Geology indicates the terrestrial Flood/post-Flood boundary is mostly in the Late Cenozoic

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Dr Marcus Ross's recent article on the location of the Flood/post-Flood boundary is based on problematic paleontological data provided by secular paleontologists. His conclusion that the only significant paleontological discontinuity is at or near the K/T boundary is disputable, as are its three underlying assumptions. Geological arguments are preferred, being clearer and more objective. Fourteen criteria, mostly geological, indicate that the end-Flood boundary is in the Late Cenozoic, and examples include the Messinian salinity crisis 'evaporites', the Absaroka Volcanics which contain the Yellowstone fossil 'forests', Miocene coal, sedimentary rocks in the Hanna Basin of Wyoming and the incredible South Caspian Basin, the erosion of the valley fill sedimentary rocks in the Bighorn Basin, the African planation surface, and the sheet transport of gravel off the south-central Asian mountains to surrounding basins.

Creationists have long debated the location of the Flood/post-Flood boundary relative to the geologic timescale (figure 1). Four primary suggestions are: 1) in the Precambrian, 2) in the Late Paleozoic, 3) near the Cretaceous/Tertiary (K/T), and 4) in the Late Cenozoic. There are a number of reasons for this wide divergence of suggestions, especially: a) a lack of geological, geophysical, and paleontological information; b) premature conclusions that the Flood could not produce certain features, usually influenced by secular ideas of their origin; c) the related problem that practically all data sets are interpreted within the evolutionary, uniformitarian paradigm; and d) the sheer volume of potentially relevant data. Clearly more research is required, as is a better understanding of how and where questionable assumptions of uniformitarian geology have exercised undue influence.

Therefore, I welcome Dr Marcus Ross's new argument for the boundary being at or near the end of the Cretaceous, based on the lack of a Cenozoic paleontological break for North American mammals.[1] Using the Paleobiology Database, Ross makes a case that 27 out of 28 mammal families, and 23% of the genera, in North America pass upward through the Pliocene/Pleistocene boundary. This, he argues, is much less significant than the strong paleontological discontinuity near the end Cretaceous between dinosaurs and ammonites of the Mesozoic and the mammals of the Cenozoic.

Ross argues that if the Flood/post-Flood boundary were at the Pliocene/Pleistocene boundary and the pre-Pleistocene mammals were deposited by the Flood, it would be improbable that post-Flood mammals would migrate to the very place where their pre-Flood ancestors lived on the western North American portion of Rodinia. It seems like a good argument, but it has problems on many fronts, including a misplaced confidence in the evolutionary/uniformitarian Cenozoic fossil arrangement, and the failure to consider clearer geological data.

Should there be a major paleontological discontinuity?

Ross simply assumes there should be a significant paleontological discontinuity at the Flood/post-Flood boundary, but this starting assumption in Ross's argument need not be the case. Before the Flood, there likely would have been a great variety within each kind of mammal. These mammals all died and presumably were buried in the Flood with each mammal kind starting out with only two representatives. As the varieties within each kind expanded in the post-Flood period, one would expect that these post-Flood mammals would walk on top of their dead ancestors buried in Flood sediments. Many of the Flood-buried and post-Flood mammals should be similar and so there need not be a paleontological discontinuity at the Flood/post-Flood boundary.

Where are the mammals, assuming the K/T boundary?

One major problem with the K/T boundary as the Flood/post-Flood boundary is that few mammals dying in the Flood were preserved, while so many that died after the Flood were preserved. Theoretically, the Flood should provide a much

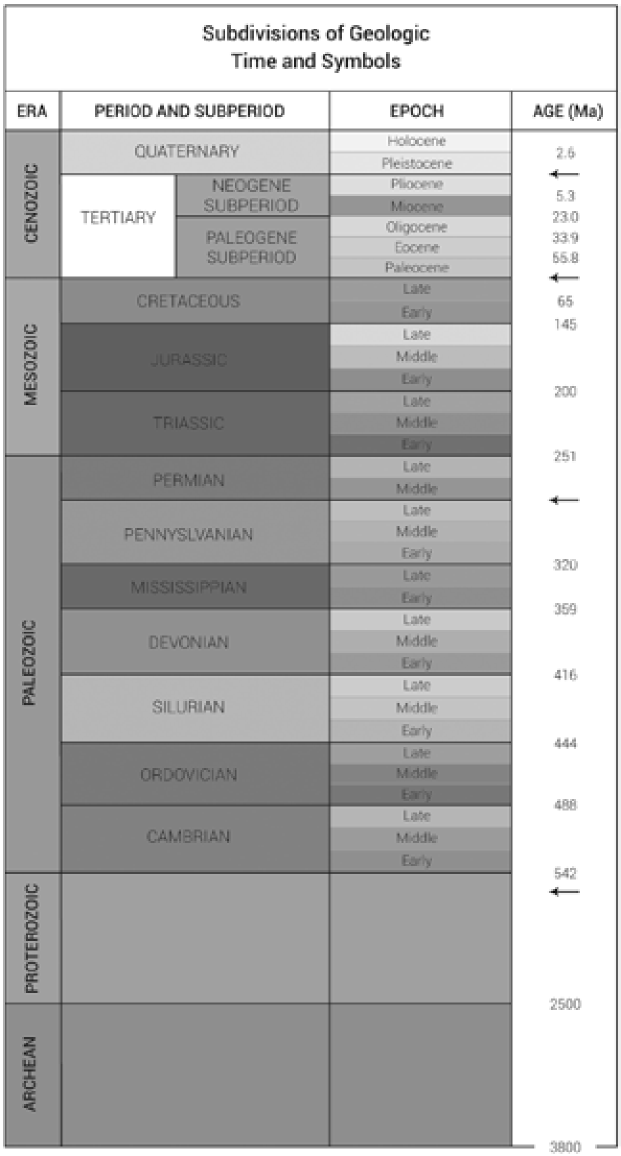

Figure 1. The Geologic Column with the four boundary locations.

better global setting for deposition and preservation of fossils than limited and local post-Flood processes.

A second major problem with the Cenozoic being post-Flood is how the supposed order of the mammals over time is to be explained. Clearly, the evolutionary explanation is not a viable alternative for creationists. Climate changes, such as the transition from a warm, dry climate to a cool, moist climate are not valid determinants of fossil succession, since both kinds of climate would have existed in local or regional areas throughout the Cenozoic. Details need to be provided on how such a climate change can result in the observed fossil order. Furthermore, since fossil successions are often dependent on correlation from one area to another, we need to know whether the correlation criteria are, or are not, compatible with biblical history.

Why we cannot trust paleontological data

Ross's argument stands specifically on paleontological data as derived from the Paleobiology Database. This raises several problems for creationists. First, it assumes *precise* dates, which in turn assume reliable methods and an accurate template in the geological timescale. Since creationists disagree, at a minimum, with the geochronology of the timescale and with the various methods that support it, the dates of the Paleobiology Database must be viewed with skepticism. Furthermore, since stratigraphers agree that the bedrock of geological dating is the evolutionary progression of life through time, then another layer of skepticism must be added.

Moving to the empirical side, creationists have demonstrated the unreliability of radiometric dates.[2–4] They have also shown that fossil dating methods, even granting evolutionary succession, are highly subjective.[5–7] For instance, there are taxonomic manipulations,[8] different names are given to the same or very similar organism when found in strata of different ages, out of order fossils are explained away by reworking or redating the strata, and lastly the range extensions of fossils continually expand. I have reported dozens of fossil range extensions over the years in this journal.[9–21] Dr Carl Werner learned by interviewing museum paleontologists that there is frequent mixing of fossil animals and plants of different ages. Though rarely reported, these problems can be found in museums or at least in their archives.[22] John Woodmorappe presented evidence that ammonite biostratigraphy is a subjective exercise.[23] Tammy Tosk showed the pitfalls of dating by foraminifera fossils.[24] It seems that the biostratigraphic record is not quite as certain as we are led to believe.

Moreover, stratigraphers have the uncanny 'ability' to make many dating systems agree; the results show a precision beyond the state of the art.[25] I believe this 'precision' is based on shared convictions stemming from a shared worldview that allows the subjective manipulation of dates and fossils. Marvin Lubenow showed how five radiometric and fossil dating schemes all agreed on the date of Leakey's 1470 skull at about 2.9 Ma. But when paleoanthropologists claimed the skull was much younger, the dating methods were refigured to about 1.8 Ma.[26] In other words, there is too much circular reasoning, and too much room for adjustment in both dates and fossil successions, with regard to, for example, with dinosaurs and iridium anomalies at the K/T boundary.[27–30] All these problems lead to questions about the paleontological discontinuity found there, and its relation to the end of the Flood, particularly in light of other paleontological discontinuities earlier in the rock record that would be from the Flood. In particular, it seems that the perennial problem of circular reasoning is found in the Cenozoic fossil successions in order to show an evolutionary sequence.

Ross's assumptions

It is always worth examining the assumptions underlying any argument, and those made by Ross are particularly interesting. I challenge his assumption that advocates of a late post-Flood boundary invariably set it at the end of the Pliocene, or the Blancan/Irvingtonian boundary in the NALMA (North American Land Mammal Ages) system. For example, some creationists do not recognize the geologic timescale as a global template of time.[31] I do not believe that it is such except in a general sense.[5–7] We must remember that the stratigraphic boundaries are subjective names with chronostratigraphic placements based on the evolutionary/uniformitarian system. The Pleistocene is not the stratigraphic equivalent of the post-Flood Ice Age, or any other post-Flood events.[32] There can be thousands of feet of Pleistocene sedimentary rocks in various places on Earth not associated with the Ice Age (see below), and that would be difficult to explain by post-Flood processes. The late Roy Holt provided abundant evidence based on many criteria that the post-Flood boundary would be better placed in the Mid Pleistocene, assuming the geological timescale.[33] Therefore, the Pliocene/Pleistocene boundary *per se* should not be seen as a potential post-Flood boundary.

A second assumption made by Ross and shared by uniformitarian paleontologists is that fossils are representative of the location and environment in which they lived and died. In this case, he assumes that Cenozoic mammal fossils in western North America represent Cenozoic conditions at those locations. Ross, accepting the Flood but with an end at the K/T boundary, posits mammal migrations from the Ark landing site, across Asia and the Bering Land Bridge, and down into North America. An alternative view is that fossils were sorted and transported by the flood—possibly over long distances—before being deposited and buried. Ross's Cenozoic mammals could have been transported to their present locations, and thus would not represent a specific vertical time sequence of evolving environments. The fact that many fossils are disaggregated bones and fragments suggests transport, and the reality of the Flood suggests the potential for long-distance transport, as well as burial in sedimentary environments completely divorced from the homes of these animals.

Third, Ross assumed that the mammals of North America would be representative of global conditions. This may or may not be the case. Animals associated directly with the Ice Age are obviously post-Flood. Those not associated with the Ice Age may or may not be associated with the Flood. Although it is difficult in any case to explain all post-Flood faunal distributions, such as marsupials in Australia, endemic animals on Madagascar, and flightless birds on Pacific islands, other animals seem to be more *cosmopolitan* than their supposed Cenozoic ancestors. Ice Age animals lived over much of the non-glaciated areas of the Northern Hemisphere. Horses, for example, are found to have inhabited the entire northern hemisphere during the Ice Age, and horses would be expected to walk on the strata containing horse fossils from the Flood. So, why focus exclusively on western North America?

Ross's evidence

Ross presents geological criteria for a K/T post-Flood boundary, based on previous work by Austin, Wise, and others.[34] These include the idea that Flood strata would be transcontinental while post-Flood strata, such as the Cenozoic strata within the basins of western North America, would be more localized.[35] Table 1 shows six arguments previously analyzed in this journal.[36–38] I have previously shown that no strata are truly continental, while some Cenozoic strata are more widespread, deposited in regional settings.[36] The point is that a mechanism is still needed to erode, transport, deposit, and re-erode Cenozoic strata. What is the post-Flood mechanism? The Flood can deposit *both* widespread strata and more regional or local strata.

Table 1. Six postulated evidences that the Flood/post-Flood boundary is at or near the K/T.

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

Geologic evidences for a Late Cenozoic boundary

Because of the shortcomings of the Paleobiology Database and evolutionary biostratigraphy, I believe that the post-Flood boundary should primarily be determined from a broad range of geological criteria, including 14 lines of evidence listed in Table 2.[39] There are more. Individual lines of evidence can show local exceptions, which is why multiple criteria should be applied whenever possible. Most geological evidence supports the end of the Flood sometime in strata that secular geologists call Late Cenozoic. Creationists who believe the post-Flood boundary is at or near the K/T need to address this range of contrary evidence. To date, no detailed refutation of these criteria has been published. Furthermore, they need to explain the biblical basis for post-Flood catastrophism required to deposit thick sequences of Cenozoic rocks in many areas, particularly the continental shelf deposits. Included in this explanation would be the reasons for the absence of human documentation of these catastrophic events, since they would have occurred along side human resettlement of major continental areas.

Since I have briefly mentioned examples for several of these criteria,[39] I will amplify the arguments previously presented and add more examples.

Table 2. Fourteen criteria that show the Flood/post-Flood boundary is in the Late Cenozoic.

1	Thin, widespread sedimentary rocks
2	Huge volume of sedimentary rocks
3	Lithified sediments
4	Permineralized fossils
5	Thick, pure coal seams
6	Widespread and/or thick 'evaporites'
7	Tall erosional remnants
8	Planation surfaces
9	Pediments
10	Long transported resistant rocks
11	Water gaps
12	Wind gaps
13	Continental margin sedimentary rocks
14	Fossils from a much warmer climate than in area today

Messinian salinity crisis

One example mentioned was the Messinian salinity crisis (MSC), an event spawning the widespread, thick 'evaporite' deposits on the floor of the Mediterranean Sea. These deposits are better explained by the Flood.[40] This 'evaporite' consists of salt and gypsum, and covers around 2.5 million km^2 in and around the Mediterranean Sea. Geologists date the event, which they believe comprised multiple episodes of drying and refilling the Mediterranean, between 5.96 and 5.33 million years ago, which would be the Late Miocene.[41] It varies in thickness from 0.3 to near 3 km,[42] averaging about 1 km thick, with the thickest deposits reaching 3.5 km in the Herodotus Basin of the eastern Mediterranean.[43] The Messinian 'evaporites' were later elevated and exposed on Sicily and in northern Italy. In addition, there is another 1 km of sediments on top of the 'evaporites', dated as Pliocene, that must be explained.

There is extensive literature on the Messinian 'evaporites' and about their supposed origin, which is dogged by controversy. Many imaginative secular explanations have been offered, and while no specific Flood explanation has been published, it is clear that the Flood provides the best environment to generate such a large and unusual set of strata. There is significant potential for a Flood explanation as opposed to a secular origin because the Flood allows for large-scale variations in seawater chemistry and temperature, which secular scientists tend to ignore. I think that a mechanism related to igneous activity in and around the Mediterranean provides a possible model.[44]

But it is difficult to imagine a post-Flood scenario to explain these features. Since the MSC is dated at about 5.5 Ma and the K/T is at 65 Ma, it would be logical to assume that the MSC happened well after the Flood, if indeed the post-Flood boundary is at the K/T.[45] What mechanism could explain the deposition of the thick 'evaporites' and their overlying sediments? What would explain the significant elevation of parts of the strata after deposition? What effects would these mechanisms have had on humans living near the Mediterranean, and why would these significant 'catastrophes' not be recorded by people of that time, if they had survived? Any mechanism must explain the generation, transport, and deposition of vast quantities of salt and gypsum. Furthermore, if the secular scientists are correct in thinking that the Mediterranean was drained and dried prior to deposition, what post-Flood cause could have done so?

The MSC is better explained as a product of the Flood, not of post-Flood processes. For that reason, the stratigraphic placement of the post-Flood boundary would have to be above the Late Miocene in this region at a minimum, placing it in the very late Cenozoic.

The Absaroka Volcanics and the Yellowstone fossil 'forests'

Another line of evidence that seems to conflict with the K/T explanation is also found in the western United States, in the Early Cenozoic (Eocene) Absaroka Volcanics (figure 2), which contain the fossil 'forests' of Yellowstone National Park.[46] My first four criteria would place these volcanics and their petrified trees within the Flood, not after it. The Absaroka Volcanics are a series of lahars, or volcanic debris flows, deposited over an area of 23,000 km^2 with thicknesses ranging up to 1.8 km.[47,48] After deposition, the top of the volcanics were eroded, forming a planation surface still seen at the top of the southern Absaroka Mountains (see Table 2, criterion 8).[49] After this large-scale planing event, the Absaroka Volcanics were further eroded and dissected, leaving valleys over 1,000 m deep (figure 3). This two-stage erosion is easily explained by the two-stage recession of the floodwaters. The first would have occurred during the Abative (Sheet Flow) Phase, and the second during the Dispersive (Channelized Flow) Phase.[50] Based on Walker's biblical geological model, the Absaroka Volcanics would have been laid down either late in the Inundatory Stage or early in the Recessive Stage of the Flood. The geomorphology fits a Flood runoff model,[51] but would be difficult to explain by any post-Flood event.

The Absaroka Volcanics contain a number of petrified trees, as well as the areas with numerous layers of petrified trees. At Specimen Creek, northwest Yellowstone Park, there are 48 layers containing upright trees, and another 17 organic layers without vertical trees, representing a total of 65 layers (figure 4).[52,53] Organic material is also found in some of the layers that contain vertical trees. They are not fossil soils, as secular scientists claim, but are composed mostly of well-preserved needles and leaves. Trees need soils to grow and soils are absent. This suggests catastrophic deposition of the trees during the formation of the lahars, which in turn suggests the Flood. Evidence favouring a Flood origin includes: 1) bark and roots are rare on the trees; 2) there are no animal fossils; 3) tree rings match on different layers; and 4) there are trees and pollen from 200 tree/plant species ranging from tropical to cool, temperate climate species. Although this was once presented as a challenge to Flood geology, Austin's observations at Spirit Lake[54] suggest a Flood mechanism for depositing upright trees, and the phenomenon now presents a much greater challenge to the evolutionary/uniformitarian paradigm.

But how can the deposition and erosion of the Absaroka Volcanics and their vertical petrified trees be explained in a post-Flood scenario? Given all of the associated features, it would seem quite difficult to find a regional disaster that would deposit the volcanics over a wide area of the uplifted Rocky Mountains, transport and deposit the trees, and then create a two-stage erosional event at such a high elevation. If the Flood explanation is accepted, then the end of the Flood would have to be much later than the Eocene strata.

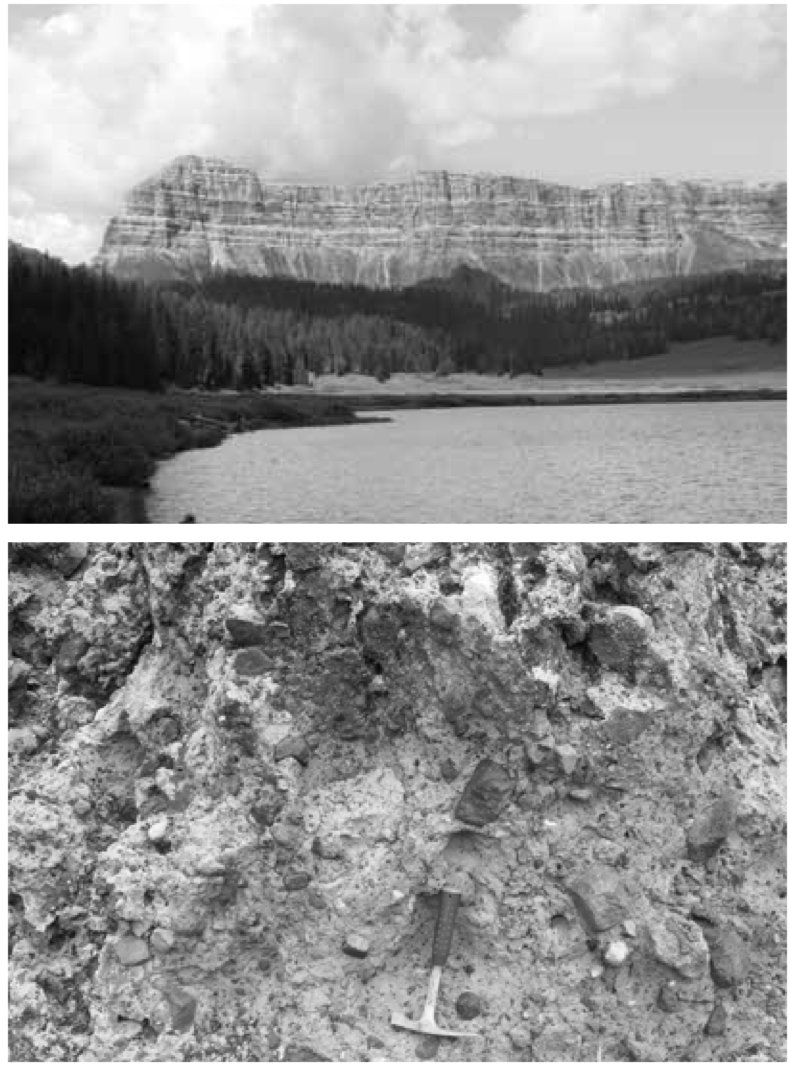

Figure 2. Absaroka Volcanics (layers and up-close breccias).

Figure 3. Deep valley in the Absaroka Volcanics.

Miocene coal favours a Late Cenozoic boundary

Another indication of a high Flood boundary is the existence of thick, pure coal seams (criterion 5 in Table 2) in the Cenozoic, such as those in the Powder River Basin. The difficulty of explaining these Eocene deposits with post-Flood processes makes it more likely that they are products of the Flood. There are also large Miocene (Mid-late Cenozoic) coal

Figure 4. Specimen creek.

Figure 5. Tatman Mountain gravel-capped planation surface (background), view south from a lower gravel-capped planation surface.

beds that provide the same problems for those adhering to a K/T Flood boundary. These are found around the world. Late Miocene coal with polystrate trees occurs in Hungary,[55] and the thick Latrobe coal in southeast Australia is dated as Miocene.[56] In addition to the organic rich strata that produced the coal, its thick overburden must also be accounted for, much of which was later eroded, and so the erosion event must also be explained. This much activity after the Mid-late Cenozoic pushes the post-Flood boundary up to the very late Cenozoic.

Basin-fill sedimentary rocks of Wyoming

Sedimentary basins occur all across the earth and in rocks of all ages. If the Flood were restricted to the pre-Cenozoic strata, then we would expect later basins to be smaller and contain less sedimentary rock. However, there are many large, deep basins with thick Cenozoic basin fill. I will mention several that provide a powerful testimony for the post-Flood boundary being in the Late Cenozoic.

Some of these Cenozoic basins occur in the Rocky Mountains. At this time, large faults were active, reflecting significant differential vertical tectonic activity. Most of the basin-fill sedimentary rocks were eroded from the surrounding mountains as they were uplifted. Several well-known basins are found in Wyoming. Assuming a generally horizontal upper crust before uplift, the total differential vertical movement was about 13,715 m.[57,58] Table 3 lists the altitudes of the granite top of the uplifted mountains and the bottom of the basins. Note that the Hanna Basin of south-central Wyoming, about 2,100 m above sea level, has a basin fill depth of about 11.5 km; 7 km is dated as upper Cretaceous, 4 km as Early Cenozoic (Paleocene), and 0.5 km is considered Late Cenozoic.[59] But that is just what is presently preserved; the top of the basin fill has been eroded. In some areas of the Rocky Mountains, that erosion is significant (see below). Absent a post-Flood catastrophe of regional extent and great intensity, it is difficult to explain the uplift, erosion, transport, deposition, and late erosion of the sedimentary basins. Once again, this suggests an upper Cenozoic end-Flood boundary.

Erosion of the basin-fill sedimentary rocks in the Bighorn Basin, Wyoming

Tatman Mountain in the central Bighorn Basin is an erosional remnant of a high gravel-capped planation surface (figure 5). Some of the gravel is quartzite, but the closest source of quartzite is central Idaho,[60] about 400 km away. The top of Tatman Mountain is 1,899 m above sea level (msl). Greybull, Wyoming, in the northeast Bighorn Basin, is about 45 km east-northeast of Tatman Mountain with an elevation of 1,155 m msl. The difference in elevation is 744 m, which represents the minimum amount of erosion in the eastern Bighorn Basin. It is a minimum because there must have been fairly thick sediments or sedimentary rocks above the level of Tatman Mountain before erosion in order to

Table 3. Elevations of granitic rocks in some mountain ranges and below the sedimentary fill in adjacent basins in Wyoming.

Mountains		Basins	
Wind River Mountains	4,265m	Wind River Basin	-7,000m
Beartooth Mountains	3,960m	Bighorn Basin	-6,400m
Bighorn Mountains	3,960m	Powder River Basin	-4,265m
Medicine Bow Mountains	3,655m	Hanna Basin	-9,450m
Owl Creek Mountains	2,740m	Washakie Basin	-6,400m
Laramie Range	3,050m	Red Desert Basin	-7,000m
		Green River Basin	-4,265m

facilitate cementation of the rocks at the top of the present mountain surface. Since most of the thick, widespread, horizontal sedimentary rocks in the Bighorn Basin are dated as Early Cenozoic, the erosion of the Bighorn Basin must have occurred in the Mid to Late Cenozoic.

If the post-Flood boundary is at the K/T, then a mechanism to erode sedimentary rocks from the surrounding mountains, transport the sediment to the Bighorn Basin, and deposit the sediment in a widespread, thick layer must be found. The Bighorn Basin is about 190 km north-south and 110 km east-west for an area of 20,900 km^2, not an insignificant area. Then a widespread erosional event must have removed at least 744 m of the basin fill in the eastern half of the basin. And since this rock is not seen downgrade, it must have been transported a great distance, perhaps all the way off the continent. Predominantly volcanic rocks are found to the east and southeast.[61] The Bighorn Basin is similar to most other basins in the western United States. What post-Flood mechanism could have accomplished all of this geological work?

The incredible South Caspian Basin

The South Caspian Basin provides a more dramatic example of late Flood activity. It lies in the southern part of the Caspian Sea. This deep sedimentary basin is somewhat circular with a diameter roughly 400 km,[62] or 350 km by 550 km.[63] It is infilled by sedimentary rocks measuring up to 28 km thick![64] Seismic profiling shows that the sedimentary layers are generally horizontal, and interbedded with some volcanic rocks.[63] The basin is surrounded by uplifts,[65] such as the Alborz Mountains, Iran, that wrap around the southern part of the basin and are believed to have risen about 10 km as the South Caspian Basin subsided.[66] The Greater Caucasus Mountains to the west were also rapidly uplifted when the basin subsided.[67] Needless to say, this presents a significant challenge to uniformitarian geologists:

> "The Caspian Sea basins of Central Eurasia constitute one of the major petroleum provinces of the world (Devlin *et al.*, 1999), and one of the most enigmatic basin systems worldwide."[68]

Most of the basin fill is Cenozoic; possibly some of the lowest strata are Cretaceous.[68] The top 10 km are thought to be Pliocene and Quaternary, the very late Cenozoic![62,69] Those who think the Flood ended at the K/T boundary are faced with the necessity of explaining the uplift of the mountains, sinking of the basin, and deposition of 28,000 m of basin fill sediments. To complicate matters, the sediments are not simply from landslides. The horizontal bedding precludes that explanation. Instead, rapid subaqueous deposition is required. Again, this strongly suggests the Flood extending into the very late Cenozoic in the region.

African planation surface

Large-scale planation surfaces, especially those existing at altitude, are difficult to explain by any other mechanism than the withdrawal of the Flood's waters in its late stage. These occur all over the world, although one of the most remarkable is that found in Africa.[70] Despite controversy over the number and ages of planation surfaces in Africa, a synthesis has claimed that numerous smaller surfaces are in fact one large planation surface that has been dissected and elevated to different altitudes by structural deformation.[71] The African Surface, as it is called, covers most of Africa. Mountains, rift flank uplifts, and volcanoes were all once eroded down to form this planation surface up until the Mid Cenozoic. Then it was tectonically deformed, causing the erosion that created the Great Escarpment that circles southern Africa—also within the Late Cenozoic. The Great Escarpment is up to 3,000 m high in southeast Africa and is called the Drakensberg. It probably represents the final product of about 100 km of westward erosion of the planation surface. It is difficult to imagine a post-Flood hypothesis that would explain such widespread erosion, both in creating the original large planation surface and the subsequent Great Escarpments. The strong implication is that the Flood created these features and the Flood/post-Flood boundary in much of Africa is in the very late Cenozoic.

Gravel transported around south-central Asian mountains

The origin of far-transported, resistant, well-rounded quartzite rocks in the northwest United States and adjacent Canada has been documented in creationist literature.[72] These gravel- to boulder-sized rocks have been transported up to 1,200 km east of the Rocky Mountains and 650 km west, and have filled deep paleovalleys with over 4,500m of thick conglomerate in eastern Idaho and northwest

Wyoming during the very late Cretaceous and Cenozoic. The very late Cretaceous age is based on the finding of dinosaur bones and tracks in the gravels and interbeds in northwest Wyoming. Despite having been available in publications since 1998, the existence of these gravels and the late-Flood explanation of their origin have not been addressed or challenged by proponents of the K/T post-Flood boundary or explained with reference to post-Flood catastrophes.

Similar gravel deposits have been found in south-central Asia.[73] The transport of resistant rocks from the erosion of the surrounding mountains in that locale is somewhat different from that in the northwest United States and Canada in that the gravel mainly forms an apron around the edges of the surrounding basins. The distance of transport was less than that in North America, probably because the area was more mountainous at the time of erosion, diverting and slowing the currents. Although the coarse gravel in south-central Asia was not transported as far, it accumulated in thicker sheets; often reaching 1,000 m with a maximum of around 3,000 m! *All* of the erosion of the mountains and the accumulation of thick gravel occurred in the Late Cenozoic. It is difficult to imagine activity on this scale occurring after the Flood, arguing again for a post-Flood boundary in the very late Cenozoic.

Summary and discussion

Dr Ross's argument from paleontology is interesting, but it rests on the successions shown in the Paleobiology Database, which assumes evolutionary sequences and the validity of the geological timescale. Those assumptions are at best highly questionable from the viewpoint of biblical history, and therefore the argument loses its force. Specific empirical problems also remain to be answered, especially with regard to the paucity of mammal fossils in the proposed Flood sediments.

Positive evidence for a late post-Flood boundary has been amplified from previously defined criteria for the post-Flood boundary.[39] Examples based on these criteria showing a Late Cenozoic end of the Flood include the Messinian salinity crisis, the Absaroka Volcanics with the Yellowstone fossil 'forests', Miocene coal, thick Cenozoic basin-fill sedimentary rocks in the Hanna Basin of Wyoming and the South Caspian Basin, erosion of the top of the basin-fill of the Bighorn Basin, the African planation surface, and the sheet transport of gravels in both North America and south-central Asia. All of these examples are best explained by processes unique to the Flood and seem to have no reasonable explanation in terms of post-Flood processes on a young earth. The most reasonable conclusion to date would be that the Flood ended in what secular geologists call the Late Cenozoic and that there has been *relatively* little geologic activity since in the end of the Flood. This should encourage those still advocating the end of the Flood in older strata to reconsider their positions.

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References

1. Ross, M.R., Evaluating potential post-Flood boundaries with biostratigraphy—the Pliocene/Pleistocene boundary, *J. Creation* **26**(2):82–87, 2012.
2. Vardiman, L., Snelling, A.A. and Chaffin E.F. (Eds.), *Radioisotopes and the Age of the Earth: A Young-Earth Creationist Research Initiative*, Institute for Creation Research and Creation Research Society, Dallas, TX, and Chino Valley, AZ, 2000.
3. Vardiman, L., Snelling, A.A. and Chaffin, E.F. (Eds.), *Radioisotopes and the Age of the Earth: Results of A Young-Earth Creationist Research Initiative*, Institute for Creation Research and Creation Research Society, Dallas, TX, and Chino Valley, AZ, 2005.
4. Woodmorappe, J., *The Mythology of Modern Dating Methods*, Institute for Creation Research, Dallas, TX, 1999.
5. Oard, M.J., The geological column is a general Flood order with many exceptions; in: Reed, J.K. and Oard, M.J. (Eds.), *The Geological Column: Perspectives within Diluvial Geology*, Creation Research Society Books, Chino Valley, AZ, pp. 99–121, 2006.
6. Oard, M.J., Is the geological column a global sequence? *J. Creation* **24**(1):56–64, 2010.
7. Oard, M.J., The geological column is a general Flood order with many exceptions, *J. Creation* **24**(2):78–82, 2010.
8. Oard, M.J., Taxonomic manipulations likely common, *J. Creation* **25**(3):15–17, 2011.
9. Oard, M.J., Evolution pushed further into the past, *J. Creation* **10**(2):171–172, 1996.
10. Oard, M.J., How well do paleontologists know fossil distributions? *J. Creation* **14**(1):7–8, 2000.
11. Oard, M.J., Supposed eukaryote evolution pushed back one billion years, *J. Creation* **15**(1):4, 2001.
12. Oard, M.J., Arthropods supposedly invaded land 40 million years earlier, *J. Creation* **17**(2):3–4, 2003.
13. Oard, M.J., 'Evolutionary origins' continue to be pushed back in time, *J. Creation* **18**(3):7, 2004.
14. Oard, M.J., The origin of grass pushed well back into the 'Mesozoic', *J. Creation* **21**(1):9, 2007.
15. Oard, M.J., Jurassic mammals–more surprisingly diverse, *J. Creation* **21**(2):10–11, 2007.
16. Oard, M.J., Modern-looking lampreys 'older' than thought, *J. Creation* **22**(1):5, 2008.
17. Oard, M.J., Evolutionary fossil-time ranges continue to expand, *J. Creation* **23**(3):14–15, 2009.
18. Oard, M.J., Further expansion of evolutionary fossil time ranges, *J. Creation* **24**(3):5–7, 2010.
19. Oard, M.J., Post-Flood man is becoming smarter and more human, *J. Creation* **26**(1):3–4, 2012.
20. Oard, M.J., Fossil ranges continue to expand, *J. Creation* **26**(1):15–16, 2012.
21. Oard, M.J., Fossil range expansions continue, *J. Creation* (in press).
22. Dr Carl Werner, personal communication, 22 August, 2012.
23. Woodmorappe, J., The cephalopods in the creation and the universal Deluge; in: *Studies in Flood Geology,* 2nd edn, Institute for Creation Research, Dallas, TX, pp. 179–197, 1999.

24. Tosk, T., Foraminifers in the fossil record: implications for an ecological zonation model, *Origins* **15**(1):8–18, 1988.
25. Oard, M.J., The supposed consistency of evolution's long ages, *J. Creation* **15**(3):3–4, 2001.
26. Lubenow, M.L., The pigs took it all, *Creation* **17**(3):36–38, 1995.
27. Oard, M.J., The extinction of the dinosaurs, *J. Creation* **11**(2):137–154, 1997.
28. Oard, M.J., End-Mesozoic extinction of dinosaurs partly based on circular reasoning, *J. Creation* **15**(2):6–7, 2001.
29. Oard, M.J., Paleocene dinosaurs and the reinforcement syndrome, *J. Creation* **17**(3):5–8, 2003.
30. Oard, M.J., *Dinosaur Challenges and Mysteries: How the Genesis Flood Makes Sense of Dinosaur Evidence Including Tracks, Nests, Eggs, and Scavenged Bones*, Creation Book Publishers, Powder Springs, GA, pp. 156–162, 2011.
31. Reed, J.K., Klevberg, P. and Froede Jr., C.R., Toward a diluvial stratigraphy; in: Reed, J.K. and Oard, M.J. (Eds.), *The Geological Column: Perspectives within Diluvial Geology*, Creation Research Society Books, Chino Valley, AZ, pp. 31–51, 2006.
32. Oard, M.J., *Frozen in Time: Woolly Mammoths, the Ice Age, and the Biblical Key to Their Secrets*, Master Books, Green Forest, AR, 2004.
33. Holt, R.D., Evidence for a late Cainozoic Flood/post-Flood boundary, *J. Creation* **10**(2):128–167, 1996.
34. Wise, K., Austin, S.A., Baumgardner, J.R., Humphreys, D.R., Snelling, A.A. and Vardiman, L., Catastrophic plate tectonics: a global Flood model of earth history; in: Walsh, R.E. (Ed.), *Proceedings of the Third International Conference on Creationism*, technical symposium sessions, Creation Science Fellowship, Pittsburgh, PA, pp. 609–621, 1994.
35. Ross, ref. 1, p. 83.
36. Oard, M.J., Is the K/T the post-flood boundary?—part 1: introduction and the scale of sedimentary rocks, *J. Creation* **24**(2):95–104, 2010.
37. Oard, M.J., Is the K/T the post-Flood boundary?—part 2: paleoclimates and fossils, *J. Creation* **24**(3):87–93, 2010.
38. Oard, M.J., Is the K/T the post-Flood boundary?—part 3: volcanism and plate tectonics, *J. Creation* **25**(1):57–62, 2011.
39. Oard, M.J., Defining the Flood/post-Flood boundary in sedimentary rocks, *J. Creation* **21**(1):98–110, 2007.
40. Oard, M.J., The Messinian salinity crisis questioned, *J. Creation* **19**(1):11–13, 2005.
41. Garcia-Castellanos, D. and Villaseñor, A., Messinian salinity crisis regulated by competing tectonics and erosion at the Gibraltar arc, *Nature* **480**:359–363, 2011.
42. De Lange, G.J. and Krijgsman, W., Messinian salinity crisis: a novel unifying shallow gypsum/deep dolomite formation mechanism, *Marine Geology* **275**:273–277, 2010.
43. Rouchy, J.M. and Caruso, A., The Messinian salinity crisis in the Mediterranean basin: a reassessment of the data and an integrated scenario, *Sedimentary Geology* **188-189**:35–67, 2006.
44. Heerema, S., A magmatic model for the origin of large salt formations, *J. Creation* **23**(3):116–118, 2009.
45. Whitmore, J.H. and Wise, K.P., Rapid and early post-Flood mammalian diversification evidenced in the Green River Formation; in: Snelling, A.A. (Ed.), *Proceedings of the Sixth International Conference on Creationism*, Creation Science Fellowship, Pittsburgh, PA, pp. 449–457, 2008.
46. Coffin, H.G., The Yellowstone petrified 'forests', *Origins* **24**(1):5–44, 1997.
47. Feely, T.C. and Cosca, M.A., Time vs. composition trends of magmatism at Sunlight volcano, Absaroka volcanic province, Wyoming, *GSA Bulletin* **115**:714–728, 2003.
48. Sundell, K.A., A geologic overview of the Absaroka volcanic province; in: Snoke, A.W., Steidtmann, J.R. and Roberts S.M. (Eds.), *Geology of Wyoming*, Geological Survey of Wyoming Memoir No. 5, pp. 480–506, 1993.
49. Love, J.D., Reed, Jr., J.C. and Pierce, K.L., *A Geological Chronicle of Jackson Hole & the Teton Range: Creation of the Teton Landscape*, Grand Teton Association, Moose, WY, pp. 88–89, 2007.
50. Walker, T., A Biblical geological model; in: Walsh, R.E. (Ed.), *Proceedings of the Third International Conference on Creationism*, technical symposium sessions, Creation Science Fellowship, Pittsburgh, PA, pp. 581–592, 1994.
51. Oard, M.J., *Flood by Design: Receding Water Shapes the Earth's Surface*, Master Books, Green Forest, AR, 2008.
52. Coffin, ref. 46, p. 9.
53. Hergenrather, J., Vail, T., Oard, M. and Bokovoy, D., *Your Guide to Yellowstone and Grand Teton National Parks: A Different Perspective*, Master Books, Green Forest, AR, 2012.
54. Morris, J. and Austin, S.A., *Footprints in the Ash: The Explosive Story of Mount St. Helens*, Master Books, Green Forest, AR, 2003.
55. Hámor-Vidó, M., Hofmann, T. and Albert, L., In situ preservation and paleoenvironmental assessment of *Taxodiacea* fossil trees in the Bükkalja Lignite Formation, Bükkábrány open cast mine, Hungary, *International J. Coal Geology* **81**:203–210, 2010.
56. Holdgate, G.R., Cartwright, I., Blackburn, D.T., Wallace, M.W., Gallagher, S.J., Wagstaff B.E. and Chung, L., The middle Miocene Yallourn coal seam—the last coal in Australia, *International J. Coal Geology* **70**:95–115, 2007.
57. Love, J.D., Cenozoic sedimentation and crustal movement in Wyoming, *American J. Science* **258-A**:204–214, 1960.
58. Thornbury, W. D., *Regional Geomorphology of the United States*, John Wiley & Sons, New York, p. 354, 1965.
59. Grimaldi, D.A., Lillegraven, J.A., Wampler, T.W., Bookwalter, D. and Shedrinsky, A., Amber from upper Cretaceous through Paleocene strata of the Hanna Basin, Wyoming, with evidence for source and taphonomy of fossil resins, *Rocky Mountain Geology* **35**(2):165, 2000.
60. Oard, M.J., Hergenrather, J. and Klevberg, P., Flood transported quartzites—east of the Rocky Mountains, *J. Creation* **19** (3):76–90, 2005.
61. Duller, R.A., Whittaker, A.C., Swinehart, J.B., Armitage, J.J., Sinclair, H.D., Bair, A. and Allen, P.A., Abrupt landscape change post–6 Ma on the central Great Plains, USA, *Geology* **40**(10):871–874, 2012.
62. Artyushkov, E.V., Formation of the superdeep South Caspian basin: subsidence driven by phase change in continental crust, *Russian Geology and Geophysics* **48**:1002–1014, 2007.
63. Nadirov, R.S., Bagirov, E., Tagiyev, M. and Lerche, I., Flexural plate subsidence, sedimentation rates, and structural development of the super-deep South Caspian Basin, *Marine and Petroleum Geology* **14**:383–400, 1997.
64. Knapp, C.C., Knapp, J.H. and Connor, J.A., Crustal-scale structure of the South Caspian Basin revealed by deep seismic reflection profiling, *Marine and Petroleum Geology* **21**:1073–1081, 2004.
65. Richardson, S.E.J., Davies, R.J., Allen, M.B. and Grand, S.F., Structure and evolution of mass transport deposits in the South Caspian Basin, Azerbaijan, *Basin Research* **23**:702–719, 2011.
66. Axen, G.J., Lam, P.S., Grove, M. and Stockli, D.F., Exhumation of the west-central Alborz Mountains, Iran, Caspian subsidence, and collision-related tectonics, *Geology* **29**:559–562, 2001.
67. Knapp *et al*., ref. 64, p. 1073.
68. Artyushkov, ref. 62, p. 1005.
69. Richardson *et al*., ref. 65, p. 704.
70. Oard, M.J., The remarkable African planation surface, *J. Creation* **25**(1): 111–122, 2011.
71. Burke, K. and Gunnell, Y., The African Erosion Surface: A Continental-Scale Synthesis of Geomorphology, Tectonics, and Environmental Change over the past 180 Million years, *Geological Society of America Memoir 201*, Boulder, CO, pp. 1–66, 2008.
72. Oard, ref. 39, p. 105.
73. Oard, M.J., Retreating Stage formation of gravel sheets in south-central Asia, *J. Creation* **25**(3):68–73, 2011.

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