huge number were buried and fossilized after the Flood in presumably smaller post-Flood catastrophes
5. How are the Tertiary mammal changes to be explained?
6. Big problem explaining mammal extinction after the Flood
7. Ignores the abundant evidence that the boundary is in the late Cenozoic

Most people would expect a substantial mammalian fossil record from the Flood and the 'Tertiary' provides it. This is another inconsistency in the K/T position: they find few mammals from the Flood, but find massive numbers from 'post-Flood catastrophes'. Would these post-Flood processes have even had the ability to permineralize fossils like those in the Flood?

The original proposition of Whitcomb and Morris in *The Genesis Flood*[57]—that mammals would flee to higher land during the early Flood catastrophe and hence would be buried later—remains both cogent and reasonable, especially given the same phenomenon observed in the Cayman Islands during Hurricane Ivan. An aerial survey of Grand Cayman revealed that the only sign of activity on the ground were animals congregated on *higher ground*.[58] Similar behaviour would be expected from mammals at the onset of the Flood, making them the last group of animals to be buried and fossilized. Likewise, mammals may have lived at higher elevations than reptiles and amphibians before the Flood. Their warm-blooded nature and fur would have made them more suitable for higher altitudes—again, we are indebted to Whitcomb and Morris and others for the concept of ecological zonation.

If we are to accept the chronology of the geological time scale, then K/T boundary advocates must be able to explain the *order* of 'Tertiary' mammal fossils. Why did the titanotheres, an extinct rhinoceros-like beast, live soon after the Flood only to be later replaced by other mammals? There are more odd-toed ungulates (hoofed mammals such as the horse, tapir, and rhinoceros), called perissodactyls, than even-toed ungulates (such as deer, bison, and antelope), called artiodactyls, in the early Tertiary.[59] That trend is reversed in the late Tertiary. Why would we see such a temporal distribution of animals that existed at the same time after the Flood? More troubling is the variety of Ice Age mammals, such as woolly mammoth, ground sloth, etc., that are *not* found until late in the record.

Another problem with the K/T boundary theory is the extent of extinction among mammals after the Flood. How would this happen at a time when mammals were filling the earth and migrating across continents to fill the various ecological niches? Why did the titanotheres become extinct right after the Flood, while woolly mammoths disappeared only hundreds of years after the Flood? I could multiply examples, but the point has been made. Localized post-Flood catastrophism must be able to explain the massive mammal extinctions around the world in the order of extinction inferred from the geological column, all within a few centuries after the Flood. These mammals were selectively spread across time in a manner not consistent with the post-Flood world.

Finally, there is abundant positive evidence for the late Cenozoic Flood boundary (late Tertiary or early to mid Pleistocene). It is important to assess all the evidence, not select evidence that is appealing or familiar. If the proponents of the K/T boundary model do not believe the evidence for a late Cenozoic boundary, it is up to them to refute the evidence that has been presented,[3,34,40,60] but this has not been done.

In conclusion, there are multiple problems with the K/T argument that mammals in high intermountain basins and the High Plains were buried post-Flood. These are summarized in table 2.

Tertiary bird and mammal tracks and the Devil's Corkscrews

Bird, reptile, amphibian, and mammal tracks are found in Tertiary sedimentary rocks in the western United States,[61] such as the Eocene Green River Formation in Utah. Cat-like tracks are found in the Eocene Clarno Formation of central Oregon, and bird and mammal tracks are found in the Pliocene and Miocene of southeast California and northern Arizona. Tracks of birds and mammals are also found in the Tertiary of Europe.[62] One of the most interesting ichnofossils of the Tertiary is the unique corkscrew-shaped burrows in Miocene sedimentary rocks in western Nebraska, called the "Devil's Corkscrews" (figure 2).[63,64] The discovery of beaver fossils in the burrows demonstrates their origin. It is argued that these features could not have formed during the Flood, so they must have formed post-Flood.

Because of the highstand during the middle stages of the Flood, these 'Tertiary' tracks must be made either during the Flooding Stage (up through Day 150) or after the Flood—there are only two choices. Tracks are one of Tas Walker's defining criteria for the Flooding Stage of the Flood.[65] Debate over whether all animals were killed during the first 40 or 150 days of the Flood continues, but I accept the latter as the maximum allowable time for terrestrial life to exist outside the Ark, at the end of the Flooding Stage.[66,67] If the tracks are not post-Flood, then they must have been made during the first 150 days. That conflicts with our template of the geological time scale which supposedly assures many that the Tertiary was late in Earth's history, and therefore must represent late- or post-Flood times.[68,69]

Assessing the evidence for either choice requires defining criteria.[3] These were not only defined, but have

been used to analyze late Tertiary mammal tracks and fossil features from Ashfall Fossil Beds State Historical Park in northeast Nebraska, as shown in table 3.[70] Some features of the Ashfall site indicate a post-Flood environment, but other features indicate fossilization by the Flood. In addition to the eleven criteria, other criteria provided a preponderance of evidence for a Flood interpretation, including: (1) the amount of erosion in the area, (2) the presence of warm-climate animals, (3) the lack of typical Ice Age animals, and (4) the likelihood of the nearby Nebraska Sand Hills being early Flood deposits—Flooding Stage.

This type of analysis can be applied to other Tertiary deposits. If it is true that these Tertiary deposits were actually formed early in the Flood, then it demonstrates a very important principle for diluvialists—that we cannot rely on uniformitarian dates or the location of geological units in the geological column for identifying Flood stages. Clearly, we cannot assume that the Tertiary sedimentary units are late- or post-Flood just because they have been assigned near the top of the geological time scale. Creationists must develop and apply our own stratigraphic criteria for each geologic unit.[71] The time scale cannot simply be compressed into a year and taken as the sequence of the Flood. Sedimentation during the Flood was probably more catastrophic at the beginning, diminishing after Day 40 and certainly less after Day 150.[72]

Some creationists seem to forget that the Retreating Stage of the Flood, Days 150 to 371, would have been primarily an *erosional* event, especially in the rising terrain of the western United States (figure 3). With local exceptions, there is no reason to expect a strong depositional signature in that region (and others like it) after Day 150. In fact, Holt called the period the "Erodozoic".[73] Given the potential energy of the gradient and volume of water, this erosional event would have removed large parts of sedimentary rocks deposited in the *Flooding Stage* of the Flood (figure 3). If this inference is correct, then the extant sedimentary rocks, even those *at the present day surface*, would represent rocks deposited much earlier in the Flood. Some of these rocks are dated by secular geologists as Tertiary, creating a major disconnect between the time scale and the true history of the Flood. Like dinosaur tracks, bird and mammal tracks, as well as the Devil's corkscrews, represent animal activity during the Flood, before Day 150.[34,41] Such tracks were made on "**b**riefly **e**xposed **d**iluvial **s**ediments" (BEDS) during fluctuations in relative sea level during the Flooding Stage.[55,56]

Table 3. Environmental deductions for the Ashfall Fossil Beds State Historical Park based on the eleven diagnostic criteria.[3]

Diagnostic Criterion	Environmental deduction
Thin, widespread sediments	Flood
Huge volume	Flood
Lithified sediments	Post-Flood
Permineralized fossils	Post-Flood
Thick, pure coal seams	Not applicable
Widespread and/or thick evaporites	Not applicable
Tall erosional remnants	Not applicable
Planation surfaces or pediments	Flood
Long-transported cobbles and boulders	Flood
Water and wind gaps	Not applicable
Part of continental margin	Not applicable

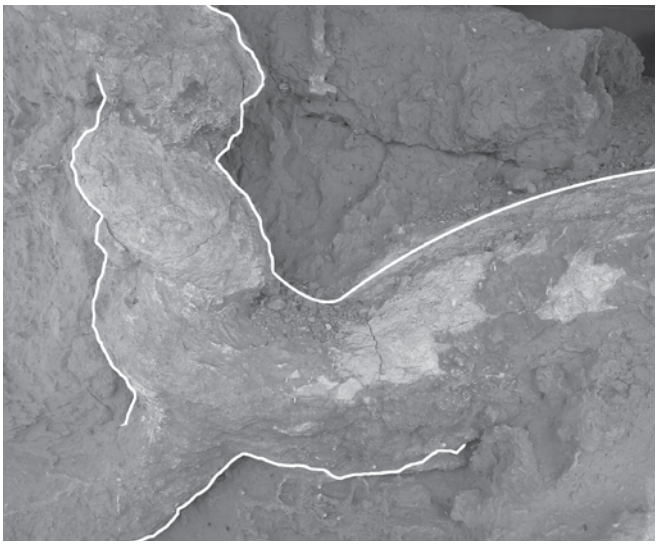

Figure 2. Devil's Corkscrew from Agate Fossil Beds National monument, western Nebraska, USA.

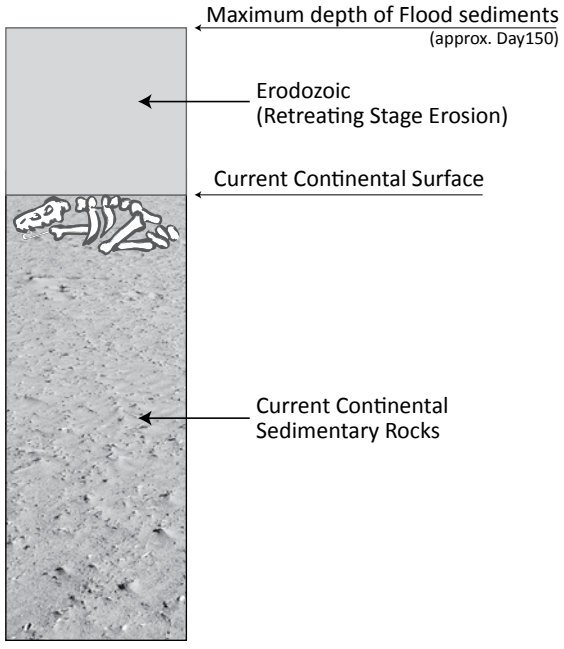

Figure 3. A simple block diagram showing the current continental sedimentary rocks with the volume of sediments eroded after Day 150, the 'Erodozoic', during the Retreating Stage of the Flood (drawn by Melanie Richard).

Conclusion

The K/T boundary has been considered a logical location for the post-Flood boundary. Six lines of evidence have been suggested to support that position, three of which have been analyzed in this paper. The Tertiary cooling trend is subjective, and largely based on uniformitarian paleoclimatological assumptions, which advocates of the K/T as the post-Flood boundary are happy to question for 'older' strata, but not for the Tertiary. The abundance and diversity of mammal fossils in the Tertiary, and lack thereof in 'older' strata, suggests the Tertiary is the majority of the mammal fossil record from the Flood. Mammal and bird ichnofossils in the Tertiary mirror Mesozoic dinosaur tracks, and are likely made on BEDS (briefly exposed diluvial sediments) during the Flood, similar to the dinosaur tracks. Placing so many fossils post-Flood, as K/T advocates do, relies too heavily on dubious uniformitarian assumptions (which they throw out in reference to "older" strata) and ignores the most obvious solution within a biblical Flood model for the origin for so many fossils. Two final evidences suggested for the K/T boundary hypothesis will be analyzed in part 3.

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