Where is the Flood/post-Flood Boundary in the Rock Record?

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ABSTRACT

It is here argued that the Flood/post-Flood boundary in the geological record is in the Late Cainozoic. Three reasons are drawn from a study of the Ice Age, ten reasons are based on evidence from the geology of Montana and Wyoming, and six reasons come from characteristics surrounding the Columbia River Basalt Group of Washington, Oregon and Idaho. Thirteen objections to the subaqueous origin of the Columbia River Basalts are questioned.

INTRODUCTION

Controversy over where the Flood sediments leave off and where the post-Flood sediments begin is not new. American creationists have mostly considered the boundary somewhere in the so-called Cainozoic Period, whereas a number of European creationists have in recent years been promoting the boundary as somewhere in the Mesozoic,[1,2] or even in the Late Palaeozoic.[3-9]

Part of this controversy revolves around the status of the so-called geological column as the creationist geological chronology. Possibly, the geological column, or part of it, may loosely represent a burial by ecological zonation or some other processes during the Flood, but this needs to be demonstrated with rigour for the whole world and not for small regions or local areas. However, it is tentatively assumed here that the geological column is a real time sequence, since those who believe the Flood/post-Flood boundary is low in the geological column seem to assume the geological column is a factual entity.

Allied to this is the question of what are data in the conventional geological literature and what are interpretations, for it is the data we need for reinterpreting the rocks within a Flood paradigm. We know that many observational data are tainted by assumptions, like uniformitarianism, so each creationist has to make decisions in distinguishing between data and interpretation. This problem, of course, potentially leads to different understandings of the evidence, which is part of the problem of determining where the Flood/post-Flood boundary lies.

The principle of uniformitarianism, a fairly strict assumption of the conventional geological establishment, can still get us into trouble, despite today's trend to accept some catastrophism. I am convinced the Flood was a gigantic catastrophe that is difficult to envisage with our small analogues, such as flash floods. Probably hundreds of unique events occurred during the year-long Flood that we are only beginning to recognise within the rock and fossil record.

We should also use as much biblical data as we can bring to this problem. Walker's new rock classification system[10] is an excellent step with which to begin, while Froede has also emphasised the need to dispense with the uniformitarian system and develop a creationist geological time-scale.[11]

THE ICE AGE

One approach in the quest for the Flood/post-Flood boundary is to begin with a study of the Ice Age.[12,13] Copious volcanism occurred during and after the Flood, which produced a shroud of dust and aerosols in the stratosphere for many years thereafter. This would have cooled the higher latitudes, especially land surfaces within continental interiors. The 'fountains of the great deep' and all that volcanism had produced warm ocean water from pole to pole and top to bottom by the end of the Flood. This unique climatic combination would be a very potent mechanism for an Ice Age.

(1) The Boundary is Just Under the Glacial Debris

The Ice Age should have begun **immediately** after the Flood, there being no physical mechanism that could have delayed it. (This is not to say glaciation began immediately after the Flood everywhere the ice sheets developed. In some areas close to the warm ocean the onset would have been delayed until the water cooled sufficiently.) The volcanic dust would tend to wane with time as the Earth settled down from the tectonic catastrophe of the Flood. Due to evaporation (the stronger mechanism) and conductive cooling from cooler air blowing over warm water, the oceans would have cooled fairly quickly after the Flood.[14] It would not have taken long, perhaps 500 years, before the ocean was too cool to cause an Ice Age.

The point of this is that the Flood/post-Flood boundary should therefore lie just under the glacial debris in most areas.[15] This is especially true for those areas that likely were glaciated immediately after the Flood, such as the interior of North America, the mountains of British Columbia, and the mountains of Scandinavia. Ice age sediments are generally classified as Pleistocene. Therefore, the Flood/post-Flood boundary should generally lie just below the Pleistocene sediments in glaciated areas. In western North Dakota, an area that should have been glaciated early in the Ice Age, Pleistocene debris lies on the Oligocene White River Group and the Eocene and Palaeocene Golden Valley Formation that contain a warm climate palaeofauna and palaeofora.[16] This strongly suggests that the Flood/post-Flood boundary lies above the early Cainozoic.

(2) There is a Specific Ice Age Fauna

A second reason the Flood/post-Flood boundary is in the Late Cainozoic is because a specific Ice Age fauna is associated with Pleistocene sediments, mostly in unglaciated areas. This fauna includes the woolly mammoth, woolly rhinoceros, cave bear, ground sloth, sabre-toothed tiger, bison and Irish elk. These animals can be traced all over the Northern Hemisphere from Europe and Asia, across the Bering Land Bridge, and down into North America. They are pictured on the walls of caves in Europe.[17] On the other hand, few mammals earlier than the Pleistocene are associated with Ice Age sediments or are found on cave walls. Titanotheres and dinosaurs are not the objects of cave art. All these latter animals are unearthed within sedimentary rocks of great lateral and vertical extent on the Great Plains of North America, such as the Mesozoic sediments in Montana[18] and the Cainozoic sediments of South Dakota and Nebraska.[19,20] There does not appear to be much, if any, mixing of pre-Pleistocene animals with Pleistocene mammals. If all the Mesozoic and Cainozoic animals left Mount Ararat together, one would expect much more interaction and mixing of fauna as their populations increased, as one would expect if the Flood/post-Flood boundary was in the Mesozoic or Late Palaeozoic. (This of course begs the question of whether Noah took dinosaurs, titanotheres, etc. on the Ark.)

(3) There are Warm-Climate Palaeofauna and Palaeoflora in a Cold 'Palaeoclimate'

The immediate post-Flood climate must have been quite cold in the summers over land areas of mid and high latitude due to volcanic dust and aerosols in the stratosphere. Winters could easily have been warmer, but still significantly below freezing, due to the warm mid and high latitude oceans. Then how are the warm-climate palaeofauna and palaeoflora of the Mesozoic and Cainozoic to be accounted for after the Flood? For instance, dinosaur remains are today found in Antarctica, the North Slope of Alaska, and northern Canada.[21] Dinosaur footprints have been found in Spitsbergen, north-east British Columbia, and the North Slope of Alaska,[22,23] which means they were alive at one time on these landmasses. Warm temperate, subtropical, and even tropical, palaeoflora from the Cretaceous and Early Tertiary are found in Antarctica, Alaska, western North America, and parts of Europe.[24] Especially interesting are the Eocene subtropical trees found on Axel Heiberg Island in the Queen Elizabeth Islands at 80°N in Canada.[25] Alligators and lemurs that normally require a warm climate are dated as Eocene on adjacent Ellesmere Island.[26] A new analysis of fossil crocodiles in the United States and southern Canada shows crocodiles are found as far north as extreme southern Saskatchewan in the Eocene, as well as in the Miocene.[27] Plate tectonics does not appear to help these situations, since the palaeolatitude of northern North America has supposedly changed little since the Cretaceous.[28]

How can the warm climate palaeofauna and palaeoflora survive an Ice Age climate? Even if there were no Ice Age or the Ice Age were delayed, climate simulations indicate that high latitudes and mid latitude continental interiors would be quite cold in winter, even with much warmer polar oceans.[29,30] Although imperfect, these climate simulations are the state of the art.[31] They likely give general climatic information for the particular initial and boundary conditions employed, which were biased towards warmth. Figure 1 shows the simulated average January minimum temperature over North America during the Eocene period, using low altitudes for the mountains and polar sea surface temperatures 6-12°C warmer than present with no sea ice. Under these favourable conditions, winter temperatures are much too cold for the fauna and flora that supposedly inhabited these areas. A previous simulation of the Cretaceous climate, using presumed Cretaceous geography today, produced temperatures **a little colder than at** present.[32] The main reason for such cold temperatures in winter is because at mid and high latitudes, temperatures are controlled mainly by the **lack of sunshine.** Although this is a uniformitarian problem, it still holds true if one believes the Mesozoic and Early Cainozoic are post-Flood. Sloan and Barron see little hope for resolving the contradiction between the warm palaeofloras and cold palaeoclimate during the Early Cainozoic and Cretaceous periods:

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

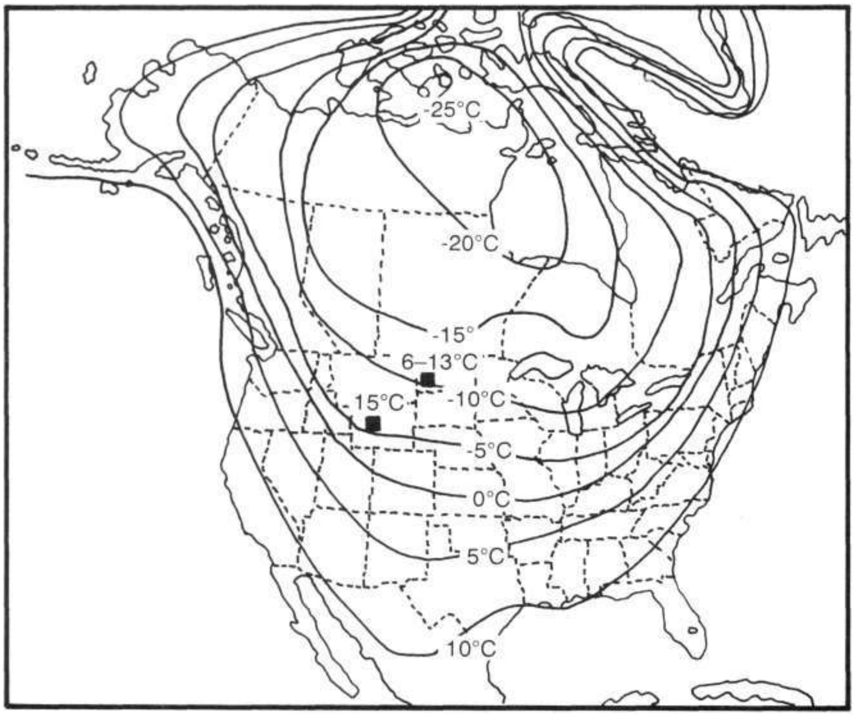

Figure 1. *Simulated minimum January surface temperatures for the Eocene period of North America using a polar sea-surface temperature 6-12°C warmer than today with low topography Minimum surface temperatures for Eocene palaeoflora are indicated for western Wyoming and western North Dakota (square dots). (Redrawn from Sloan and Barron [1992] by David and Nathan Oard.)*

temperature gradient, or topography, above freezing temperatures in winter for continental interiors at middle to high latitudes cannot be maintained.[33]

It seems much more reasonable that the warm-climate palaeofauna and palaeoflora are a result of the Flood and not from the post-Flood climate. This is a third reason for a Late Cainozoic Flood/post-Flood boundary.

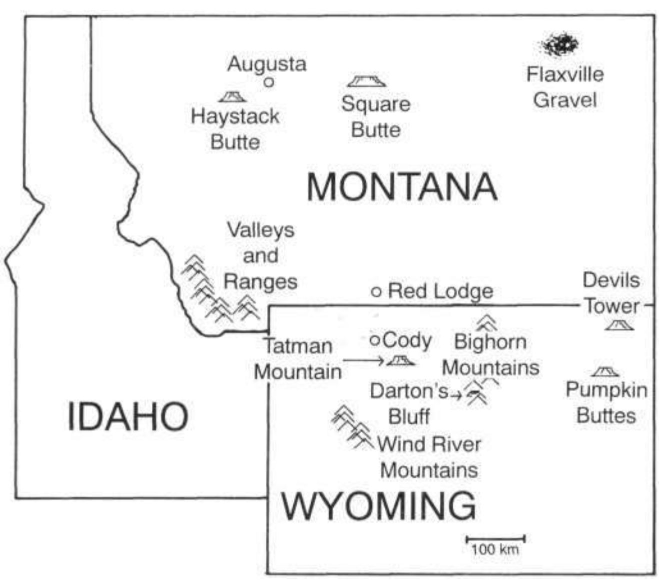

***Figure** 2. Location map of places discussed from the geology of Montana and Wyoming. (Drawn by Nathan Oard.)*

EVIDENCE FROM THE GEOLOGY OF MONTANA AND WYOMING

There is much evidence from the geology of Montana, Wyoming and adjacent Idaho that the Flood/post-Flood boundary is in the late Cainozoic. Figure 2 shows the map of Montana, Wyoming, and Idaho with the locations discussed in the text.

(1) Volume of Mesozoic and Cainozoic Sediments Too Large

The first indication that the Mesozoic and most of the Cainozoic sediments are Flood sediments is their great lateral extent and thickness in Montana, Wyoming, and the Great Plains. Mesozoic sedimentary rocks outcrop over much of central Montana. They either outcrop or are continuous in the subsurface over extensive areas east of the Rocky Mountains in Canada and the United States. The area of Mesozoic sediments is roughly 5,000 km north-south, and about 1,500 km east-west. The sediments are likely more than 1,000 m thick. The layers are generally horizontally bedded and a large percentage are marine.

Similarly, Cainozoic sedimentary rocks cover large sections of the high plains of Montana, Wyoming, and other areas east of the Rocky Mountains in the United States. Much of the surface of the eastern third of Montana is covered by the Palaeocene Fort Union Formation. The mid to late Miocene Ogallala Group covers an area 1,300 km long from south-western South Dakota southward to western Texas and is 500 km wide.[34] The formation is composed mostly of what are determined to be 'fluvial' sandstones within the uniformitarian system.[35] There are also minor amounts of conglomerates and volcanic ash. It is horizontally bedded and up to 150 m thick.

What sort of post-Flood event could erode and deposit this vast amount of sediments? What could lay down all the Mesozoic and Cainozoic sediments of the Great Plains of the United States in what appears to be a gigantic alluvial fan, and then lift them well above sea level? Thick extensive Mesozoic and Cainozoic deposits are found elsewhere on the Earth. In fact, sediments of these presumed ages form approximately half the sedimentary rocks on Earth.[36]

(2) Extensional Tectonics and Valley Fills

Very thick layers of generally conformable Cainozoic sediments fill the valleys of south-western Montana and adjacent Idaho. This area is represented by many mountain ranges separated by fairly wide, flat-floored valleys that are roughly orientated north-south. The valleys range in altitude from 1.3 km to 2.3 km above sea level. Since the outlets of many valleys cut through pre-Cainozoic sediments, early geologists thought the valley fill sediments were deposited in lakes. They called the valley fills the Bozeman Lake Beds. Since then, geologists have come to recognise that the valley fill sediments were laid down by currents. Therefore within the uniformitarian system, they are considered predominantly fluvial sediments.

The depth of the Cainozoic valley fill sediments is on the order of 1-2 km. Based on deep drilling, the Big Hole Valley contains the deepest Cainozoic sediments. This valley is about 50 km long and 25 km wide. One drill hole measured a depth of about 5 km of Cainozoic sediments.[37] The lithified sediments in the south-west Montana valleys contain much volcanic material and conglomerate. They are dated from Eocene to as young as **Pliocene** based mostly on mammal fossils.

Mainstream geologists are coming to the conclusion that many of these valleys are not grabens, but gigantic extension cracks that **moved horizontally** before and during the early phase of Cainozoic sedimentation.[38] Many of these cracks moved laterally over 10 km. This is based on deep drilling and the matching of ore deposits across a few of the valleys from one mountain range to the next. What sort of post-Flood process would split these pre-Cainozoic igneous and sedimentary rocks apart and fill these valleys up with generally conformable, thick Cainozoic sediments? It seems much more reasonable that this catastrophic activity occurred during the Flood, and that the Flood/post-Flood boundary is Pliocene or younger in this area. This is a second reason why I believe the Flood/post-Flood boundary is in the Late Cainozoic. From a diluvial perspective, the south-west Montana valleys could be the result of extension cracks formed during uplift at the end of the Flood.

(3) Erosion of 1,000 m of Sediments

A third piece of evidence that the Flood/post-Flood boundary is in the Late Cainozoic is that 500-1,000 m of sediment has been eroded from the high plains of Montana adjacent southern Canada, the valleys of south-west Montana, and the broad valleys of northern Wyoming. This conclusion is based on the existence of several resistant igneous intrusions and sedimentary remnants. For example, Devils Tower rises over 400 m above the surrounding valley floor (see Figure 3). It is flat topped and very likely the neck of an old volcano.[39] Volcanic necks do not poke up into thin air; they extrude through other rocks. Therefore, at least 400 m of sediments were eroded from this area.

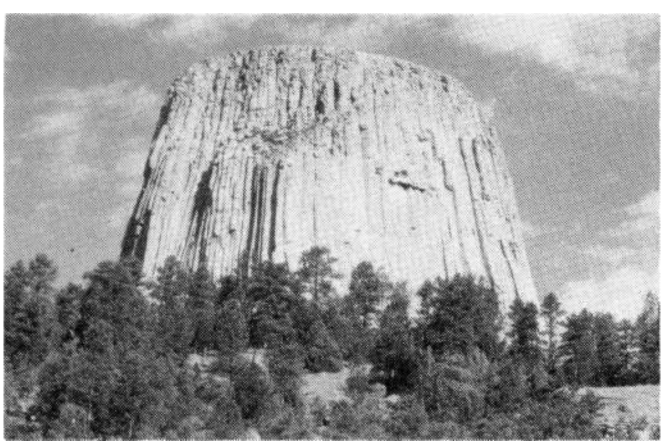

***Figure** 3. Devils Tower, north-eastern Wyoming (Photo: Tom Wagner).*

It is of interest that Devils Tower presents a uniformitarian geological puzzle. Devils Tower is dated at over 50 Ma and supposedly has been subjected to erosion for millions of years. Why hasn't erosion reduced Devils Tower down to a small igneous knob by now? There have been millions of freeze-thaw cycles over the 50 million year period in eastern Wyoming to loosen the rock. On the other hand, if the igneous rock is so resistant, is there enough talus at the base of Devils Tower to account for millions of years of erosion, similar to what is seen on the Colorado Plateau?[40]

Another igneous intrusion is represented by Square Butte and Round Butte, located about 24 km east of the Highwood Mountains of central Montana. Square Butte is a flat-topped butte that rises about 600 m above the surrounding sedimentary plains. It is composed of igneous rocks of shonkinite and syenite, and hence the sedimentary rocks must have extended above the top of Square Butte. Farther to the west, just east of the Rocky Mountain Front, is Haystack Butte, an isolated igneous intrusion[41] about 600 m above the surrounding terrain.

In the middle of the Powder River Basin of Wyoming, the sedimentary Pumpkin Buttes rise 335 m above the plains. The buttes are capped by hard, erosion-resistant sedimentary rocks of Oligocene age.[42] In the middle of the Bighorn Basin of Wyoming, Tatman Mountain is a sedimentary plateau 500 m above the surrounding sedimentary rocks.[43] The Cypress Hills in south-east Alberta and south-west Saskatchewan, Canada, are erosional remnants of sedimentary rocks that poke up around 400 m above the surrounding plains. Except for surficial sediments and coarse gravel caps, the sedimentary rocks at the tops of the buttes are well lithified. Since sedimentary rocks do not normally harden at the Earth's surface, probably at least another 500 or more metres of sediments once existed above Pumpkin Buttes and Tatman Mountain.

On the top of the southern Bighorn Mountains at 2,750 m above sea level lies an 18 km^2 patch of Oligocene and Lower Miocene sedimentary rocks dated by fossil mammals.[44,45] The top of this section at Darton's Bluff has been bevelled and capped by conglomerate (Figure 4). It is remarkably flat and even cuts across hard Precambrian plutonic and metamorphic rocks. The Lower Miocene section is about 1,200 m above the Powder River and Bighorn Basins, on either side of the mountains. These sedimentary rocks on the Bighorn Mountains could have been deposited at a lower elevation as the mountains were rising, in which case they represent incredible post-Flood tectonism. Alternately, the rocks could indicate the depth of valley fill in the surrounding basins at one time.

Figure 4. *Flat-topped erosion surface at Darton's Bluff, southern Bighorn Mountains at 2,750 m ASL.*

All these erosional remnants and the patch of Miocene sediment on top of the Bighorn Mountains all indicate that perhaps 1,000 m or more of sedimentary rock has been eroded from Montana, adjacent southern Canada and north-eastern Wyoming, not to mention surrounding areas. All this erosion highlights several provocative uniformitarian questions:

> '(a) *To what degree did the weight of 9000 feet [2743* m] *or more of post-Paleocene rocks depress the Bighorn Basin? (b) After the rapid late Cenozoic removal of most this fill, how much did the crust underlying the basin rebound? ...(d) Where was base level when the basins were being excavated, and what happened to the debris downstream ? (e) What climatic inferences can be drawn* ***(certainly, a large volume of water moving with considerable velocity was needed for basin excavation)?*'**[46] (Emphasis mine.)

Deep erosion also occurred after the Mesozoic sediments were laid down in the Big Bend National Park area of Texas.[47] Enormous erosion was likely a world-wide continental event during Mesozoic and especially Cainozoic time (see below). How could all this erosion have occurred after the Flood? Erosion should have been relatively slight during the Ice Age and the current uniformitarian times.[48] If the deposition and erosion of all this sediment were due to post-Flood catastrophism, the implied tectonics and rapid currents indeed would have been Earth shaking.

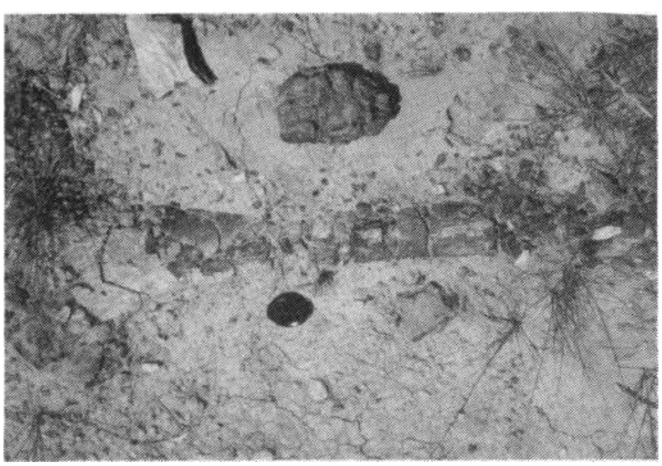

Figure 5. *Dinosaur bone and fragments from the Dragon's Grave dinosaur graveyard on the Hansen Ranch, near Newcastle, Wyoming.*

(4) Unreasonable Life Histories of Animals

A fourth problem for those who believe the Flood/post-Flood boundary is earlier than the Late Cainozoic is the unreasonable life histories of the animals that disembarked from the Ark. The dinosaurs of the Mesozoic illustrate the problem. All sedimentary rocks containing the tens of thousands of dinosaur fossils in Montana, Wyoming and southern Alberta are erosional remnants. Figure 5 shows a dinosaur bone and fragments from the Dragon's Grave dinosaur graveyard in north-eastern Wyoming.[49] The dinosaur tracks, nests, eggs and newly hatched babies in Montana and Wyoming were all covered with about 1,000 m of sediments at one time. Figure 6 shows a track of a small three-toed dinosaur near the Dragon's Grave.

Figure 6. *One of five exposed dinosaur tracks of a small three-toed dinosaur in a trackway near the Dragon's Grave.*

In a post-Flood scenario, dinosaurs after disembarking from the Ark must first increase and then spread world-wide. They needed to migrate to Alaska, Spitsbergen, New Zealand, Australia and Antarctica.[50] This would surely be a daunting task with the current position of the continents. Those who believe the Mesozoic is post-Flood can appeal to the splitting of the land during Peleg's time to facilitate rapid migration. But a continental split at Peleg's time needs much more evidence. The catastrophic impact on the biota also needs consideration.

Regardless, the dinosaurs that migrated to Montana, Wyoming and southern Alberta were covered by about 1,000 m of sediment. Then this sediment must be subsequently re-eroded. Where is all the post-Flood time for such activity? Besides, where are all the eroded sediments? They are not close by; they are likely in the lower Mississippi River Valley and the Gulf of Mexico. The Genesis Flood is an adequate straightforward mechanism to bury dinosaurs and mammals in the inundatory stage, and to re-erode the sediments in the recessive stage.

(5) High Plains Erosion Surfaces

A fifth indication that the Mesozoic and most of the Cainozoic are Flood deposits is the existence of extensive erosion surfaces on high plains.[51] There are many erosion surfaces and claimed erosion surfaces in the rocks around the world. Erosion surfaces are generally defined by three criteria:

(1) bevelled surfaces of tilted strata,
(2) accordancy of summit levels of ridges or hills, and
(3) palaeosols or weathered surfaces.[52]

However, the third criterion is a uniformitarian interpretation for lithified sediments. The second criterion could be due to regularly folded sedimentary rocks,[53] but seems to have merit in areas of similar uplift history if folding can be discounted. The first actually is the best criterion because a planation surface cut at an angle to tilted strata implies strong scour, which is universally accepted as a genuine erosional surface.[54] I will focus mainly on the first criterion in discussing the high plains erosional surfaces cut on the present topography. I will assume that, except for glaciated areas, erosion has been minimal since the Flood.[55]

Erosional surfaces, especially those formed on the landscape, present a critical challenge to uniformitarian theories. Although geologists recognise planation surfaces, they cannot explain them by present processes. Crickmay states: '*To my thinking, the two prime, existing hypotheses of the origin of this flat land are both inadequate.*'[56] Present processes do not seem to be forming planation surfaces today. In fact, present processes are mostly dissecting erosion surfaces. So many students of geomorphology have concluded the planed-off landforms are relic, that is, formed by processes no longer operating.[57] Not only are the erosion surfaces relic, but also many of them are quite old, according to the uniformitarian dating system, and little dissected, as stated by Crickmay:

> *'Furthermore, despite all the exertions of the atmosphere, many a flat, level-topped plateau has preserved its surface perfectly from the Cainozoic to the present.'*[58]

This is powerful evidence that all that suggested time of exposure for erosion surfaces is a fiction.

On the high plains from central Alberta to northern Wyoming, erosion surfaces are usually remnant buttes and plateaus that crop out at different elevations. Sometimes the tops of the buttes and plateaus are composed of horizontally-bedded resistant rock, while at other times the erosion bevelled tilted Upper Cretaceous sandstones and shales.[59] Well-rounded gravel and cobbles that were transported eastward from the Rocky Mountains cover the tops of many of these plateaus and buttes. Figure 7 shows rounded cobbles from the western part of the Fairfield Bench 3 km north-east of Augusta, Montana. This bench is a flat-topped terrace about 80 km long in an east-west direction in which the erosion surface mostly bevels the strata at a low angle. The cobbles are more scattered on the eastern part. The cobbles in the photo are from the Rocky Mountains

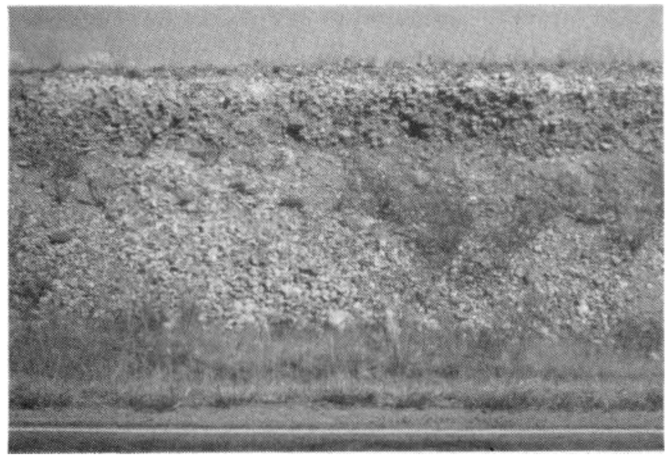

Figure 7. *The cobbles and boulders that cap the flat-topped terrace 3 km north-east of Augusta, Montana, and about 20 km from the Rocky Mountain Front.*

20 or more kilometres to the west. I have recognised distinctive trachyandesite clasts in the coarse gravel cap from a sill about 35 km to the west.

One of the more impressive erosion surfaces is the top of the Cypress Hills in south-east Alberta and south-west Saskatchewan that has bevelled the Cretaceous rocks at an angle and capped the surface with rounded quartzite cobbles 5-8 cm in diameter, with a maximum of 30 cm.[60,61] This erosion surface, which was not glaciated, stands at an elevation of about 1,400 m, 400 m higher than the surrounding plains. It is about 300 km from the source of the clasts in the Rocky Mountains. Another impressive gravel and cobble-capped plateau is the Flaxville Gravel, which outcrops extensively in north-eastern Montana and is up to 35 m thick.[62] It caps flat-topped buttes at elevations from 975 m in the west to 800 m in the east. The gravel consists of well-rounded quartzite and argillite pebbles arid cobbles up to 25 cm in diameter that were eroded from the Rocky Mountains 400 km away.

Uniformitarian scientists commonly appeal to a braided river to transport conglomerate long distances. It is difficult to see how a braided river could spread gravel and cobbles more than 400 km from the Rocky Mountains out into north-eastern Montana. It is well known that the gravel bedload of modern rivers fines downstream. For instance, a reduction in size of one phi class of gravel takes from one kilometre to several tens of kilometres, but the transition from gravel to sand (several phi classes) is quite abrupt, usually only a few kilometres.[63] The massive character of most of the gravel and cobbles capping high-plains plateaus over a wide area is more indicative of rapid Flood currents. These currents must have flowed eastward at high velocity over the Rocky Mountains and high plains. They must have been at least as wide as from central Alberta to northern Wyoming. Since these erosion surfaces form the present landscape of the area, the currents were likely from the recessive stage of the Flood.

It is expected that the highest gravel- and cobble-capped plateaus would be the oldest, within both a diluvial and uniformitarian perspective. Interestingly, the conglomerates contain scraps of Cainozoic fossils. One of the lowest conglomerates south-east of Swift Current, Saskatchewan, at an elevation of about 800 m has an Upper Eocene fauna.[64] On the Wood Mountain plateau, elevation 1,000 m, between the conglomerate south-east of Swift Current and the Cypress Hills, the conglomerate is dated as Miocene.[65] The highest Cypress Hills conglomerate has Oligocene fossils,[66] while the Flaxville Gravels contain Early Pliocene fossils.[67] The highest cobble-capped terrace has fossils of intermediate age, while the lower terraces vary from Upper Eocene to Early Pliocene. This indicates that the fossil mammal dating scheme is arbitrary — the age differences are based mainly on chance deposition of index fossils. It also indicates that the Flood/post-Flood boundary is above the Early Pliocene within the geological time-frame.

(6) Pediments in the South-West Valleys of Montana

A pediment is a broad sloping erosion surface of low relief developed at the base of mountains that is believed to have developed mostly by running water. They are most common in arid and semi-arid regions due to a presumed lack of erosion. In the south-west Montana valleys, flat-topped pediments are common along the sides of the valleys.[68] The pediments are all sheared flat and often capped by well-rounded gravel, cobbles and boulders. These pediments sometimes truncate tilted valley fill sediments (see Figure 8). The pediments also truncate outcrops of Precambrian and Palaeozoic sedimentary rocks, and most significantly plutonic rocks. The pediments look like sloping stream terraces that dip downward from the mountain front to almost the river, but they are erosional features capped by a veneer of well-rounded coarse gravel. In the south-west Montana valleys, the pediments are cut on sediments as young as Miocene and Pliocene, and hence must be 'younger'.

Uniformitarian geologists have come up with several theories to account for these admittedly mysterious pediments. However, they all have serious problems. Hadley states: '. . .*no general agreement has been reached as to the processes involved in pedimentation.*'[69] Dohrenwend corroborates:

Figure 8. *Flat-topped pediment in the Ruby Valley of south-west Montana. Notice how the erosion surface truncates the valley fill sediments at an angle.*

'Pediments have long been the subject of geomorphological scrutiny. Unfortunately, the net result of this long history of study is not altogether clear or cogent and has not produced a clear understanding of the processes responsible for pediment development.'[70]

One of the problems is that the capping coarse gravel is too massive and widespread and the boulders too well-rounded to accommodate uniformitarian theories, such as coalesced alluvial fans or bajadas. Besides, some of the stones capping pediments are not from local mountain sources, but are exotic. Thus, the 'river' that did the work was not a local one.[71]

Pediments are especially common in the south-western United States where they were first studied. They are also widespread across the Earth:

'Reported on six continents, their distribution spans the range of subpolar latitudes from the Arctic to the Antarctic and the range of climate from hyperarid to humid tropical . . .'[72]

What kind of post-Flood process would account for these gravel-capped pediments in the south-west valleys of Montana? It seems more reasonable to believe these gravel-capped pediments are erosional remnants from fast-moving currents flowing through the south-west Montana valleys as the Flood waters were draining. Since these pediments truncate sediments as young as Pliocene, the Flood/post-Flood boundary would be in the Late Cainozoic. Because of their world-wide occurrence, pediments speak more of the recessional stage of the Flood and not post-Flood catastrophism. Otherwise, the people and animals that left the Ark would be in great danger of drowning.

(7) Mountain Top Erosion Surfaces

A seventh indication is the many high-level erosion surfaces in the mountains of Montana, Wyoming and Idaho. These erosion surfaces are often represented by flat-topped mountains that truncate tilted sedimentary layers. Several remarkably flat-topped mountains at 3,500 m in the north-west Wind River Range of Wyoming bevel the bedding at a sharp angle.[73] It is as if someone had taken a giant saw and cut off the top of the mountains. Other types of erosional surfaces are shown by flat or smoothed flanks of mountain ranges.

The south-east Beartooth Mountains in Montana and Wyoming are but one example of an erosional surface with more jagged higher mountains elsewhere in the range.[74] A well-developed erosion surface occurs at high-levels of the south-western Absaroka Mountains of north-west Wyoming.[75]

The mountains of central and northern Idaho and adjacent western Montana are truncated by a remarkable erosion surface that early workers considered an uplifted peneplain that had been dissected.[76] A few patches of rounded gravel are found on this erosion surface. In the westward-trending valleys of northern Idaho, there are gravel-capped ridges and benches along the edges of the valleys, up to 335 m above the valley floors.[77] These benches slope towards the valley bottoms with distance westward. All this gravel is rounded to well rounded and predominantly quartzite. Based on their relationships to other rocks, the Idaho erosion surface is dated between late Cretaceous to Middle Miocene of the geological time-scale.

Mountain top erosion surfaces have been documented in Hungary,[78] and are extensive in Australia.[79] They are also common elsewhere around the world: '*. . . the ancient landscape of southeastern Australia may he typical of very substantial parts of the earth's surface.*'[80] Such erosion surfaces severely challenge the uniformitarian paradigm:

> *'But here a paradox arises. Although these landforms are undeniably very old, there is nothing exceptional about their geological-geomorphological setting. There is neither a dearth of erosive energy, nor a particularly great bedrock resistance. . . . Moreover, not only the upland surfaces are old, so too are the canyons which dissect them.'*[81]

They also challenge any post-Flood catastrophism, because mountain-top erosion surfaces across the Earth imply flooded continents. How would any post-Flood life survive?

These erosion surfaces probably have an origin similar to the gravel-capped pediments and the high-plains erosion surfaces. They either formed before the mountains rose, akin to an uplifted high plains erosion surface, or formed while the mountains were rising out of the Flood waters. In either situation, the mountain-top erosion surfaces must have been planed smooth by fast-moving currents. Evidence that at least some of these high-level erosion surfaces were formed as the mountains rose out of water is indicated by the erosion surface on the south-west Absaroka Mountains. These are volcanic mountains that must have formed before the erosion surface. It also implies that these mountains were partly or totally under water at one time. It is the Eocene andesites of this mountain range that contain the successive fossil 'forests' of Yellowstone Park, giving credence to Harold Coffin's hypothesis of underwater deposition of the successive 'forest' layers.[82] It also lends credence to the hypothesis that the Heart Mountain Detachment was emplaced by a large underwater landslide during the Flood.[83]

(8) Huge Volume of Long-Runout Coarse Gravel at High Elevation

An eighth indication that the Flood/post-Flood boundary is above the Eocene is the existence of locally thick beds of coarse gravel at altitudes ranging from about 1,500 m to over 3,000 m in south-west Montana, north-west Wyoming and adjacent Idaho. The coarse gravel in the northern part of the area in Montana is mostly composed of syntectonic limestone cobbles and boulders eroded from the uplifting mountain ranges.[84-86] The coarse gravel is locally up to 4,600 m thick within a fault zone.[87,88] Boulders up to 2.5 m long are common, with a few isolated blocks up to 6m in well-stratified conglomerate.[89] In the southern part of south-west Montana and adjacent Idaho the coarse gravel is mostly quartzite. The clasts are often cobbles and boulders with a maximum up to 4.5 m.[90] The quartzite clasts are well rounded, while the limestone clasts are more angular.[91]

Figure 9. *A well-rounded quartzite clast about 60 cm in diameter from the well-rounded quartzite gravel and boulders outcropping on top of the Gravelly Range, about 3,000 m, in south-west Montana. The deposit was at one time considered a tillite from the now defunct Eocene 'glaciation' in the Rocky Mountains.*

Besides being found in the valleys between mountain ranges, the coarse gravel is locally found on the **very tops of the mountains.** Well-rounded boulders of mostly quartzite outcrop at an altitude of 3,000 m on top of the Gravelly Range.[92] Figure 9 shows a 60 cm diameter quartzite boulder from this deposit. Because the conglomerate is mostly matrix supported with striated and faceted clasts overlying a striated rock surface, early geologists thought it was a 'tillite' from an Eocene glaciation. One of the highest mountains in the Snowcrest Range of south-west Montana is composed of up to 1,500 m of coarse gravel.[93] Sphinx Mountain at 3,315 m above sea level (ASL) is the highest mountain in the Madison Range. The top of this mountain consists of about 1,000 m of coarse gravel covering an area of 9 km^2.[94] On the north-east side of the mountain there are large cross-beds of coarse gravel up to 90 m high.

The source of the limestone boulders is very likely local, because the clasts are often angular and composed of local limestone lithologies from the surrounding mountain ranges. However, the source of the well-rounded quartzite clasts is an enigma. Directional indicators show that the quartzite came from the west. The nearest outcrops for this distinctive rock are 80 km away.

These outcrops are the Precambrian Belt Supergroup and the Ordovician Kinnikinic Quartzite along the east flank of the huge Idaho batholith.[95,96] Based on the clast lithologies and the relationship of the coarse gravel to other strata, geologists date the gravel between the Late Cretaceous to about Eocene.[97,98]

The quartzite conglomerate of south-west Montana and adjacent Idaho can be traced farther east and south-east. In north-west Wyoming, well-rounded, predominantly quartzite gravel and cobbles are widely scattered in the Jackson Hole area[99,100] Over 325 km^3 of quartzite clasts are preserved from an estimated original volume of 2,500 km^3.[101] The coarse gravel is locally 3,300 m thick. The largest quartzite boulder is 1.3 m in diameter. The coarse gravel can also be found on the crest of the Teton Mountains of western Wyoming,[102] in the north-western Wind River Basin of central Wyoming,[103] the extreme northern Green River Basin in west-central Wyoming,[104,105] and the western flank of the Bighorn Basin of north-central Wyoming.[106] This huge amount of coarse gravel is similar to that in south-west Montana and adjacent Idaho.[107-109] It is mostly massive, and sometimes has cross-beds with an easterly dip, indicating a source from the west.

All this well-rounded coarse gravel is an enigma for uniformitarian geologists. If the quartzite clasts in the Jackson Hole area were transported from the eastern edge of the Idaho Batholith it would have travelled 450 km.[110] The clasts in the western Bighorn Basin were transported another 100 km farther eastward.[111] That is a total distance of 550 km! Some authors have considered the source too far away for normal currents. Other authors have proposed an original erosional cycle of modest eastward transport, followed by further reworking eastward over millions of years. Geologist David Love could not comprehend coarse gravel being transported that far, so he postulated an uplift just to the west of Wyoming in south-eastern Idaho that was later eroded away. This idea is not well accepted by other geologists. Lindsey makes a strong case for direct transport by 'streams'. His case is based on the immense volume of well-rounded quartzite, lack of evidence for reworking, and the distribution of gold in the gravels.[112] The lack of reworking is bolstered by the large quartzite clasts that were transported along with the smaller clasts,[113] the strongly unidirectional palaeocurrents,[114] the well-sorted distribution of clasts[115] within remarkably extensive horizontal sheets,[116,117] and huge planar cross-beds.[118] These facies relationships are counter to suggestions that the coarse gravel was laid down in a vast braid-plain or a huge alluvial fan. Braid-plains are expected to contain a more chaotic distribution of facies,[119] while alluvial fans are poorly sorted.[120]

All this high-level coarse gravel gives testimony to huge, widespread currents capable of eroding, rounding and transporting large cobbles at least 550 km to the east. Many erosion surfaces left on the mountain tops in the area add support to widespread, fast currents.[121-124] Because some of the coarse gravel ended up in valleys, while some caps mountains, the deposition must have occurred just before and while the various mountain ranges were extending and uplifting. The fact that the deposits are scattered also indicates that the same erosional event was capable of re-eroding the cobbles and boulders in many areas.

Besides a few scraps of dinosaur bone and some plant remains, marine dinoflagellates, acritarchs and molluscs are found within the conglomerate and the minor interbeds,[125,126] implying all this activity occurred **under water.** One researcher automatically invoked 'reworking' in what he believed was a subaerial environment to account for the dinoflagellates,[127] but this does not make sense in such a violent environment. The mountain ranges in the area are well over 2,000 m and in some areas over 3,000 m ASL, indicating considerable uplift out of the water. Based on fossils, the Wyoming coarse gravel is dated from Cretaceous to Eocene. The scenario speaks of the draining Flood waters and the mountains uplifting through and above the water. The Flood/post-Flood boundary in this case would be above the Eocene. A post-Flood catastrophe to account for this long runout conglomerate would be violent indeed. Most, if not all, of western North America would have been submerged below the ocean from the Cretaceous to the Eocene. How then would the dinosaurs have lived in Montana and Wyoming during the Cretaceous?

(9) Water Gaps

A ninth indication of the Flood/post-Flood boundary being in the Late Cainozoic is the existence of rivers that seem to cut straight through mountain barriers, as if they were not there. This is a common feature in Wyoming.[128] For example, the Shoshone River just west of Cody, Wyoming cut through the hard crystalline core of the Rattlesnake Mountains. The river could have easily flowed to the south around the southern Rattlesnake Mountains, over terrain that is not much higher than the plains around Cody. Water gaps also occur at a few places in Montana, such as the Bighorn River through the Bighorn and Pryor Mountains of south-central Montana. If these rivers deposited the Cainozoic valley fills, why did they not go around the mountains? How could these rivers cut these water gaps through the mountains in post-Flood time? A more reasonable belief is that rapidly-flowing, channelised Flood currents cut rapidly through the rising mountains as the Flood waters were draining. It was truly a 'superimposed river', not from a lazy modern-type river but from a global Flood.

(10) Thick, Laterally Extensive Coal Seams, Powder River Basin

A tenth problem, which seems insurmountable, is the existence of a huge amount of coal in Early Cainozoic sediments of the Powder River Basin of south-east Montana and north-east Wyoming.[129,130] Several thick, low ash, low clay coal seams occur in this basin. The newly discovered Big George Seam in the western Powder River Basin covers an area of about 100 km north-south by 40 km east-west, and is 61 m thick. The Wyodak Seam outcrops further east

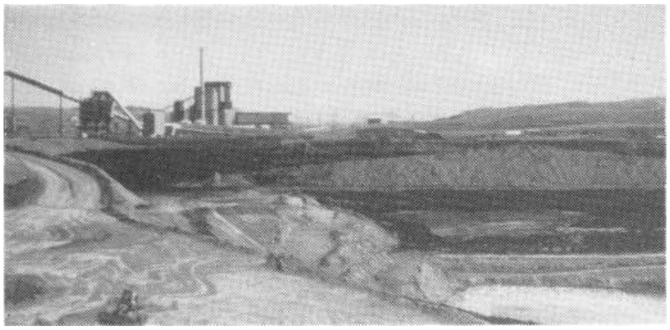

Figure 10. *Wyodak coal beds being mined near Gillette, Wyoming.*

near Gillette, Wyoming, covers an area of about 100 km north-south by 15 km east-west, and is 31 m thick (see Figure 10). The thickest seam in the Powder River Basin and in the United States, the second thickest in the world, is the Lake DeSmet Seam. It is up to 75 m thick! When considering the compaction ratio of peat to coal (which could be as much as 7:1), and the little clay or other fluvial deposits in these coal seams, at least 500 m of almost pure peat must sink and finally be covered by thick sedimentary rocks to form coal. This scenario must be repeated several times to account for the other seams in the Powder River Basin. Referring just to the Powder River Basin, how is all this vegetation going to grow, collect in one basin as thick as 500 m, and be covered by more sediments at least 1,000 m thick, all in post-Flood time?

These coal seams present a serious uniformitarian problem.[131] The difficulty is just as serious for those who believe these Early Cainozoic coals grew up after the Flood and were transported into place.[132] In fact, about half the coal in the world is found in Mesozoic and Cainozoic sedimentary rocks.[133] So the problem is of huge proportion and likely world-wide in extent. It would be difficult for extensive forests to grow on mostly, or totally, flooded continents.

There is a difference between the Late Palaeozoic coal vegetation and the vegetation that makes up Mesozoic and Cainozoic coals. The separation of the types of vegetation during the Flood could be due to ecological variables, such as differences in lateral and/or vertical pre-Flood habitats. Scheven presents a very good case that the Late Palaeozoic coals consisted of the remains of floating forests that were transported into place during the Flood.[134] The forests that make up the coals of the Mesozoic and Cainozoic could have grown on highlands and mountains, or in different locales from the floating forests. The higher elevation forests then could have been ripped up at a different time by the Flood waters and deposited in different locations.

Table 1 presents a summary of these evidences from Montana and Wyoming that the Flood/post-Flood boundary is in the Late Cainozoic. If all the many batholiths, diatremes, and lava flows and meteorite strikes of Mesozoic and Cainozoic are also included, the post-Flood catastrophism would indeed be phenomenal. With all this post-Flood activity, one would expect large landslides, but there are very few, while there are many in the Pleistocene.[135] The tectonism, volcanism, erosion and sedimentation seen in the western United States, as well as the rest of the world, would be a post-Flood catastrophe rivalling the Genesis Flood. In this scenario, it could easily be asserted that the waters of the Genesis Flood prevailed for tens to hundreds of years! On the other hand, many features seen in Montana and Wyoming, which are puzzles within the uniformitarian paradigm, fit quite naturally into a one-year Flood paradigm.

ARE THE COLUMBIA RIVER BASALTS POST-FLOOD?

The strata that have especially convinced some creationists that the Late Palaeozoic, Mesozoic, and Cainozoic is post-Flood are the huge flood basalts around the world.[136] The lava flows and other volcanic deposits of eastern Washington, northern Oregon and western Idaho are thought to be proof that most or all of the Cainozoic is post-Flood.[137-139] There are a multitude of Cainozoic volcanic formations in this area, but the most extensive and stratigraphically the latest is the Columbia River Basalt Group (see Figure 11). These basalts consist of well over 100 individual lava flows that moved rapidly westward from eruptive centres in south-east Washington, north-east Oregon and adjacent Idaho. These flows covered an area of 164,000 km^2.[140,141] The estimated volume is 175,000 km^3 for an average depth of about 1.1 km. The basalt thickens to as much as 3.5 km in the Pasco Basin, which is in the central part of the depositional area. The basalt is dated as Miocene. Several basalt flows passed through the Columbia River Gorge between the Cascade Mountains of Washington and Oregon and spread out in the Portland (Oregon) area, continuing westward into the present ocean.

Are these huge basalt flows really post-Flood? The question mainly revolves around whether the basalts erupted subaqueously or subaerially. It is still theoretically possible that flood basalts could either partially or totally be laid down subaerially during the Flood. However, I do not believe this is likely. At one time I leaned towards the theory that the Columbia River Basalts were post-Flood,[142] but a closer examination since then has changed my mind. I

(1) Volume of Mesozoic and Cainozoic sediments too large
(2) Extensional tectonics and valley fills, south-west Montana
(3) Erosion of 1,000 m of sediments
(4) Unreasonable life histories of animals
(5) High plains erosion surfaces
(6) Pediments in the south-west valleys of Montana
(7) Mountain top erosion surfaces
(8) High volume of well-rounded quartzite coarse gravel, sometimes at high elevation on mountain tops of south-west Montana and north-east Wyoming
(9) Water gaps
(10) Thick, laterally extensive coal seams, Powder River Basin

Table 1. *Evidence against a Flood/post-Flood boundary before the Late Cainozoic in Montana and Wyoming.*

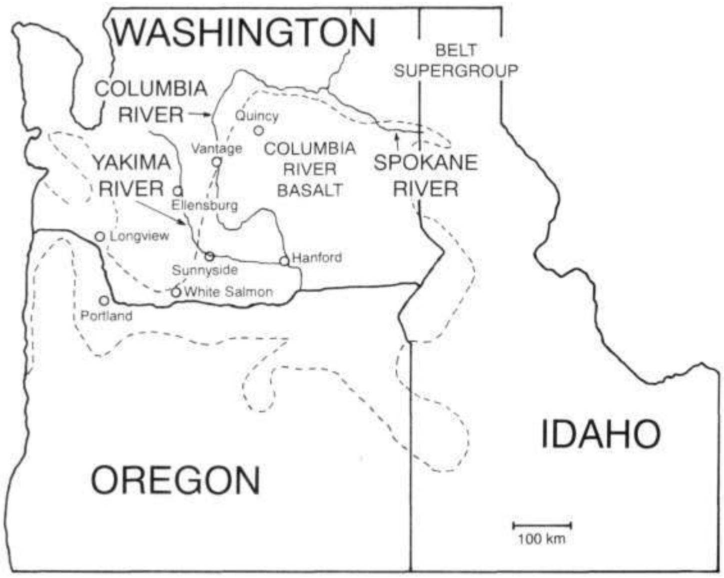

Figure 11. *Map of the extent of the Columbia River Basalt in Washington, Oregon and Idaho. The generalised boundary is outlined by dots. Places discussed in the text are also noted. (Drawn by Nathan Oard.)*

believe there is substantial evidence that these basalts were erupted under water, in which case the Genesis Flood would be an *apropos* paradigm. If the Columbia River Basalts are subaqueous, then all the other huge basalt deposits around the world likely would be **Flood** basalts also.

(1) The Troutdale Formation Conglomerate

One of the most persuasive pieces of evidence is the Troutdale Formation. This formation is composed mostly of well-rounded, generally massive, coarse gravel that outcrops extensively around Portland, Oregon. The formation is composed of a lower and upper member. The lower member, which is of particular interest, extends from south-east of Portland to north of Vancouver, Washington, a distance of about 50 km.[143] It extends north-west about 80 km down the Columbia River from Portland to Longview, Washington. The Troutdale Formation is up to 335 m thick and contains minor interbeds of sand, silt and clay. The conglomerate beds are nearly horizontal, with a dip to the west or south-west of about 2°.[144]

The most significant aspects of the lower member of the Troutdale Formation are that it is composed of at least 30 per cent quartzite clasts and the formation mostly overlies the Columbia River Basalts.[145] Tolan, Beeson and Vogt even state that the lower member is chiefly quartzite.[146] A minor proportion of quartzite clasts also occur in the upper member of the Troutdale Formation as well. Basalt boulders make up most of the remainder of these rocks. Besides overlying the Columbia River Basalts[147,148] the Troutdale is also believed to locally underlie the last lava flow in the Columbia River Gorge. Hence, the Troutdale Conglomerate spread over the area at the very end after the eruption of the Columbia River Basalts. Therefore, the formation is dated as upper Miocene and Pliocene. Figure 12 shows the Troutdale Formation in its stratigraphic context in the Portland area.

The nearest outcrop of quartzite is the western edge of the Belt Supergroup that outcrops in extreme north-eastern Washington! This is a distance of at least 500 km, not including the meandering of the Columbia River, which has been assumed to have carried the quartzite clasts into the Portland area. The quartzite cobbles can be traced eastward up the Columbia River Gorge by rare outcrops. One outcrop is at White Salmon, Washington (see Figure 13). The conglomerate can be traced farther north-east in Washington as the Snipes Mountain Conglomerate at Sunnyside, lower Yakima Valley, which is composed of 40 to 60 per cent quartzite clasts[149] (see Figure 14). The last trace of quartzite cobbles appears to be in the Hanford area of the north-western Pasco Basin.[150]

It is highly questionable whether quartzite cobbles can be rolled by a meandering Columbia River well over 500 km downstream. Of course, quartzite being a hard rock would be expected to be rolled farther down a river, but nowhere near 500 km and spread over a wide area.[151] The Troutdale Formation presents formidable problems for uniformitarian scientists, who believe the Columbia River Basalts were deposited on land and were

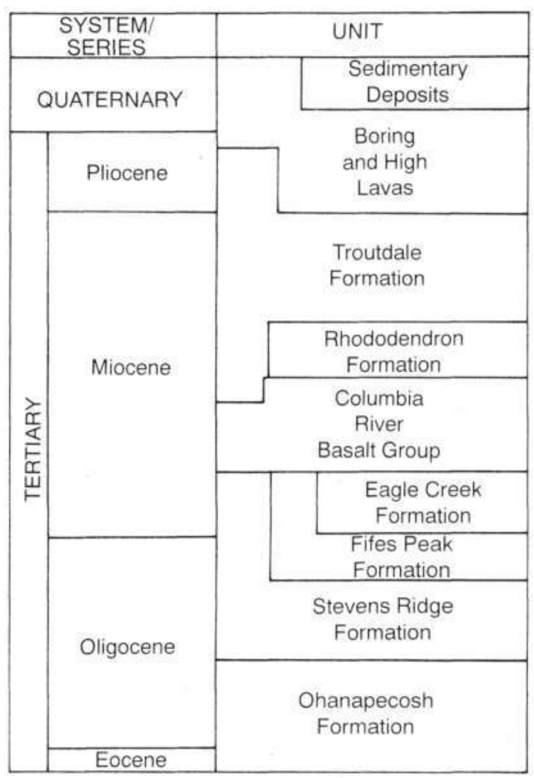

Figure 12. *Generalised stratigraphic diagram for the Columbia River Gorge area near Portland, Oregon, USA. Note that the Troutdale Formation interfingers with the highest flows of the Columbia River Basalt Group in the mid Miocene. It is also dated as young as the Upper Pliocene. Different authors have dated the formation differently. (Redrawn by Nathan Oard from Beeson and Tolan, 1987, p. 322).*

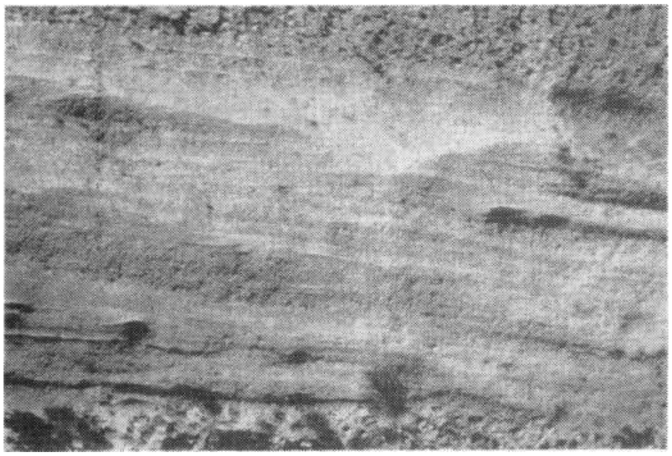

Figure 13. Well-rounded massive Troutdale conglomerate of various sized clasts at White Salmon, Washington, in the Columbia River Gorge. This isolated outcrop was protected from erosion by a capping local lava flow.

never covered by water, except for local lakes. Those creationists who postulate huge post-Flood catastrophic events must first deposit the Columbia River Basalts subaerially, then cover eastern Washington and at least northern Idaho with water. Then this water must rush westward off the area at sufficient velocity to transport quartzite cobbles to the Portland area. The water-flow east of Portland must have been very strong because there are few locations with quartzite cobbles, which means the currents allowed only local deposition or else re-eroded the cobbles after widespread deposition. The latter situation is more likely because the erosional remnant preserved at White Salmon in the Columbia River Gorge was protected by a local lava flow that capped the Troutdale Formation.

It seems much more logical that the Flood would have transported such a huge amount of gravel and cobbles from over 500 km distance. This could have occurred as the land was uplifted from deep water, with fast currents flowing westward off the rising land. Tolan and Beeson say that the upper member conglomerates locally display westerly dipping 'torrential' foreset bedding.[152] Most of the Columbia River Basalts had already been laid down when the coarse gravel swept across the northern and western part of the Columbia River Basalts in Washington, through the Columbia River Gorge, and was deposited as a thick sheet in the Portland area. Deposition was likely due to waning currents as the flow spread out at the mouth of the Columbia River Gorge. As the Flood currents abated, they were still strong enough to erode much of the coarse gravel, even in the Portland area, leaving behind erosional remnants.

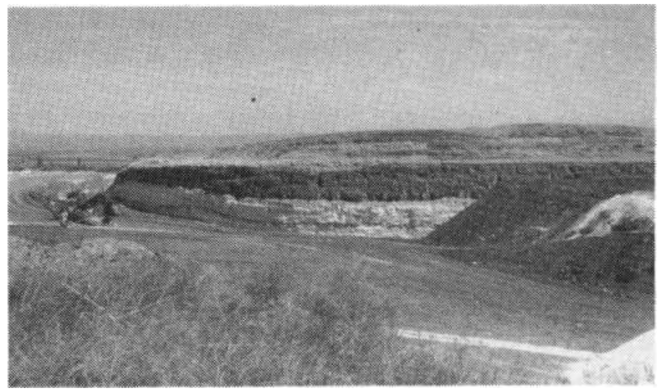

Figure 15. A 6 m layer of pure diatomite between two basalt flows of the Columbia River Basalt Group near Quincy, Washington.

(2) The Diatomite Layer Between Basalt Flows

A second reason why I believe the Columbia River Basalts were laid down in the Flood is the presence of a diatomite layer sandwiched between two layers of basalt that outcrops around Quincy and Ellensburg, Washington. Figure 15 shows the approximately 6 m thick diatomite layer from a mine at Quincy, Washington. The diatomite is nearly pure with little clay (see Figure 16). It seems doubtful that pure diatomite could have formed slowly in a lake, as

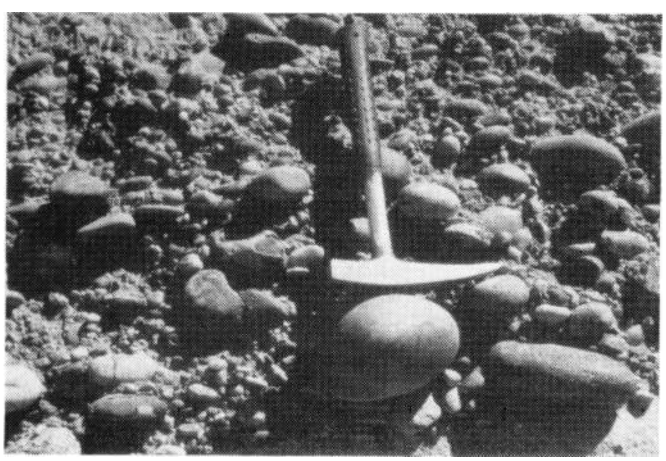

Figure 14. Close up of the massive conglomerate containing 40-60 per cent well-rounded, quartzite gravel and cobble clasts from Snipes Mountain near Sunnyside, Washington, in the lower Yakima Valley.

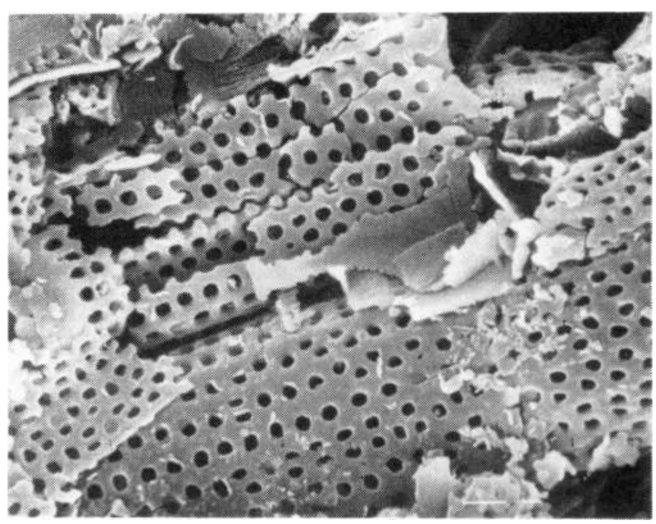

Figure 16. SEM micrograph of the diatomite at Quincy, Washington, showing crushed diatoms but no clay. Magnification 7,000 times. (Photo by Ray Strom.)

uniformitarian geologists claim. It also seems unreasonable that such pure diatomite could form in a post-Flood catastrophic scenario, even if the basalts were deposited rapidly.[153] Such purity represents unusual conditions of rapid deposition. Pure or nearly pure deposits of micro-organisms is one of the reasons why I am not convinced of a post-Flood deposition for chalk deposits in Europe and the United States, as suggested by Tyler.[154] Tyler's main evidence is the existence of hardgrounds with burrows in the European chalk and bentonite layers in the United States chalk. We do not know how fast these features can form in catastrophic Flood conditions. The hardgrounds, burrows, bentonites, and many other aspects of these chalks need a thorough investigation.

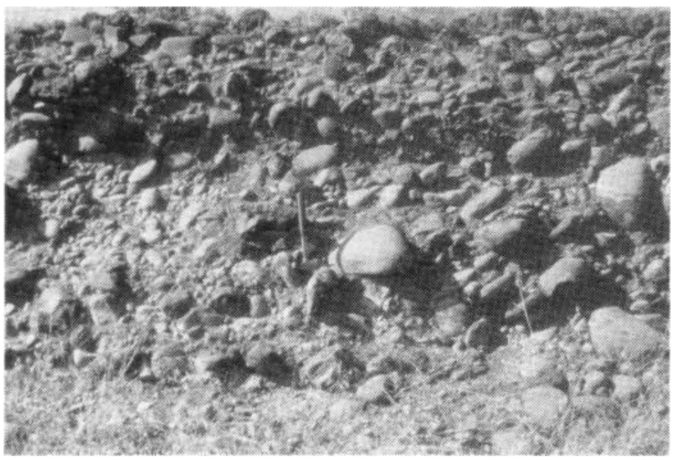

Figure 17. *The Thorp coarse gravel west of Yakima, Washington.*

(3) The Massive Thorp Coarse Gravel

A third piece of evidence is the Thorp coarse gravel that locally outcrops as a sheet in the Yakima-Ellensburg area.[155,156] In this area the Columbia River Basalts form a series of long east-west anticlines separated by synclines, with a relief of about 400 m. The coarse gravel is located in the western portion of the anticlines. It is composed of well-rounded basalt gravel, cobbles, and boulders up to at least 35 cm in diameter (see Figure 17). The Thorp coarse gravel generally forms flat-topped terraces in the synclines, or pediments that slope up to the bases of the anticlines. One such terrace outcrops over a 20 km by 10 km area west of Yakima, with a depth greater than 30 m, as seen in stream cuts.[157] The conglomerate locally is thicker than 100 m in the Ellensburg area. It takes powerful currents to transport conglomerate and deposit it as flat-topped terraces and pediments in synclines. The Flood seems to be the only adequate mechanism.

(4) The Rounded, Eroded Anticlines

The Thorp conglomerate is one indication that the anticlines of the Columbia River Basalts were eroded by water. Another indication is that the anticlines have a smooth, rounded appearance. The top of the Rattlesnake Hills anticline, south-east of Yakima, has been eroded off and rounded. Well-rounded lava and milky quartz clasts (likely derived from vugs in basalts) are found on top of the Rattlesnake Hills. The evidence of water action on the anticlines is a fourth reason why I believe the Columbia River Basalt Group is Flood-related.

(5) The Subtropical Trees Within the Lavas

The fifth reason is the subtropical trees that have been caught and fossilised in the interbeds between the lava flows. Fossil wood can be found in many areas of the Columbia River Basalts and the Ellensburg Formation, which outcrops within and on top of the lava flows in the west. Even a cast of a rhinoceros along with casts of logs have been found in an interbed of the basalt.[158,159] The most prolific area for finding fossil trees is in Ginkgo Petrified Forest State Park at Vantage, Washington, where large petrified logs abound. Of the 200 species of trees found at Vantage, the most interesting are those from a subtropical climate, such as *Eucalyptus* and *Taxodium*.[160] In order for the logs, as well as the rhinoceros, not to have been completely burned up, the lava must have been extruded in water, at least locally. This lends support to a Flood deposition of pre-Flood flora and fauna, and not *in situ* growth between post-Flood lava flows in a subtropical climate.

(6) The Water Gaps

A sixth reason for a Flood/post-Flood boundary after extrusion of the Columbia River Basalts is that the Yakima River cuts straight through topographic highs of the lava anticlines, when it could have flowed around or passed through the anticlines at low spots. The Yakima River flows eastward out of the Cascade Mountains of Washington, and near Ellensburg takes a southerly turn and cuts with incised meanders through several anticlines before emerging at Selah, Washington. It could have continued flowing eastward from Ellensburg over a low saddle and into the Columbia River. The main uniformitarian hypothesis to explain this anomalous behaviour is the antecedent river hypothesis.

The Yakima River in its straight southerly trend cuts through two more anticlines north and south of Yakima. Union Gap is the last water gap south of Yakima, between the Antanum Ridge to the west and the Rattlesnake Hills to the east. There is a low spot in the Rattlesnake Hills called Konnowac Pass. This pass is about 380 m above sea level (ASL), while the anticline on either side of Union Gap rises rapidly to over 500 m ASL, with high points over 600 m ASL. This is an approximate 200 m difference between Konnowac Pass and the anticline at Union Gap before it was cut by the Yakima River. Under uniformitarian conditions, a lake should have formed around Yakima that either drained eastward through the syncline, or flowed south over Konnowac Pass. There is no evidence of a former lake, or of a route for the river through Konnowac Pass. The river cut through anticlines from Ellensburg to south of

(1)	Troutdale quartzite conglomerate overlying basalt
(2)	Nearly pure diatomite bed between lava flows
(3)	Massive, thick Thorp coarse gravel overlying basalt
(4)	Rounded, eroded anticlines
(5)	Subtropical trees within lava
(6)	Water gaps of Yakima River through anticlines

Table 2. *Summary of the reasons why I believe the Miocene Columbia River Basalts were deposited during the Flood.*

Yakima as if the anticlines did not exist.

Although the uniformitarian hypothesis is somewhat plausible given millions of years, it seems inconceivable that the Columbia River Basalts were deposited, buckled into east-west anticlines, and then the Yakima River cut through them, all in post-Flood time. There does not seem to have been enough time since the Flood, unless catastrophic activity was on a par with the Genesis Flood. It is difficult to understand how some post-Flood watery catastrophe could cut these water gaps, unless the area was totally submerged. Thus the water gaps could have formed rapidly while the Flood waters were draining off the area via a southerly channelised flow. The flow could have been channelised by the convergence of water flowing eastward off the developing Cascade Mountains, with water flowing westward off the rising Rocky Mountains. This would have forced the water to turn south towards the only westward opening, the Columbia River Gorge. Table 2 summarises the reasons why I believe the Columbia River Basalts were formed during the Flood.

OBJECTIONS TO THE FLOOD ORIGIN OF THE COLUMBIA RIVER BASALTS

The above evidence will elicit questions from those who believe the Columbia River Basalts were extruded subaerially and therefore after the Flood.[161,164] I have compiled a list from their papers of 13 reasons why they believe the Columbia River Basalts, and by extension other flood basalts, are subaerial. These are presented in Table 3.

Widespread basalt layers are believed to be subaerial

(1)	Basalt layers widespread
(2)	Rarity of pillow lavas
(3)	Columnar structures
(4)	Welded tuff
(5)	Pumice fragments within tuff beds
(6)	Location at edges of continents
(7)	Interbedded sediments
(8)	Local laterites and palaeosols, some tree-bearing
(9)	Terrestrial fossils in interbedded sediments
(10)	Poor textural sorting of tuffs, similar to air-fall tuffs
(11)	Clasts in conglomerate from a local source
(12)	Abrupt lateral variation in facies
(13)	Thickness of volcanic deposits

Table 3. *Thirteen reasons why several creationists believe the Columbia River Basalts were extruded subaerially and hence are post-Flood.*

because underwater extrusion would 'quench' the liquid lava, slowing it down, and restricting its lateral spread. It is true water would more rapidly quench the lava than would air, and as a result we observe only short runout lava flows in the subaqueous environment today. However, flood basalts are widely recognised to have resulted from the rapid extrusion of hundreds of cubic kilometres of lava (although there is a trend today to de-emphasise this conclusion[165,166]). Such extremely rapid extrusion on such a vast scale is not occurring today, so we really do not know how fast, either subaqueously or subaerially, these lavas could have travelled.

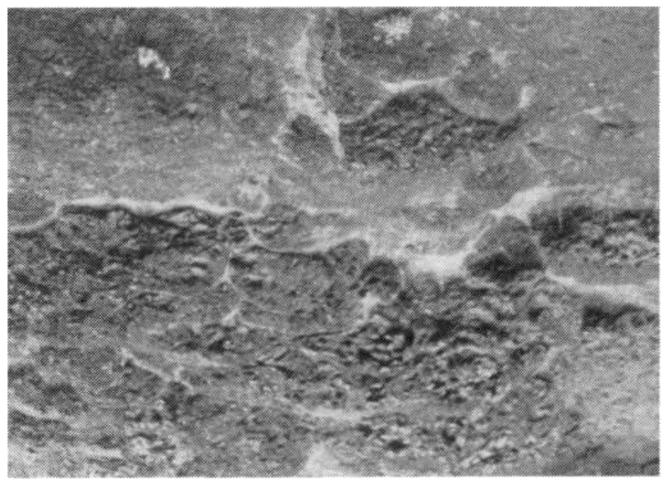

Figure 18. *A pillow-pelagonite complex near Crown Point, east of Portland, Oregon.*

The lack of pillow lavas is a second objection. However, non-pillowed basalt has been discovered on the bottom of the ocean,[167] so lack of pillows is not necessarily an indication of subaerial deposition. Besides, pillow lava and pelagonite are relatively common along the Columbia River and in road cuts of eastern Washington.[168,169] Pelagonite is a yellowish breccia caused by disintegration of lava in water. Figure 18 is a pillow-pelagonite complex near Crown Point, east of Portland, Oregon. Since uniformitarian geologists believe the Columbia River Basalts were emplaced subaerially, the evidence for water deposition is simply attributed to flow into a lake. Whether a lava flow forms pillows or not very likely depends upon the rate of extrusion.[170]

Columnar joints, the third objection, are a sign of slow cooling which allows the lava to form a shrinkage network. Again, whether columns form may very well depend upon the volume of lava extruded. Great masses of lava should cool slowly forming a shrinkage network. Of course, small subaqueous lava flows observed today likely would not form columnar joints. It is interesting that columnar joints are also observed associated with, and even between, pillow lava on Crown Point and at Multnomah Falls (personal observation).

Of course, tuffs from the puny eruptions of today are not expected to form welded tuff (the fourth objection).

Although controversial, some geologists, however, do believe tuff can be welded under water.[171] Possibly the great size of volcanic eruptions during the Rood could have aided this process.

Common sense says that in a volcanic eruption pumice fragments should float on water and be separated from tuff which sinks. Consequently, the observation of pumice within tuff seems like a valid argument for subaerial deposition. Unfortunately for our simple deductions, nature often is more complex. Recent observations of volcanic debris on the ocean bottom near volcanic islands indicate that indeed pumice can be deposited within tuff under water.[172] Submarine eruptions cause pumaceous layers, with the pumice settling to the bottom as fast as lithic grains. Moreover, experiments simulating subaerial eruptions have shown that hot pumice cubes sink almost immediately when dropped in water. This happens because the hot air in the pores suddenly contracts and the water is sucked into the pumice, and also because some of the water turns to steam within the pumice, expelling the air and condensing the steam.

Garner makes the point that all flood basalts are located along the edge of continents and are mostly associated with early continental rifting.[173] If I correctly understand this seventh argument, this basalt associated with continental breakup is supposed to be proof of subaerial basalt extrusion. However, this argument seems to be straight uniformitarian thinking. A Flood model is non-uniformitarian by definition.

The Columbia River Basalts contain interbeds between the many flows. These interbeds mostly occur along the edges of the Columbia River Plateau. In the west, they are called the Ellensburg Formation and in the east the Latah Formation. Garner sees these sediments as fluvial, lacustrine and aeolian.[174] The basis for the lacustrine interpretation presumably is the pure diatomite discussed previously. However, fluvial, lacustrine and aeolian are purely uniformitarian environmental interpretations that have little to do with a Flood paradigm. They cannot constitute evidence against the Flood. The gravel-capped plateaus, pediments and mountain tops from southern Alberta to northern Wyoming **automatically** are given a fluvial environmental interpretation, based mainly on the well-rounded clasts. It does not matter to uniformitarians whether the rounded coarse gravel was transported 500 km and is widespread and thick. We thus need to be careful of uniformitarian environmental interpretations. Within a Genesis Flood paradigm, interbeds within the basalts could simply be short pauses between flows in which other types of Flood sediment were quickly deposited.

Uniformitarianism seems to be the reason behind the eighth objection, the local existence of laterites and palaeosols, some tree bearing. Lately, uniformitarian scientists seem to see palaeosols almost everywhere. Laterites are basically red beds, which seem to be locally associated with flood basalts. However, just because a sediment is red does not mean it is a laterite or a soil. It could be a product of hydrothermal alteration.[175] Palaeosols rarely have an A organic horizon and are difficult to distinguish from sediment that has undergone diagenesis.[176] Consequently, all these ancient palaeosols now showing up in the sediments could easily be hydrothermal alteration products during or soon after the Flood. There are upright trees in interbeds of the Columbia River Basalts. But, there are also plenty of logs that are prone. A good explanation for upright trees within a volcanic province has been addressed by several creationists in the floating log mat model.[177,178]

The ninth objection is the lack of marine fossils associated with the Columbia River Basalts and other volcanism in the area. However, what appear to be marine dinoflagellate microfossils have now been found in interbeds between lavas on the Rattlesnake Hills[179] and in Palouse Canyon of south-east Washington.[180] Sponge spicules have also been found in the Latah Formation interbeds near Spokane, Washington.[181] Conditions generally were not conducive for fossilisation when the Columbia River Basalts were erupting. However, where conditions were favourable, the fossils we now see are those that just happened to have been transported into each particular location, whether terrestrial or marine. Just because an organism lived in a terrestrial environment does not necessarily mean it was buried on land within the Flood paradigm. Uniformitarian scientists are almost automatically constrained to postulate a terrestrial environment whenever a dinosaur, mammal or tree fossil is found.

The tenth objection, a similar texture of the tuff to air-fall tuff, does not automatically exclude a subaqueous deposition. During the Flood, some volcanic eruptions would be expected to erupt either on land or break the surface if under water.[182] So, volcanic ash in the atmosphere is expected during the Flood. If volcanism is catastrophic, as shown by huge deposits in eastern Oregon, it is possible the tuff did not have time to sort as huge amounts were rapidly dumped in water. This lack of sorting could be aided by the ash being dumped into a large depositional basin caused by the rising Cascade and Rocky Mountains. So, poorly sorted tuffs on a catastrophic scale could occur.

The eleventh objection — clasts in conglomerate from local sources — seems to be based on preconceived ideas about the Flood, namely, that Flood deposits would always contain exotic clasts. Wouldn't we expect both local and exotic clasts in a Flood depositional sequence, depending upon which of the multitudinous variables were operating at the time? The clasts in the high-level conglomerates in south-west Montana, north-west Wyoming and adjacent Idaho are both exotic and local, with some areas containing more of one than the other. Since volcanism was so catastrophic in the north-west United States, mostly volcanic clasts would be expected.

The last two objections will be discussed together, mainly because they do not seem to be arguments against a Flood deposition at all. In catastrophic volcanism, as shown by flood basalts around the world, very thick deposits on at least a local scale would be expected, whatever the environment of deposition. The argument of rapid facies changes was mainly applied to the John Day area volcanism in north-eastern Oregon. The Columbia River Basalts, which are but one facies in the John Day area, actually show little or no facies changes over a long distance. In the John Day area, tuff indicates rhyolitic and andesitic eruptions, while the basalt was less viscous and non-explosive (except on a local scale). One would expect that for multiple explosive volcanic centres along with basaltic vents, there would be multiple facies in eastern Oregon. This would be the case whether the volcanic activity happened while the area was mostly under water or subaerial. In an underwater environment, there should also be reworking by water and volcanic debris flows, often commingled with other volcanic products.

In summary, there are reasons to believe that the Columbia River Basalts, as well as many of the other volcanic products in the region, were deposited under water during the Flood. The controversy over these volcanic products is probably in part due to the problem of scale. Our modern analogues, like the observed pillow lavas forming on the ocean bottom, are of much too small a scale to be compared with the 175,000 km^3 of the Columbia River Basalts, which were released in rapid pulses.

SUMMARY AND DISCUSSION

There are three reasons from a study of the Ice Age, ten reasons based on the geology of Montana and Wyoming, and six reasons from the characteristics surrounding the Columbia River Basalt Group for why I believe the Flood/post-Flood boundary is in the Late Cainozoic. The character of the Columbia River Basalts does not exclude a subaqueous origin. All this evidence seems quite strong.

However, there are also many problems that can, and will, be pointed to when we look at details of the rocks and fossils. In the conventional geological literature there are many claims made for radiometric dates, palaeosols, burrows, root casts, hardgrounds, mudcracks, ancient 'varves', sediments that represent ancient ice ages, etc., that challenge not only the Flood, but also the short time-scale of Scripture. It is possible that these and many other structures in the rocks will not be easy to explain by creationists within our paradigm. But that still does not mean they are not a product of the Genesis Flood, or must be attributed to post-Flood catastrophism. It may take time for creationists to find reasonable explanations for these diverse phenomena during a one-year Flood. Persistent research is what is needed.

The recent papers by Robinson,[183] Scheven,[184] Tyler,[185] Garton[186] and Garner[187,188] contain many good points. However, many statements do not have adequate support and can be challenged. They all believe the Flood/post-Flood boundary is between the Carboniferous and Permian. One of the first questions to ask these authors is: How can post-Flood catastrophism in a matter of tens to hundreds of years account for more than half the so-called Phanerozoic sedimentary rocks in the world,[189] and yet not overwhelm the newly released occupants of the Ark? How could people and animals survive the volcanic winter caused by the tremendous volcanism shown in the post-Carboniferous record,[190] not to mention meteorite impacts? Inevitably in their attempt to explain palaeosols, hardgrounds, burrows, etc. within a time-scale of tens of years, they will have to theorise mechanisms that are so fast, according to the uniformitarian time-scale, that they probably will not be much different from a one-year Flood mechanism. I believe their model will create more questions than it will answer.

Some of the many problems uniformitarian scientists present against the one-year Flood model do have reasonable answers — for example, the creationist explanation for the successive fossil 'forests' in Yellowstone National Park,[191] the post-Flood Ice Age,[192] and the sedimentation of the Grand Canyon area.[193]

Another crucial issue is that of dinosaur tracks, eggs, nests and babies that are found upon thousands of metres of Flood sediments. One statement I wholeheartedly agree with is that these dinosaur activities are either early Flood or post-Flood.[194] If an animal made tracks, it was alive. All air-breathing, land animals[195] had to expire within at least the first 150 days of the Flood, based on the straightforward reading of Genesis.[196] The European authors do not believe all this dinosaur activity can occur in the early part of the Flood,[197] so they opt for all the dinosaur evidence of the Mesozoic being post-Flood.

Of course, I can understand how the European authors could surmise all the dinosaur activity was post-Flood if all terrestrial animals were **completely annihilated** at the beginning of the Flood. By complete annihilation, they explain the lack of dinosaurs and mammals in the Early to Middle Palaeozoic.[198-200] But I question whether Genesis really means that the terrestrial animals were completely disintegrated when it says 'destroyed'. Besides, in Genesis 6:13 it says that God will destroy all flesh 'with the Earth'. The Earth did not disappear. There are many well-preserved marine creatures in the Early to Middle Palaeozoic. After a period of mass deposition, one would expect to find at least some scrap of terrestrial fauna and flora. I also question whether dinosaurs could have spread all over the Earth on a single supercontinent, survived the splitting of that landmass, and become buried by hundreds to thousands of metres of sediments, which were then re-eroded, all during post-Flood catastrophism. The world-wide catastrophism seen in the Mesozoic and Cainozoic record is so violent that it does not seem possible for dinosaurs or any animal to have survived.

I believe a better solution for dinosaur tracks, nests, eggs, etc. is provided by the early Flood.[201] We seem to be limited in our conception of a one-year Flood, or else we have locked into our minds images of how the Flood should have operated. A one-year global Flood may not fit all our expectations, such as how much sedimentation was produced during certain stages of the Flood.[202] It is reasonable that at the beginning of the Flood, some areas were experiencing massive deposition of sediments, while other high areas were little affected. These high areas would provide refuges for a while. After a period of massive deposition, one would expect local areas of the sediments to become exposed for a while during the Flood. There are at least two reasonable mechanisms for this to occur: either uplift of land due to sinking land elsewhere, or locally falling sea level due to the dynamics of water velocity in relatively shallow water.[203] As the refuges of the animals were being inundated, they would be forced to swim or find new ground, or both. It is reasonable that dinosaurs would come to occupy newly exposed Flood sediments.

In Figure 15 of Garton's article,[204] he seems to misunderstand what I mean by newly exposed Flood sediments. He also assumes uniformitarian deductions of what is considered a terrestrial environment. In the Flood, terrestrial animals will often be buried in marine sediments. If there are no marine fossils close to dinosaurs, then a terrestrial environment is presumed. The newly exposed strip of sediments would show evidence of once being submerged by marine waters. There are plenty of marine fossils in the sediments. Hence, the evidence for a 'marine seaway'. So, I see no problem with dinosaur tracks, nests and eggs being laid on the sediments of this temporarily exposed 'marine seaway'. On the other hand, if the strip of land, labelled western interior seaway in Figure 15 of Garton, was marine during post-Flood time, how did the tracks, nests and eggs get there within their model? The seaway had to be periodically exposed, just as I surmise for the early Flood.

Most of the objections to my model of exposed land during the Flood have been dealt with previously.[205] With more information, I believe the remaining objections can be answered. One objection, especially, has been adequately answered, and that is the significant wear on the teeth of newly hatched babies. Garner uses this information as evidence for an early Flood time greater than 150 days:

> *'However, not only had a nest been built, and eggs laid and hatched, but according to the authors, wear on the teeth of these young dinosaurs indicates that they had been feeding for some time.'*[206]

One of the authors referred to by Garner in the above quote is Jack Horner. Recently, Horner and Philip Currie have discovered actual **embryos** with worn teeth in a nesting site near the Montana-Alberta border.[207] Some dinosaurs grind and wear down their teeth while in the egg! I offer this as an example of how objections, made by both uniformitarian scientists and creationists, to a Flood model with a late Cainozoic Flood/post-Flood boundary can be solved with further research.

Since I have some familiarity with alleged overthrusts, I will add a few comments on Robinson's belief that all overthrusts are real.[208] Overthrusts are a difficult problem for both creationists and uniformitarian scientists. Given the difficulty of understanding, an apparent belief in all alleged overthrusts needs extensive documentation and creationist research. All overthrusts are not the same. There are detachment faults, a type of overthrust in which the rocks slide downhill and settle on a low slope.[209,210] Then there are nappes, bent over folds, that characterise the Alps (probably due to catastrophic uplift of the plutonic rocks in the Alps).[211] There are thick-skinned overthrusts, which are more like reverse faults in which plutonic rocks are thrust over sedimentary rocks. These are common in the mountain ranges of Wyoming. For example, two oil wells drilled in granite in the eastern Bighorn Mountains penetrated sedimentary rocks of the Powder River Basin at 1 and 1.8 km downhole, respectively.[212]

Finally, there are many overthrusts that supposedly were pushed up a gently inclined plane, such as the Lewis Overthrust in north-west Montana, south-east British Columbia and south-west Alberta. A 300 mile (500 km) north-south block of rock was supposedly pushed eastward about 35 miles (60 km) up a slight incline. How this could have occurred is not known, although many speculations have been made. I have examined several of the outcrops of the Lewis Overthrust, as well as other alleged overthrusts in Montana. They commonly have hard rocks over soft rocks, such as shale, and most perplexing, the soft rocks show little evidence of deformation, except local folding in the footwall. The dip of the beds both above and below the thrust contact are generally parallel. This characteristic is apparently common in alleged overthrusts, as stated by Rodgers and Rizer:

> *'One of the major characteristics of overthrust belts is that the major thrust faults are nearly bedding-parallel in incompetent units and are bedding-transverse in competent units . . .'*[213]

The contact in the Lewis overthrust is sharp and may contain a layer of clay from 1 cm to 3 m thick. As far as I know there is no mylonite, fault breccia, or fault gouge. When you compare this information to other types of faults in the area, there is plenty of fault breccia and gouge in the latter. In fact, the greater the movement on the fault, the more fault breccia and gouge.[214,215] To those creationists, as well as to uniformitarian scientists, who believe in overthrusts, I ask what am I to conclude from this information?

I will finish with a few general observations. In Scheven's fine papers[216,217] I could find little to support his placement of the Flood/post-Flood boundary in the Late Palaeozoic, except for a belief that all terrestrial animals had to be totally disintegrated in the Flood (Genesis 6:7) and that the Earth was physically divided at the time of Peleg (Genesis 10:25). I have already commented on the first point. On the second point, the context of Genesis is the dividing by language and families. Besides, if the word for 'divide' really had to be translated as a division of the land, it could refer to some other division, such as rising sea level at the end of the Ice Age cutting off land bridges.[218]

The interpretation of the geological column is a somewhat crucial aspect as to how the sedimentary rocks are to be interpreted within a Flood paradigm. I have made enough comments on the subject elsewhere. But a number of statements made by Robinson relating to the geological column need much more documentation. For instance, he states that the geological column was well in place before the time of Darwin, implying evolution had little or nothing to do with its construction.[219] However, evolution was around before Darwin. Although the early catastrophists developed the geological column, they also believed in multiple catastrophes in which one organism was replaced by another. The Genesis Flood was just one of these catastrophes. What preconceived ideas did the early catastrophists believe when they set up the geological column? Since the geological column was set up in Europe, how did lithology and biostratigraphy intermingle in determining periods? There are many more basic questions just on the development of the original geological column, not to mention how it is extrapolated globally. I hope to see much more documentation and field work on this issue.

These are all the comments that I will make at this time on the European paradigm of a Flood/post-Flood boundary in the Late Palaeozoic. I am sure other creationists will have more to add. Based on the data presented by Holt[220] and in this paper, the case for the boundary being in the Late Cainozoic is strong. I liken this geological data to the observation of debris from an explosion. Looking over the debris, you can conclude there was an explosion. But if you put your microscope to various parts of the mess, you will question how this particular feature or that particular feature could ever be the product of an explosion. You would also be under pressure to doubt that an explosion had occurred if you listened too much to those who say it wasn't an explosion, but the product of slow and gradual processes over long periods of time.

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