# Vertical Tectonics and the Drainage of Floodwater A Model for The Middle and Late Diluvian Period—Part II

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## Abstract

A continued explanation of a model is presented for the erosional effects in the mid and late Flood due to vertical tectonics of the crust coupled with Flood water movement. The sediments eroded during the sheet erosion phase would be deposited as sheets along the edge of the continents forming the continental margin. As the Flood flow became more channelized during the Dispersive Phase, canyons and valleys would be rapidly eroded. Water and wind gaps, as well as pediments—all mysterious within the uniformitarian paradigm—would form rapidly on land. Submarine canyons would quickly be cut on the continental shelves and slopes. The model has significant implications for other models and concepts concerning the Flood.

## Introduction

In part I of this article, several Flood models were briefly discussed, pointing out that these models are a healthy sign according to the principle of multiple working hypotheses. The model developed in this paper is a further elaboration of the Whitcomb-Morris model using the terminology of Tas Walker (see Figure 2, Part I). Evidence for great upward vertical tectonics of continents and subsidence of the ocean basins was presented. The evidence for this mass vertical tectonics is ubiquitous in the form of sheet erosion, erosional remnants, erosion surfaces, and the long distance transport of resistant clasts.

## Where Did All the Sheet Erosion Sediments Go?

If the continental erosion occurred by slow processes over millions of years as envisioned by mainstream geologists, this eroded material likely would form thick debris from the highest land to the coast, especially along river and stream valleys. The surface of the continents would be one large waste surface inclined towards the coasts. Once the debris enters the coastal zone, it would be spread away from river mouths as large deltas. Currents and slides would rework the material along the continental shelf and into the deep ocean. However, this debris from postulated slow erosion over millions of years is not observed on land. Although river deltas are observed, they are not nearly large enough for the massive continental erosion that has occurred. Hence, the debris likely has been removed from the continents.

In the Flood model being presented, large-scale sheet erosion would deposit sediments in areas where waning currents existed. A good analogy would be the Portland Delta formed during the Lake Missoula Flood (Bretz, 1928, pp. 697–700). As the Lake Missoula Flood rushed through the Columbia Gorge at more than 30 m/sec, it slowed as it came to the wide mouth of the gorge in the Portland, Oregon and Vancouver, Washington area. The waning current deposited a giant sand and gravel delta up to 125 m thick and 500 $km^2$ in area. Later, this delta was dissected where the Columbia and Willamette Rivers are now located, probably as the flood subsided and the currents became more channelized.

So where would we expect sheet deposition from massive continental erosion? The answer is either in large, low elevation continental basins such as the Lower Mississippi River Valley (before being filled by sediments that have since lithified) or along the continental margins. The continental margins would have been at the edge of deep water in which the currents rushing off the continents would diminish. The eroded material from the continents, therefore, would form the continental shelves, slopes and rises. Much finer-grained sediment would likely be transported greater distances into the ocean and form some of the clay deposits of the abyssal plains.

Continental shelves are enigmatic from a uniformitarian point of view. Figure 1 is an illustration of the continental margin showing the continental shelf, slope, rise, and abyssal plain. The continental shelf is very flat with a slope of less than 0.1 degree and a relief of less than 20 m

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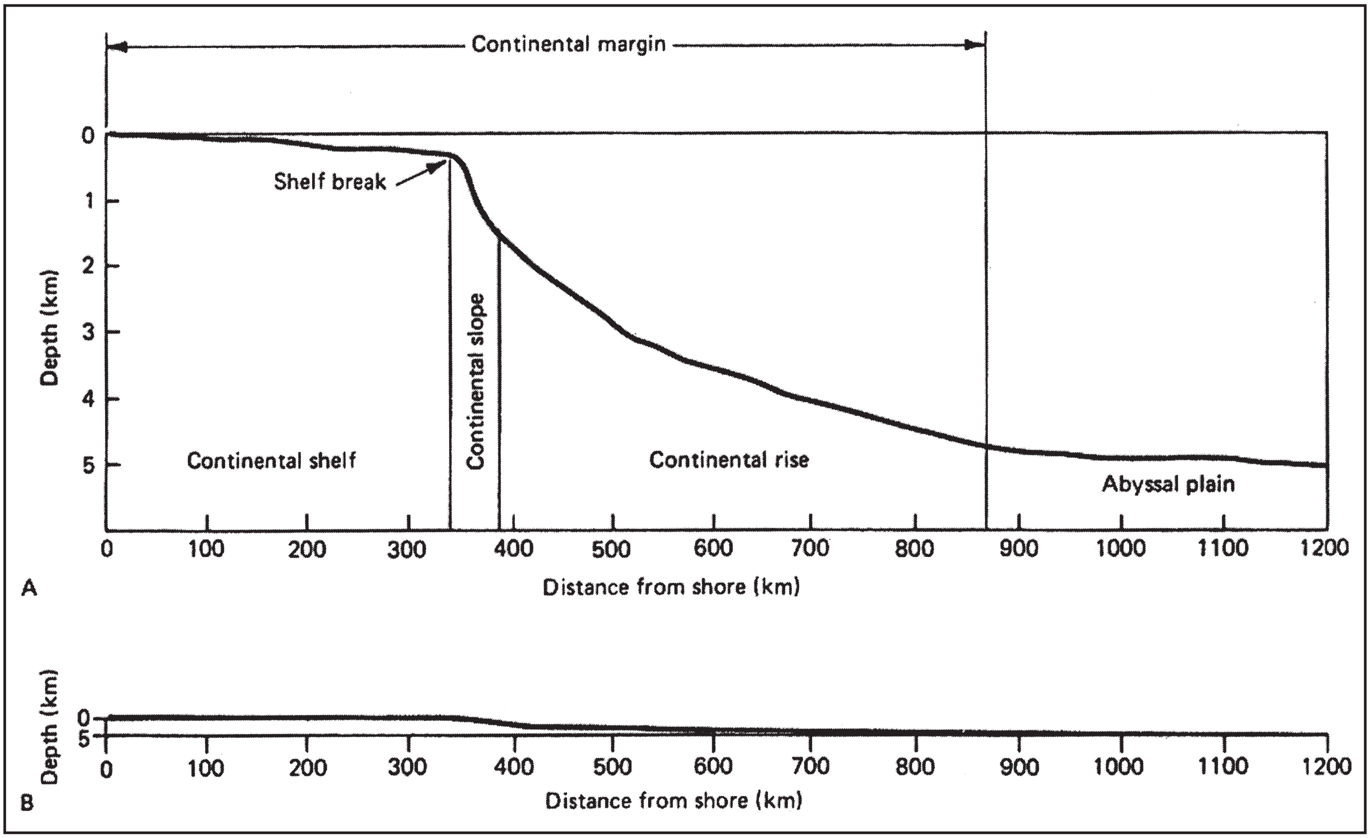


**Figure 1. Principal features of the continental margin with a vertical exaggeration of 1/50 (A) and actual horizontal scale noted in scale (B) (from Kennett, 1982, p. 27; redrawn by Nathan Oard).**

(Kennett, 1982, p. 29). It averages 78 km wide but varies from a few kilometers to over 400 km wide, i.e. on the Bering Sea shelf and the Grand Banks. Then suddenly at the shelf break at an average depth of 130 m, the gradient of the slope abruptly becomes significantly greater (approximately 4° ). This narrow zone plunges to depths of 1500 to 3500 m below sea level to the 100–1000 km wide continental rise. The rise slopes gently downward to an abyssal plain. These features of the continental margin are mysterious because natural processes would favor a gradual descent to the ocean depths; there should be no continental shelf or slope. Seismic reflection profiles generally show delta-like features prograding seaward as well as gentle oceanward-dipping sediments with the slope of the sediments greater the deeper the sediment. Lester King (1983, pp. 199, 200) describes continental shelves and the problems they present to uniformitarianism:

> There arises, however, the question as to what marine agency was responsible for the levelling of the shelf in early Cenozoic time, a levelling that was preserved, with minor modification, until the offshore canyon cutting of Quaternary time? Briefly the shelf is too wide, and towards the outer edge too deep, to have been controlled by normal wind-generated waves of the ocean surface...The formations and unconformities have been tilted seaward (monoclinally) at intervals during the later Cenozoic. There have been repeated tectonic episodes: always in the same sense—*the lands go up and the sea floor down*... [emphasis mine].

Where have we heard a similar statement as the last phrase? In his book, *The Natal Monocline*, King (1982, p. 45) further adds in referring to the continental shelf:

> We note that all the formations drilled dip offshore. The oldest and deepest formations dip at several degrees, the youngest and uppermost dip at less than one degree.

It is interesting to note that the sediments of the shelf and rise are planar with very few canyons cut into them until the sediments were deposited as sheets. Fulthorpe and Austin (1998, p. 262) notice in regard to the "Miocene": "The rarity of middle-upper Miocene clinoform slope canyons contrasts starkly with conditions on the heavily dissected modern slope." This lack of canyons cut in the planar beds of the continental margins until after nearly all the sediments were laid down is why King, in the quote above, refers to the offshore canyon cutting phase as occurring in the *Quaternary*, the last period of geological time. (This aspect will be developed further in the section on submarine canyons.)

The unnatural shape and seismic profile of the continental margin strongly indicates that the sediments were

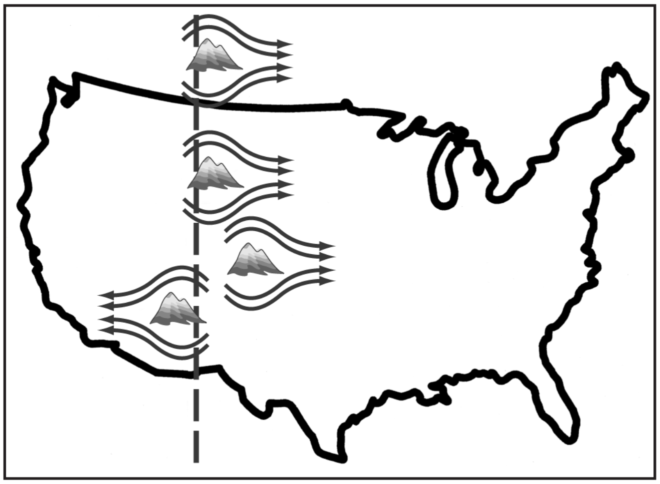

Figure 2. Schematic diagram illustrating sheet flow becoming more channelized as mountains and plateaus are the first to rise out of the Flood waters. The water is forced to flow away from an early "continental divide" (dashed line) (From a drawing by Peter Klevberg, redrawn by Mark Wolfe).

deposited rapidly as sheets that were carried far out to sea. As the ocean basins sank and the continents rose, the sediments became less tilted the shallower the sediment depth. The evidence better supports the Abative Phase of the Flood and defies uniformitarianism.

Furthermore, it is likely that the continental margins were formed all over the world at the same time. The Recessive Stage is one event that likely would have affected all continents at the same time in the same way, mainly because of the similar shape and depth of the continental margins worldwide. If during the Recessive Stage of the Flood only Asia rose out of the Flood water, the continental shelves likely would be quite different, if formed at all, on the other continents. If continents rose sequentially out of the water after the Flood, there likely would be multiple "continental shelves," some exposed on land. Thus, the similar geomorphology of the continental shelves worldwide indicates that during the Flood all continents rose together and that sea level assumed a stable position at the end of the Flood. Consequently, what Noah saw in his region after the Flood can reasonably be applied elsewhere around the world.

## Evidence for the Dispersive or Channelized Phase of the Flood

As more and more mountains and plateaus became exposed during the Recessive Stage of the Flood, the Flood waters would have been forced to flow around these obstacles. The flow would have become more channelized (Figure 2). This is called the Dispersive Phase in Walker's model. The transition from the Abative to the Dispersive Phase likely would have been gradual. The channelized flow would accelerate in many areas where the water movement became more restricted, like water flowing from a large pipe into a narrow one. As discussed previously, erosion would generally increase at about a power of two of the water velocity (Blatt, Middleton, and Murray, 1972, p. 93). Therefore, valleys and canyons would be rapidly carved during the Dispersive Phase.

Figure 3. A lower erosion surface on the southeast Beartooth Plateau, north central Wyoming and south central Montana. The surface is at an altitude about 3000 m ASL. Note that the surface is dissected by canyons in granitic rock.

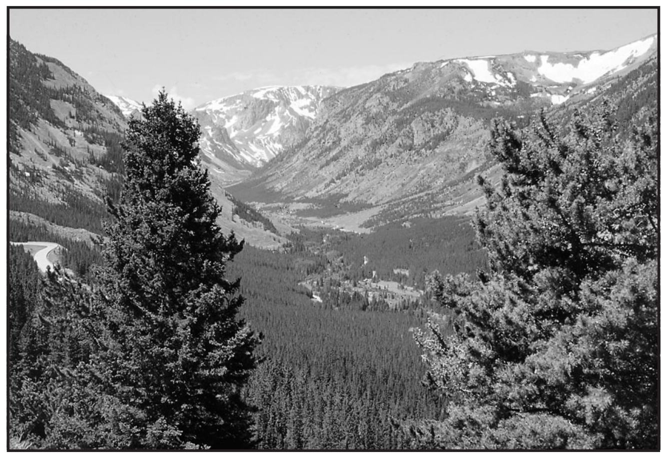

Figure 4. Rock Creek, northeast Beartooth Mountains southwest of Red Lodge, Montana. The 1500 meter deep U-shaped canyon has been modified by a glacier during the ice age.

The channelized flow would be the most impressive when it dissects a planar erosion surface formed during the Abative Phase. Such topography is observed in many places, for instance on the Beartooth Plateau of south central Montana and north central Wyoming where a second erosion surface in granitic rock at about 3,000 meter ASL (Figure 3) has been deeply dissected by canyons (Figure 4).

Sheet flow followed by channelized flow is a common theme in geomorphology. Herbert Gregory (1950, p. 166),

**Figure 5. The Susquehanna water gap, north of Harrisburg, Pennsylvania, that cuts nearly straight through four flat-topped, even crested ridges. The strata below the ridges dip at steep angles, and the ridges represent an erosion surface. (In William Morris Davis's defunct "geographical cycle," this surface represents the uppermost Schooley Peneplain.)**

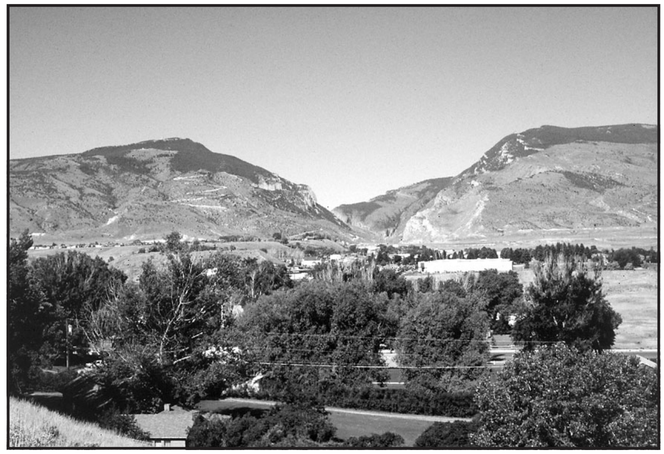

**Figure 6. Water gap through the Rattlesnake Mountains west of Cody, Wyoming. The Shoshone flows eastward through the water gap.**

writing within the uniformitarian paradigm, describes the general erosional features of Zion National Park that shaped the current topography:

> For convenience in description these two long [erosive] periods have been designated (1) the precanyon cycle, which records the history of the region before it was stripped of its Cenozoic strata, and (2) the canyon cycle, during which the present landscape has been modeled. In the studies so far made it appears than each cycle was initiated by a regional uplift...

The precanyon cycle represents a large-scale, nearly planar erosion surface (Gregory, 1950, p. 167). The canyon cycle represents vertical cutting of this planar erosion surface with times of canyon cutting punctuated by times of deposition within the canyons. The youth of these canyons has inspired Gregory to date the canyon cutting cycle as post-Pliocene. The precanyon cycle transpired after regional uplift during a long still stand, according to the uniformitarian explanation, while the Canyon cycle developed during a later uplift with minor stillstands. Regardless, both are associated with vertical tectonics[1].

## Water Gaps

Another mysterious phenomenon observed world wide are water and wind gaps. A water gap is: "A deep pass in a mountain ridge, through which a stream flows; esp. a narrow gorge or ravine cut through resistant rocks..." (Bates and Jackson, 1984, p. 559). A wind gap is defined as: "A shallow notch in the crest or upper part of a mountain ridge, usually at a higher level than a water gap" (Bates and Jackson, 1984, p. 564). A wind gap is considered an ancient water gap that was subsequently abandoned. There are many classic examples of wind and water gaps in the Appalachian Mountains, for instance on the Susquehanna River (Figure 5), that have perplexed geologists for many years (Ver Steeg, 1930). Williams et al. (1994) analyzed the Pine Creek gorge water gap in Pennsylvania. Unaweep Canyon, a narrow canyon cut about half way down through the Uncompahgre Mountains of western Colorado, is an example of a wind gap (Shaver, 1998; Oard, 1998a; Williams, 1999). Water gaps are only impressive if the stream could have chosen an easier path around a rock barrier *instead of cutting right through it*. Only the latter type of water gaps will be discussed further.

Water gaps are ubiquitous over the earth; there are well over one thousand of them. An example is the Shoshone River west of Cody, Wyoming, that cut a gap 300 meters deep through the granitic-cored Rattlesnake Mountains (Figure 6). The river could have easily gone around the Rattlesnake Mountains a few miles to the south in the past when the valley was at a higher level. Another example is the Yakima River that flows through Ellensburg and Yakima, Washington (Oard, 1996, pp. 270–271). The Yakima River could have easily kept flowing east from Ellensburg into the Columbia River, but instead it flows abruptly southward and cuts (with incised meanders) through at least four anticlines of the Columbia River Basalt Group. Hells Canyon is a water gap 80 km long and up to 2400 meters deep through the Wallo-

[1]Editor's Note: In a later publication (*The geology and geography of the Paunsaugunt region, Utah*, U.S.G.S. Professional Paper 226), Gregory [1951, pp. 83–84) postulated a seven-stage model for physiographic "evolution" of the plateau country, including Zion National Park, Utah.

wa Mountains of northeast Oregon and the Seven Devils and Cuddy Mountains of west central Idaho (Vallier, 1998). Supposedly this water gap is only 2 to 6 million years old in the uniformitarian time scale. The Sweetwater River of Wyoming cuts through the nose of an exhumed, plunging anticline when it could have easily flowed around the barrier only one-half mile to the south (Thornbury, 1965, p. 359). Eleven rivers start on the Tibetan Plateau or the north slopes of the Himalaya Mountains and cut through the full width of the range in deep gorges (Oberlander, 1985). One of these rivers, the Arun River, has cut 15,000 meters through a transverse anticline east of Mount Everest.

The Zagros Mountains, southwest Iran, have peaks commonly in the 3,350 to 4,600 meter range with more than 300 water gaps (Oberlander, 1965). The deepest water gap is about 2,400 meters deep. These water gaps, cut through mountains that rose in the "Pliocene" and "Pleistocene" of the uniformitarian geological time scale, seem to defy rationality. Here is a brief sampling of some of Oberlander's (1965, pp. 1, 9, 16, 21, 89) description of the amazing Zagros water gaps:

> The Zagros drainage pattern is distinctive by virtue of its *disregard* of major geological obstructions, both on a general scale and in detail...the unusually precipitous defiles created by southwest-flowing streams and their tributaries, large and small, whose course appear to be developed in *almost uniform disregard* of their physiographic and structural matrix... [In the central Zagros] major streams utilize longitudinal valleys to a *minimum* degree, despite the presence of the greatest structural barriers to be found in the orogenic system... In a surprising number of instances plunging fold noses are crossed by engorged transverse streams although open valley paths pass the ends of the ridges less than a mile away...Certain streams ignore structure *completely*; some appear to "seek" obstacles to transect [emphasis mine].

There are several occurrences of a stream that cuts through the *same* transverse ridge anywhere from two to five times. This would be like the Willamette River of western Oregon cutting through the Cascade Mountains to the east and then back again—twice! The Zagros drainage system is distinctive, but similar water gaps are found in other mountain ranges:

> The drainage history of this region is as obscure as is that of most of the Cenozoic and older mountain systems of the world whose transverse streams have been deduced, in the absence of evidence to the contrary, to be antecedent, superimposed, or the result of headward extension under unspecified controls." (Oberlander, 1965, p. 149)

There are three major uniformitarian hypotheses to account for water gaps: antecedence, superposition, and piracy (Williams, Meyer and Wolfrom, 1991, 1992a,b; Austin, 1994, pp. 85–92). It is rare that there is any evidence for any of these hypotheses:

> Large streams transverse to deformational structures are conspicuous geomorphic elements in orogens of all ages. Each such stream and each breached structure presents a geomorphic problem. However, the *apparent absence of empirical evidence* for the origin of such drainage generally limits comment upon it. Transverse streams in areas of Cenozoic deformation are routinely attributed to stream antecedence to structure; where older structures are involved the choice includes antecedence, stream superposition from an unidentified covermass, or headward stream extension in some unspecified manner. Whatever the choice, *we are rarely provided with conclusive supporting arguments* [emphasis mine] (Oberlander, 1985, pp. 155, 156).

Therefore, water gaps are:

> ...one of the more perplexing and ubiquitous enigmas of regional physiography; the anomaly of through-flowing drainage that is transverse to the structure of an orogenic system (Oberlander, 1965, p. 1).

Their hypotheses are desperate attempts to explain a most-confounding uniformitarian mystery.

Water, as well as wind gaps, could have been formed rapidly and easily during the massive erosion of the Recessive Stage of the Flood, especially within the Dispersive Phase. The gaps can be cut by currents flowing transverse to the structure either while there is a "covermass" over the structure or after the ridge became more exposed. The initial notch in a transverse ridge could have been initiated during the Abative or Sheet Flow Phase. It is not unusual for a sheet flow to have areas of enhanced flow (Schumm and Ethridge, 1994, p. 11), which would locally be more erosive. The initial notch also could be eroded in a "soft" portion of the transverse ridge. Once the notch forms, higher velocity flow with abrading material could cut out the water gap rapidly. Post-Flood erosion, especially associated with the ice age, could eroded the water gap a little deeper. Emmett Williams (1998) postulated that the Black Canyon, Colorado, water gap formed during late Flood channelized erosion followed by further erosion by high water during the Ice Age. Figures 7a–d represent how I visualize the formation of water and wind gaps during the Flood. The Dispersive Phase of the Recessive Stage of the Flood can explain these ubiquitous and mysterious geomorphic features found worldwide.

**Pediments**

Pediments are another one of those ubiquitous, geomorphic features that have evaded explanation for over 100 years. A pediment is:

**Figure 7. Schematic diagrams of suggested origin of wind and water gaps (drawn by Peter Klevberg).**

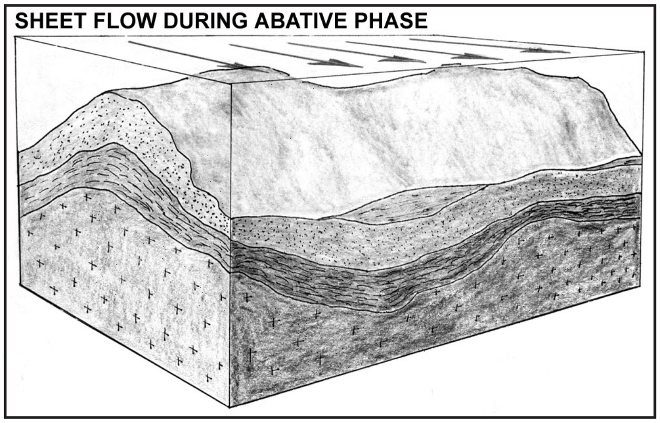


**Figure 7a. Sheet flow of Flood transverse to a ridge. Faster flow within the sheet flow or more-eroded softer rocks cause saddles in the ridge.**

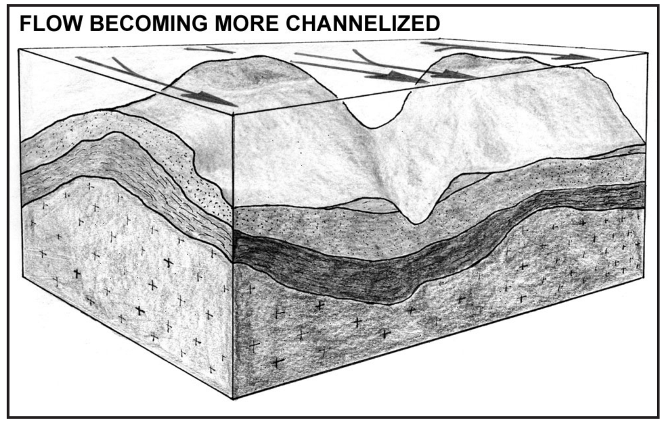


**Figure 7b. The water level lowers and becomes more channelized in the low areas where the ridge is exposed.**

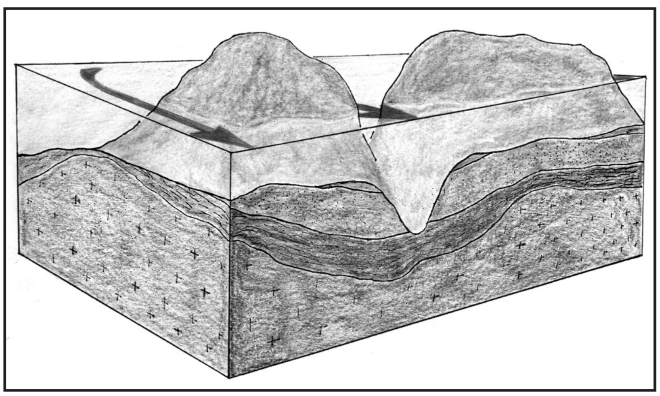

**Figure 7c. The water level continues to lower. Faster currents loaded with abrasive material or presence of easily erodible rocks cause a deeper cut in the middle of the ridge.**

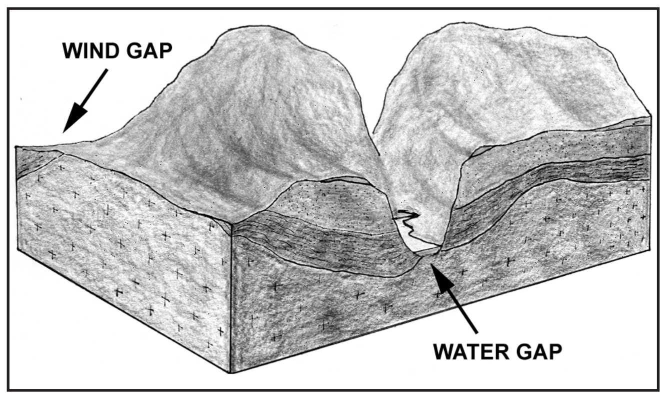


**Figure 7d. The ridge is completely exposed. After the Flood a river flows through the deep cut, a water gap, while the abandoned cut to the left is hanging, a wind gap. Both were formed by Flood water movement.**

> ...a broad gently sloping erosion surface or plain of low relief, typically developed by *running water*, in an arid or semiarid region at the base of an abrupt and receding mountain front; it is *underlain by bedrock* that may be bare but is more often mantled with a thin discontinuous veneer of alluvium... [emphasis mine] (Bates and Jackson, 1984, pp. 372–373).

Pediments are commonly observed as generally flat surfaces at the foot of mountains in relatively dry areas (Figure 8), as well as in wetter climates. They are observed *worldwide*. John Dohrenwend (1994, p. 321) states: "Clearly, pediments are azonal, worldwide phenomena..." Pediments are erosion surfaces cut mostly in hard sedimentary or plutonic rocks and often capped by a veneer of water-worn debris. Pediments usually form a sharp angle with the mountain front. Figure 9 shows a pediment in the Ruby Valley of southwest Montana cut *against* the dip of the sedimentary rocks. Figure 10 shows the veneer of generally rounded rocks (indicative of water action) that mantle the pediment. Pediments can be eroded in soft rocks or sediments, which is difficult to imagine by naturalistic means.

Pediments can be of fairly large scale. Figure 11 shows a gravel-capped pediment from the Jefferson Valley of southwest Montana that is about 16 km long, 5 km wide, and 300 meters high from the Jefferson River to the base of the mountains. Early workers thought pediments were coalesced alluvial fans, called bajadas, but were shocked to find that the gravel was simply a *veneer* on top of hard, eroded rock. It can be visualized as the side of a mountain range being eroded to a nearly flat surface with a carpet of mostly rounded rocks left behind.

When analyzing pediments there are complications with depositional sediments and post-formational erosion. Sometimes an alluvial fan does overlie a pediment, but the pediment formed first and was later covered by the erosional material from the adjacent mountains. Occasionally streams from the adjacent mountains have eroded a channel or channels into the pediment.

**Figure 8. Pediment along base of mountain, 10 km southeast of Hoover Dam, Nevada (photograph by Ray Strom).**

**Figure 9. Gravel-capped pediment near Ruby Reservoir, southwest Montana. Note that the valley fill sedimentary rocks dip right (eastward), while the pediment dips west, truncating the sedimentary rocks.**

**Figure 10. Close up view of the gravel on the pediment shown in Figure 9. Note the rounded to sub-rounded rocks.**

**Figure 11. Gravel-capped pediment on the western edge of the Tobacco Root Mountains, southwest Montana. The distance from the river (foreground) to the base of the mountains (background) is 5 km.**

Except for small-scale examples along a few rivers (Crickmay, 1974, p. 205), pediments are *not* observed forming today; they are observed being dissected (Figure 11 in Part I). However, some researchers cannot conceive of pediments as relics from a past condition, so they believe and write as if they are continuing to develop today.

There are two main hypotheses for the formation of pediments: sheet erosion by rainstorms and lateral planation by streams emerging from the mountains. These hypotheses have many problems. Water moving as a sheet over a pediment is rare and as several geomorphologists have noted, the planed surface must *first* exist before water from heavy rain can flow as a sheet over the surface (Crickmay, 1974, p. 211). Lateral planation is mostly seen as inadequate because streams and rivers flowing out of the mountains either dig moderately deep valleys on the pediment or dump alluvial fans on existing pediments. The erosion from these streams destroys, rather than creates a pediment. The idea that these streams can sweep all over a rough slope at the side a mountain range forming a smooth surface is beyond reason. The origin of pediments is still a mystery that has fueled much controversy and imaginative thought:

> 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 (Dohrenwend, 1994, p. 321).

I believe Crickmay (1974, pp. 211–213) comes closest to the actual mechanism that formed pediments. He observed that pediments have great lateral continuity and often contain exotic rocks, indicating that the “super-flood,” as he calls it, flowed *laterally* and did not emerge from the mountains:

> Many pediments of this type are carpeted with thin gravel deposits that include among their pebbles

**Figure 12. Postulated origin of mountain valley pediments during the Dispersive Phase of the Flood (drawn by Peter Klevberg).**

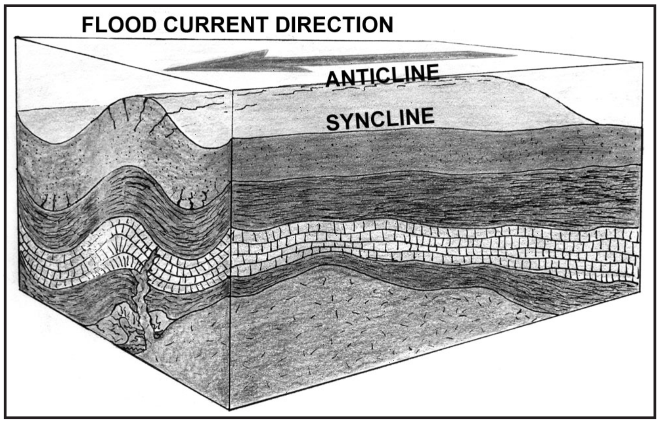


**Figure 12a. An anticline rises as the Flood waters flow parallel to the ridge. Because of the stretching of sedimentary rock, the top of the anticline is much faulted.**

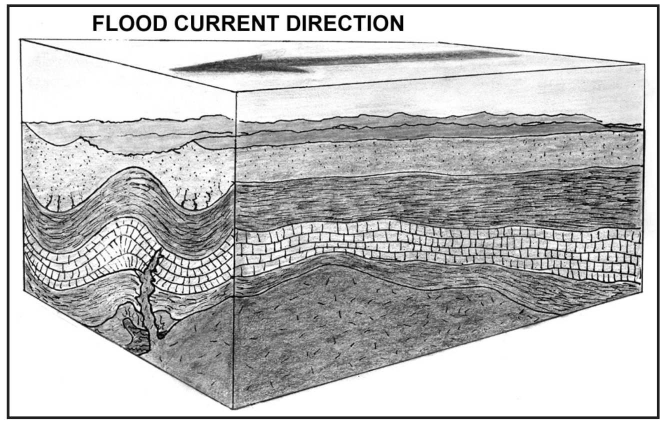


**Figure 12b. Erosion is especially strong on top of the anticline because of faulted and broken rock.**

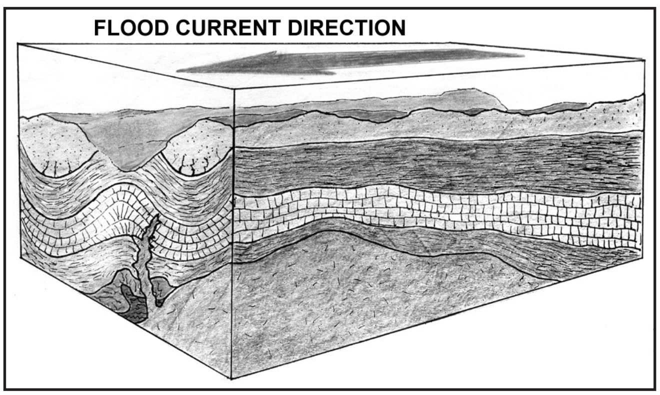


**Figure 12c. Anticlinal valley and synclinal ridges form (a rather common geomorphologic and structural form).**

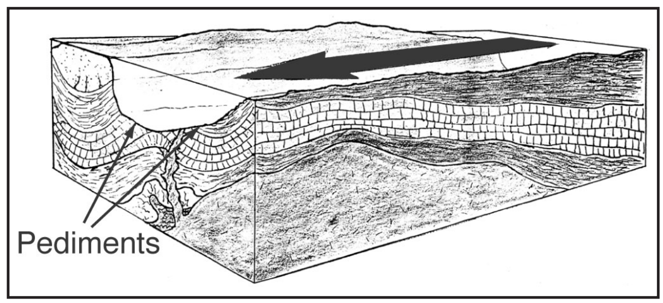


**Figure 12d. As the ridges become exposed with falling base level, the water becomes more channelized into a smaller region causing rapid valley excavation with pediments forming at the base of the ridge.**

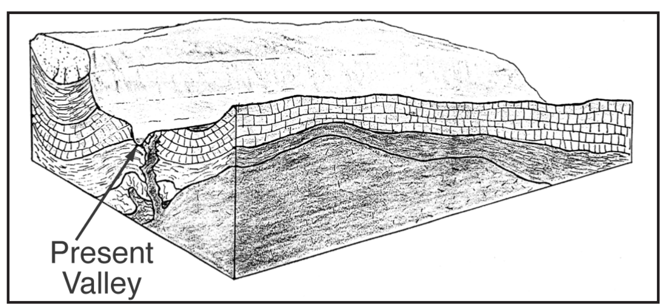


**Figure 12e. The area completely exposed. Note the generally flat areas at the base of both ridges that truncate the strata at an angle. A river now flows in the valley below the pediments.**

> a greater variety of rock types than is represented in the bed-rock of the immediate vicinity. These facts, together with the peculiarly continuous, linear form of the pediplains [pediments], suggest that perhaps one should look in an entirely different direction for the mode of origin of the features. Rather than looking to the small streams...that *now* run *down the slope* of the pediplain [pediment] as the possible agent of its making, one should perhaps visualize a stream that formerly *ran* the *lateral length* of the pediplain [pediment]...These suggestions raise a suspicion that such a pediment is not an active surface, that its shaping has been achieved in the past, and that the agent of its shaping has migrated to a situation where we can not readily recognize it [emphasis in original] (Crickmay, 1974, p. 213).

There is one basic problem with Crickmay's superflood idea: such a flood, viewed as possibly a one-in-a-900 year event, has never been observed, as he admits. Moreover, such a large flood would likely both erode and deposit sediment as cut and fill structures and terraces on the side of a mountain. But, pediments are large-scale, *smooth* features.

I believe Crickmay's "superflood" must be the Genesis Flood at the time mountain valleys were being carved during the Dispersive Phase. It is likely that the pediment represents remnants of the valley bottom formed by the last waning of high velocity currents that *filled the whole* valley.

This would be a *lateral current* spreading rocks from both the adjacent mountains and upstream onto the flat eroded surface. With water filling an entire valley and the current moving at high velocity, dissection and depositional (cut and fill) structures likely would not form. The pediment can be viewed as the last major valley bottom in the erosional process just as the currents were finally waning or thinning near the lowest point in the valley. This is the time when erosion was ending and the deposition of the clasts, which greatly aided the erosion, began. Figure 12 is a series of schematic diagrams illustrating the probable origin of valley pediments during the draining of the Flood waters through a valley.

### Submarine Canyons

What would have happened when these accelerated, channelized currents moved off the continents? Instead of being depositional, they likely would have eroded the sheet deposits, especially as the depth of the Flood water decreased. These channelized currents would have carried copious debris with the larger clasts moving along at the lower depths. These clasts would be like cutting tools that would have aided the generally linear erosion. Thus, submarine canyons would have formed rapidly.

Submarine canyons are ubiquitous on the continental shelves and slopes, not only off of the continents, but also off of large islands, such as western Corsica. Submarine canyons would have been excavated similar to deep valleys cut into erosion surfaces on land, as shown in Figures 3 and 4. The likely dissection of the Portland Delta (Bretz, 1928) as the Lake Missoula Flood was waning and the flow in the area became more channelized in a smaller region provides a good analog. Hence, another major mystery of the earth's surface, this time underwater, can be explained by the Recessional Stage of the Flood.

Submarine canyons resemble river-cut gorges on land and nearly all are eroded in *hard* rock with *surprisingly steep* walls that are sometimes overhanging (Shepard and Dill, 1966). Submarine canyons are common and average 1000 m deep and 50 km long. They are cut on the continental shelf starting at an average depth of 107 m (the depth can vary from about one meter to 300 m). Many canyons are *deeper* than Grand Canyon. Several large submarine canyons have been discovered at the edge of the very wide Bering Sea Shelf (Carlson and Karl, 1984). Bering Canyon, 495 km long, is the longest canyon in the world, even longer than the Grand Canyon (Karl, Carlson and Gardner, 1996, p. 309). Of these submarine canyons, Zhemchug Canyon is the deepest in the world—100 km wide and 2,600 m deep at the shelf break and extending 160 km with an average width of 30 km (Karl, Carlson and Gardner, 1996). The canyon represents an excavated volume of 5,800 km$^3$.

There are several hypotheses to account for the origin of submarine canyons—all with serious problems. The most popular idea is that submarine canyons were cut by turbidity currents, especially during lower sea level throughout the ice age. Tom Waters (1995, p. 47) writes:

> Over millions of years, most geologists now believe, turbidity currents have carved undersea canyons as surely as the Colorado River has cut the Grand Canyon.

We know how well the Colorado River has cut the Grand Canyon! There are many problems with the turbidity current hypothesis, one being that according to the uniformitarian time scale, the canyons are much older than the duration of the ice age (Shepard, 1981). Furthermore, some canyons start on the continental slope, too deep to be caused by any process acting on the shelf or due to a postulated sea level fall during the ice age (Pratson et al., 1994; Pratson and Coakley, 1996).

The origin of these ubiquitous canyons is still a mystery. In a new book on the continental margin of the United States, O'Leary (1996, pp. 47, 58) notes:

> The origin of submarine canyons of the U.S. Atlantic continental margin remains a subject of controversy and speculation...A new model of canyon evolution and activity is required that takes GLORIA data into account.

(GLORIA is a side-scan sensor that picks up the shape of ocean bottom features.) A new model has yet to be developed. Talling (1998, p. 89) reiterates:

> At present, there are few studies of the processes by which submarine canyons are initiated and grow (Pratson and Coakley, 1996), and further work is needed to document how shelf-indenting submarine canyons form and how they interact with subaerially incised valleys.

Submarine canyons commonly are reflections (homologies) of the topography of the adjacent land. For instance, submarine canyons seem to extend landward as a canyon or valley. Lester King (1983, pp. 197, 199) states:

> Geomorphic homology between coastal hinterland and continental shelf...Pleistocene gorges are continued as submarine canyons of the same age...In this way coastal hinterlands and shelf areas show remarkable geomorphic homologies throughout a long history.

In other words, the geomorphology of the coastal area is reflected on the continental shelf and slope.

Especially interesting is that submarine canyons are sometimes cut through *hard crystalline or metamorphic rocks*, and they occur off arid coasts (Shepard and Dill, 1966; Shepard, 1981). For instance, San Lucas Canyon off the southern tip of Baja California is a steep-walled gorge cut up to 1000 m deep in granite. I believe these facts sug-

**Figure 13. Postulated origin of the submarine canyons during the Dispersive Phase of the Flood (drawn by Peter Klevberg).**

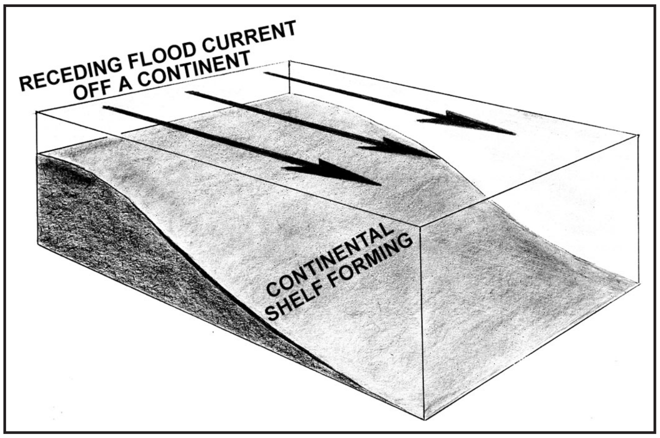


**Figure 13a. Deposition on the continental shelf which is being formed during the sheet flow sequence of the Abative Phase of the Flood.**

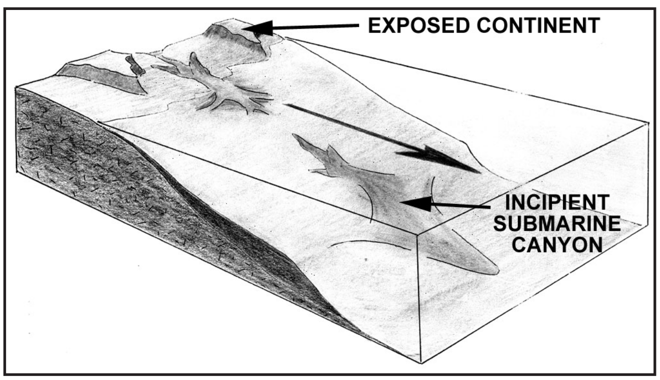


**Figure 13c. Flood Dispersive Phase erosion of submarine canyons as land becomes more exposed.**

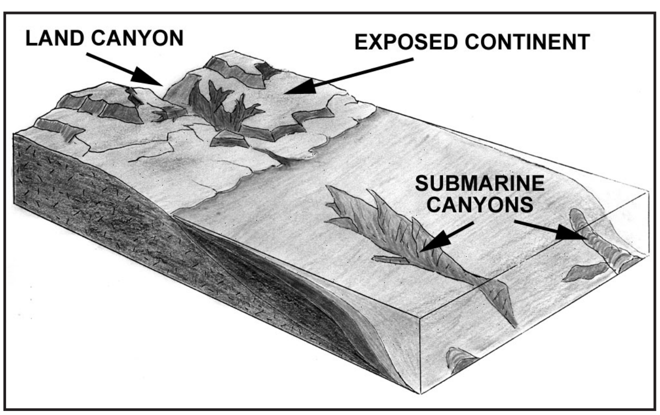


**Figure 13e. Flood has ended. Note that submarine canyon reflects topography on the land. Other submarine canyons could form by slumping and sliding on the oversteepened continental slope.**

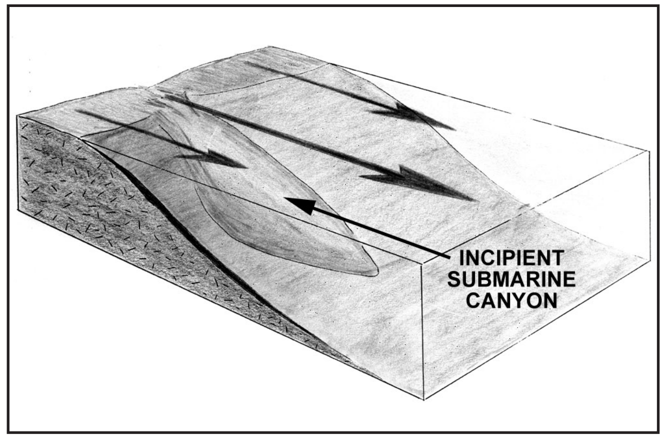


**Figure 13b. Sheet flow off the rising continents becomes locally stronger out from the more channelized flow moving off the continent. This could have happened either during the Abative Phase when little sediment had accumulated as shown or during the Dispersive Phase after most of the sediment of the continental shelf had been deposited.**

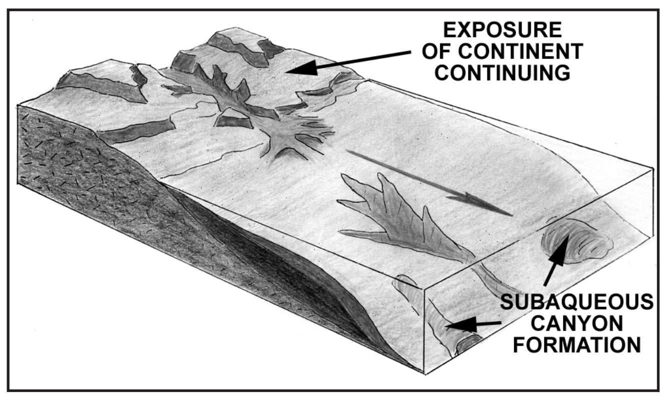


**Figure 13d. Submarine canyon erosion continues during the Dispersive Phase.**

gest the mechanism for the cutting of submarine canyons, and not by normal naturalistic means but by the channelized flow during the Recessional Stage of the Genesis Flood. In other words, the canyons were cut during the great vertical tectonics at the end of the Flood, which helped power the strong, channelized currents. Lester King (1983, pp. 208,209) relates submarine canyons to vertical tectonics:

> Following the great monoclinal tiltings of the continental margin towards the sea, the rivers of the mainland have been entrenched by 350–550 metres. These entrenchments are continued (by turbidity current action) across the shelf, and submarine canyons are numerous along the edge of southeast Africa.

During the Flood, these mysterious submarine canyons would have been cut rapidly during the channelized erosion of the continental shelves by "super turbidity currents". The deep, submarine canyons eroded in crystalline rocks are little different from Rock Creek cut into the

Beartooth erosion surface (Figures 3 and 4)—both in *crystalline rocks*. Figure 13 illustrates how I postulate that submarine canyons were rapidly cut during the Dispersive Phase of the Flood. The debris eroded from submarine canyons likely formed the great submarine fans, which contain a much greater amount of sediment than the volume of the canyons. Much of the fan debris likely came from the continents during the Dispersive Phase erosion. Some of the eroded debris continued to flow seaward and form the coarser sediments of the abyssal plains.

## Model Summary

Based on the Bible, Tasman Walker (1994), Carl Froede (1995), and Whitcomb and Morris (1961) have worked out a general sequence of events for the Flood. Focusing on the Recessional Stage from Day 150 to Day 370, great vertical changes of the crust occurred as the continents rose out of the water and the ocean basins sank. There is copious evidence for this effect of the Flood.

During this great vertical tectonism, massive erosion of the continents would have occurred, first as sheet erosion (the Abative Phase), followed by channelized erosion (the Dispersive Phase), leaving the following geomorphic features on the continents: large-scale erosion surfaces, valleys, canyons, pediments, water gaps and wind gaps. All of these are considered mysteries within the "slow processes over millions of years" model.

The eroded continental sediments during the Abative Phase would collect as huge sheet deposition at the continental margin as the water flow decelerating upon reaching deeper water. Later, the Dispersive Phase water flow of the Flood would carve gigantic submarine canyons in the deposited sheet sediments. Both continental shelves and slopes, and the submarine canyons formed after their deposition, are problems in the uniformitarian paradigm.

Indeed, the results of the Recessive Stage of the Flood with its two phases, the Abative or Sheet Flow Phase and the Dispersive or Channelized Flow Phase, are a *worldwide geomorphic theme*, attesting to a *global* deluge as described in the Bible.

## Implication for Other Flood Models and Hypotheses

The above model has a number of implications for other Flood models and ideas. There are many positive aspects to these other models. However, they cannot all be correct in every aspect. They need modification. Also, I am open to feedback on the model presented in this series and anticipate the need to modify it in the future.

### The Cenozoic is not a Chronological Flood or Post-Flood Sequence

The first implication is that the upper part of the uniformitarian geological column, the Cenozoic, is *not chronological* within the Flood or post-Flood sequence on a worldwide basis. The Cenozoic is usually considered late Flood or post-Flood by many creationists. During the Recessive Stage of the Flood, a huge thickness of sediment was eroded from the high continental areas as sheets creating erosion surfaces. During the Dispersive Phase, erosion scoured valleys. The consolidated sediments, therefore, that *remain* in higher continental areas after the erosion of the Recessional Stage likely were laid down in the Inundatory Stage of the Flood during the first 150 days.

By Day 150, all land mammals had died, based on Genesis 8:22: "...and all that was on the dry land, all in whose nostrils was the breath of the spirit of life, died." Many mountain valleys and regions of the high plains of North America contain Cenozoic sediments, dated mostly by fossil mammals, that were left over after the great erosional event of the Recessive Stage. Some of the dates for the left over erosion surfaces are as young as *Pliocene*. Baulig (1967, p. 925) states:

> In middle latitudes there are, however, almost everywhere locally planed surfaces that bevel moderately resistant terrains even as young as Pliocene.

This would imply that even the youngest Cenozoic sediments, such as the Pliocene, *were deposited during the first 150 days of the Flood* in these regions, because these sediments remained after the great planing and erosion of the Recessional Stage. This is also consistent with preserved Cenozoic mammal tracks (Lockley and Hunt, 1995, pp. 243–281), as well as Mesozoic dinosaur tracks, found within sedimentary rocks, especially in the intermountain west and high plains (Oard, 1998b, pp. 79–81). Both the dinosaur and the mammal tracks were produced during the Inundatory Stage of the Flood.

Cenozoic mammal fossils are found within sand interbeds of the Cypress Hills and the Flaxville Gravels. They are dated from the middle Eocene to the early Pleistocene (Oard and Klevberg, 1998, pp. 427, 428). These mammals likely died earlier during the first 150 days of the Flood and were either reworked or were floating in the Flood waters after Day 150 because of bloating (Froede, 1996), and were entombed in Recessional Stage deposits. Therefore, some mammals finally were buried *between Day 150 and Day 370 of the Flood*.

The continental shelf deposits, according to the model presented, would have been deposited during the Recessional Stage of the Flood. There would be very few if any mammal fossils, exposed and removed from the rising continents, that would remain intact to be deposited on the continental shelves since the violence of the receding waters would destroy the remains. The continental shelf deposits would instead entomb mostly microorganisms. (Continental shelf deposits are mostly dated as "Cenozoic," based on these microorganisms.) In general, mammal fossils are not found in the strata that contain microorganisms along the coast and on the continental shelf and slope. Johnson, Opdyke, and Lindsay (1975, p. 5) affirm this general separation of various continental and marine index fossils:

> The correlation of continental and marine strata is difficult because these mutually exclusive environments of deposition preclude the frequent interdigitation of diagnostic faunas and floras.

Thus the "Cenozoic" from the continental shelf and slope formed during the Recessional Stage of the Flood.

Some sediment would be deposited well out in the ocean in the deep abyssal plains. These sediments also would contain microorganism fossils deposited during the Recessive Stage of the Flood. However after the Flood, fairly rapid sedimentation of microorganisms would likely continue forming carbonate and siliceous oozes (Oard, 1990, pp. 180–186). These microorganisms also are dated mostly as "Cenozoic." However, some of these oozes likely contain ice-rafted debris as old as Oligocene and Miocene (Oard, 1998b, p. 81). Ice rafting would occur late in the post-Flood ice age (Oard, 1990), so these oozes would have been deposited well after the Flood. Thus, much of the Cenozoic oozes likely would have been laid down in the *post-Flood* period. This concept also supports Larry Vardiman's (1996) use of Cenozoic oozes as a general record of post-Flood oceanic cooling during the ice age.

So we have the situation in which some Cenozoic fossils were deposited during the first 150 days of the Flood, some between day 150 and day 370, and some after the Flood. How then can the "Cenozoic" represent a *specific* time related to the Flood? The "Cenozoic" on a worldwide scale is essentially meaningless as part of a chronology of the Flood and post-Flood events. It mainly represents strata that contain certain fossils believed to be young according to the theory of evolution. If a modeler incorporates the Cenozoic as part of a Flood chronology, he likely will come to misguided conclusions.

The reader is cautioned that even though the Cenozoic is meaningless, it does not follow that the remainder of the geological column has no chronological value for the Flood. How the geological column relates to the Flood, if at all, needs to be developed and demonstrated with a copious amount of geologic data.

Practically all of the current sedimentary rock in the intermountain west and high plains of the United States, as well as most continental areas of the world, would have been deposited during the Inundatory Stage of the Flood. Much of the rock eroded during the Recessive Stage and deposited along the continental shelves would have been first deposited during the Inundatory Stage. Hence, most of the sedimentary rocks of the world were first eroded during the first 150 days of the Flood. (A small amount of un-reworked volcanic material would have been added to the sedimentary rocks during the Recessional Stage.) Thus, the implication for a Flood model of the Inundatory Stage is that we need to explain much more erosion and sedimentation during the first 150 days than most models currently envision. We require a very powerful mechanism to generate all this sediments within this time period. What was that mechanism? I do not know. At the moment, I am leaning towards meteorite impacts as the cause of the Flood and for the phenomenal erosion and deposition during the first 150 days (Spencer, 1998a,b; Faulkner, 1999). Multiple impacts could have generated copious sediments and caused worldwide tectonics. They could possibly have caused 40 days and nights of heavy rain. Obviously, the impact model must be refined, but it has the potential to explain the volume of eroded sedimentary rock and many large-scale features resulting from the Flood.

Massive erosion during the Recessional Stage may also explain why we find very few human fossils. If the remains of humans were mostly deposited in the highest sedimentary layers by Day 150, the layers could have been eroded during the Recessive Stage. As this area was reeroded by strong currents, the humans, as well as any other organisms, would be mostly pulverized (Austin et al., 1994, p. 614).

### A Late "Cenozoic" Flood/Post-Flood Boundary

A second implication is that for those who believe the geological column is a more or less exact Flood sequence, the Flood/post-Flood boundary on land is in the "late Cenozoic" and possibly even in the early to mid "Pleistocene" where not related to the ice age (Holt, 1996). This implication follows from what was stated above in that practically all the sedimentary rocks were formed in the Flood. Copious evidence has previously been provided to support this view (Coffin, 1983; Holt, 1996; Morris, 1996; Oard, 1996, 1998b, 1999; Roth, 1998, p. 209; Froede and Reed, 1999).

In the catastrophic plate tectonics model of Austin et al. (1994, p. 614), which is said to be in its formative stage, they assumed the Flood/post-Flood boundary is tentatively at the Cretaceous/Tertiary (K/T) boundary of the geological column. One criterion given for this assignment is: "For our purposes here we would like to define the Flood/post-Flood boundary at the termination of global-scale erosion and sedimentation" (Austin et al., 1994, p. 614). This assignment neglects regional and local scale erosion and sedimentation, and likewise neglects some of the Abative Phase and *all* of the Dispersive Phase of the Flood. It seems more reasonable that the last stages of the Flood would have more regional-scale and local-scale channelized currents after mountains and plateaus appeared out of the Flood waters. There is another reason why Austin et al. (1994) need the Cenozoic to be after the Flood, and this will be discussed below. This example shows that the placement of the Flood/post-Flood boundary is not simply an academic exercise within Flood geology. Rather, it affects many aspects of a particular model and how the geological data are interpreted.

### Very Little Post-Flood Catastrophism

A third implication is that there was very little "post-Flood catastrophism" relative to some of the other models. Simply, the above model would account for practically *all* major geological events that have been postulated as "post-Flood catastrophism" as occurring *during* the Flood. All major vertical tectonics and volcanism would have ended. Local "catastrophes" could have occurred after the Flood, such as the ice age, smaller-scale volcanism, local tectonics, landslides, and events such as the Lake Missoula Flood.

Those who postulate "post-Flood catastrophism" believe that most, if not all, the Cenozoic strata were laid down after the Flood. The Austin et al. (1994, p. 614) model *requires* post-Flood catastrophism because the basalt of the new ocean floor must cool and sink, while the continents isostatically rise. This would require much more than one year. Roy Holt, John Woodmorappe, Carl Froede, and I have previously presented copious evidence against the idea of "post-Flood catastrophism." If the Cenozoic was post-Flood, advocates of this hypothesis would not only have to explain the supposed "order" of the fossils *after* the Flood (since they believe strongly in the geological column), but also would need to account for the *enormous* geological activity during that period. According to the evolutionary paradigm, most of the mountains of the earth were raised, eroded, and raised again *during the Cenozoic*. Within the context of the uniformitarian paradigm, King (1983, p. 19) states:

> Most of the world's orogenic ranges, folded in the mid-Cenozoic, were obliterated and the terrain reduced to a plain by Miocene and earlier erosion.

Massive volcanic activity would have totally shrouded the earth in dust and aerosols for years, resulting in "nuclear winter" (Holt, 1996). Since the continental shelves are mostly Cenozoic, tremendous erosion and deposition would have occurred on the edge of the continents. How would these massively catastrophic events occur after the Flood?

Another argument against post-Flood catastrophism is the thick early Cenozoic coal seams, such as found in the Powder River Basin of Wyoming (Holt, 1996, pp. 153,154; Oard, 1996, pp. 266, 267). For instance, the extent of the early Cenozoic Big George coal seam is approximately 100 km north-south, 40 km east-west, and 61 m thick. It is almost pure, low ash, low clay coal! Just think of the post-Flood scenario needed to gather all this vegetation into one place after the Flood and form this huge volume of almost pure coal.

Those who advocate Cenozoic post-Flood catastrophism have published few reasons for their beliefs and have not addressed the criticisms of their ideas. Advocates of post-Flood catastrophism accept immense vertical tectonics, huge earthquakes, and massive subaerial, continental landsliding after the Flood. Besides the obvious question of how man and beast would survive, Klevberg and Oard, 1998; and Oard and Klevberg, 1998 have shown that for the Cypress Hills, the Flaxville Plateaus, and other regions that the last event on the high plains was a massive *erosion by huge watery flows coming off of the Rocky Mountains* and not by landsliding.

### The Breached-Dam Hypothesis for the Grand Canyon not Likely

The dam-breach hypothesis for the Grand Canyon postulates that after the Flood, three large lakes were impounded by water in the Colorado River Basin, being blocked by the Kaibab Upwarp (Brown, 1995; Austin, 1994). Then about 200 years after the Flood, the lakes gave way, catastrophically forming the Grand Canyon. I was favorably disposed toward the hypothesis at one time—until I considered the geological evidence of the Lake Missoula Flood. I wrote an article to the effect that there would be enough rainfall during the ice age to fill and/or sustain and even overflow the postulated lakes (Oard, 1993). I also noted five potential geological problems that should be addressed in the future. Since then, I have discovered more geological problems, and now I lean 98% against the hypothesis.

The geological problems with the dam-breach hypothesis at the Grand Canyon are numerous, some more serious than others. Perhaps one of the most serious problem is the lack of shorelines for the putative lakes. Although Holroyd's (1994) sophisticated analysis of the Colorado Plateau using satellite pictures showed a preferred elevation for cliffs close to the highest levels of the lakes, the study is only suggestive. Abundant shorelines and high deltas from adjacent valleys *should be obvious*, as they are around glacial Lake Missoula, the pluvial lakes in the southwest U.S., and other ephemeral pro-glacial lakes during the ice age. As far as I know, there are no shorelines or raised deltas associated with these postulated lakes, and advocates of the dam-breach hypothesis have been unable to identify any.

The Biddahochi Formation is claimed to be sediments from "Lake Hopi" in the Little Colorado River Valley. However, the Biddahochi Formation extends about 300 m *higher* than the top of the postulated lake outlet. Further-

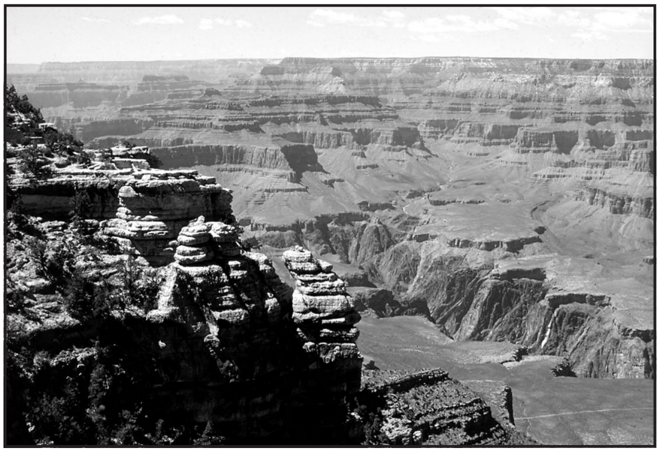

**Figure 14. Grand Canyon. Note the flat top of the canyon geography.**

more, one would expect lake sediments to mostly be deposited in deltas and at the bottom of the postulated lakes, such as occurred with glacial Lake Missoula. The sediments would be deposited in the deeper parts of the lake by turbidity currents and the sinking of fine-grained suspended sediments. As "Lake Hopi" supposedly drained through its narrow outlet, one would expect that much of this bottom sediment would have remained uneroded due to weak currents in the postulated lake. Except for the high altitude Biddahochi Formation, very little, if any, sediment remains in the bottom of the presumed lake.

One would also expect to find an outlet for what is called Grand or Canyonland Lake trapped northeast of the Kaibab Upwarp. This lake should have overflowed north of the Kaibab Upwarp and into the Virgin River. This overflow should have cut a fairly deep canyon, especially in view of the much higher rainfall and significantly less evaporation during the ice age (Oard, 1993). However, no canyon is observed.

Another major problem is that side valleys into the Grand Canyon should be *hanging valleys*, such as seen associated with the Lake Missoula Flood in eastern Washington and even with submarine canyons (Shepard and Dill, 1966). Several long canyons slope *gradually* down to the Grand Canyon, such as the Havasu Valley. This is not what would be expected from a catastrophic breach.

One wonders about the sufficiency of piping to start the breach and whether the release of water by three lakes would be synchronized to provide enough erosive power. Is there a huge gravel delta at the mouth of the Grand Canyon, similar to the Portland Delta from the Lake Missoula Flood? Canyon cutting by water is normally by headward erosion, such as occurred at Palouse Canyon during the Lake Missoula Flood. The water from the breached dam was released *upstream*, similar to the Lake Missoula Flood. What is to prevent the water from spreading out laterally, as observed during the Lake Missoula Flood when the water extended laterally 160 km in eastern Washington? Water that spreads laterally is less concentrated and less able to dig a deep canyon. Is the amount of water postulated from the lakes of sufficient quantity to carve the Grand Canyon?

I have concluded that the dam-breach hypothesis is simply an *outgrowth* of the belief in post-Flood catastrophism, which is related to catastrophic plate tectonics. Those who advocate the hypothesis believe that most, if not all, the Cenozoic is post-Flood. Since the Grand Canyon was cut in the "Cenozoic," that would make the carving of Grand Canyon automatically a post-Flood event. From my study of geomorphology, the Grand Canyon is simply one more, although very impressive, water gap. The formation of Grand Canyon fits in nicely with the sheet flow and channelized flow phases of the Recessional Stage of the Flood, which is a simple hypothesis. The flattened top of Grand Canyon would develop during the Abative or Sheet Flow Phase of the Flood (Figure 14). Red Mountain (Figure 7 of Part I), just south of Grand Canyon, is 300 m above the rim of Grand Canyon and capped by basalt, indicating that the upper sediments in the Grand Canyon region were removed by erosive processes. The canyon development fits quite well into the Dispersive or Channelized Phase near the end of the Flood. There is no need to postulate either post-Flood catastrophism or a synchronized dam breach for the origin of the Grand Canyon.

### Catastrophic Plate Tectonics not Likely

Simply put, many of the key features used to support plate tectonics, such as trenches and mid-ocean ridges, likely developed during vertical tectonism in the middle and at the end of the Flood. I am one of several creationists who have become critical of plate tectonics and its creationist offspring, catastrophic plate tectonics (Reed, 2000). There are many anomalies associated with plate tectonics that are either swept under the rug or minimized by advocates (Oard, 2000b). Supporting evidence for plate tectonics can likely be explained by other mechanisms, of which vertical tectonics is a prime candidate.

To be brief, I will focus on trenches as evidence of subduction zones. There really is little evidence in support of convergence of plates, but there is ample evidence for extension, in subduction zones (Oard, 2000a). Without subduction, neither plate tectonics nor catastrophic plate tectonics can occur, unless the Earth expands. I will attempt to explain "subduction zones" within the model presented above.

During the Recessive Stage of the Flood, continental margins would be areas of great differential vertical tectonics in which the continents rose and the ocean basins sank. They would also be regions of very rapid sedimentation and lithification. Sediments likely would have lithified rapidly due to compression and/or the presence of copious cementing agents in the debris, since many carbonates

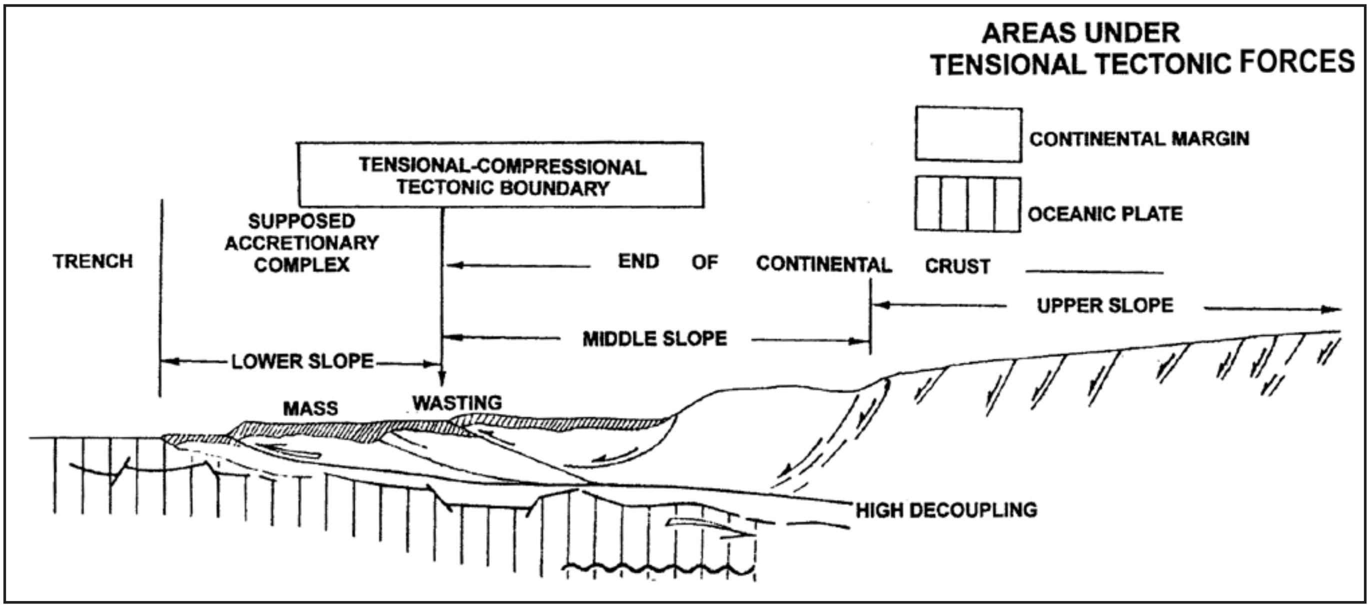


**Figure 15. Schematic diagram of the Andean margin off Peru in the Paita area (from Bourgois et al., 1988; redrawn by Nathan Oard).**

(one of several cementing agents) were eroded from the continents. Thus, one would expect great normal faulting on the continental shelves and upper slopes with huge slumping and mass wasting on the middle and lower slopes of continental margins, such as offshore of western North and South America where trenches are located. It is interesting that normal faulting is now observed to be common on the continental shelves and upper slopes. McNeill et al. (1997, pp. 12,123) state that normal faulting and margin subsidence are *common on passive margins and forearcs of convergent margins*:

> Listric normal faulting is a common feature of passive margins, where fault movement contributes to crustal thinning and margin subsidence. Extension and normal faulting are also *a fairly common phenomenon on convergent margins throughout the world*...Discovery of these extensional structures requires a reevaluation of structures previously interpreted as folds and faults related to plate convergence (emphasis mine).

The evidence of extension in the form of normal faults is now considered common for the mid and upper continental slope. However, the features on the lower slope have been interpreted as compressional features related to plate subduction. Can one tell the difference between subductional accretion or slumping features on the lower slope? No! Figure 15 is a schematic diagram of the continental margin off the Peru-Chile Trench. This drawing indicates that convergent margins are locations of slumping and mass wasting, as expected during the great vertical tectonics occurring during the Recessional Stage of the Flood. They are not accretionary wedges due to plate subduction.

**Summary of Flood Model Implications**

All of these implications are controversial and merit further investigation, but the vertical tectonics model for the mid and late Flood would note:

1) That at least the Cenozoic has nothing to do with Flood or post-Flood chronology on a worldwide scale: the "Cenozoic" can be either early Flood, late Flood, or post Flood.

2) For those who do assume the "Cenozoic" is part of a Flood or post-Flood chronology, the Flood/post-Flood boundary is in the late Cenozoic.

3) Large-scale catastrophism immediately after the Flood, including the dam-breach hypothesis for the formation of the Grand Canyon, likely did not occur.

4) Many of the features crucial to plate tectonics and catastrophic plate tectonics, like subduction, are better explained within mid and late Flood vertical tectonics. This implies that plate tectonics and catastrophic plate tectonics are not likely.

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*CRSQ*: *Creation Research Society Quarterly*

*CEN Tech J*: *Creation Ex Nihilo Technical Journal*

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