# The Origin of Grand Canyon

# Part V: Carved by Late Flood Channelized Erosion

**Michael J. Oard***

## Abstract

Following the Great Denudation by sheet erosion, the Great Erosion ensued. Deep canyons, including Grand Canyon, were carved during this latter time by channelized currents flowing toward the west. A late-Flood channelized hypothesis is presented. The cutting through of the Kaibab Plateau was first initiated by the convergence of two currents, one from the northwest and the other from the southwest. The southeast Kaibab Plateau thus presented an obstacle in the flow, resulting in a horseshoe-shaped erosional pattern that persisted, carving Grand Canyon along the southwest edge of the Kaibab Plateau. That convergence of currents caused Grand Canyon to be cut toward the west of the Kaibab Plateau. The channelized current was diverted toward the south by volcanism on the Shivwits Plateau. Rising volcanic mountains to the south and southeast and the rapid sinking of the Grand Wash trough may have been responsible for the current turning 135° around the southern Shivwits Plateau. The Esplanade, Tonto Platform, Little Colorado River Canyon, and Marble Canyon would have been carved by narrowing currents.

## Introduction

Part I of this series (Oard, 2010a) demonstrated that uniformitarian hypotheses for the origin of the Grand Canyon do not hold water—even after 150 years of speculation. This leaves a catastrophic mechanism for its formation, and two have been presented by creationists. In Part II (Oard, 2010b), I analyzed the currently popular dam-breach hypothesis and demonstrated that it suffers from many geological problems, two of which seem fatal. Starting in Part III (Oard, 2010c), I developed the case that the origin of Grand Canyon needs to be placed at the end of the Flood, during the channelized-flow phase (Walker, 1994). In Part IV (Oard, 2010d), I reinforced this timing by discussing the Great Denudation, an obvious great erosional event that would conform to the sheet-flow phase early in the retreat stage of the Flood. It is widely recognized from the geomorphology of the Colorado Plateau that after the great horizontal erosion of the Colorado Plateau, vertical dissection occurred during which Grand Canyon was carved. Uniformitarian geologists call this the Great Erosion, which fits well with the phase following the sheet-flow phase, and that is the channelized-flow phase.

In this part, I will attempt to flesh out how Grand Canyon was eroded during

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**Figure 1. Peach Springs Canyon, 12 miles from the top (view northeast). The Hurricane Fault is shown with basement igneous and metamorphic rocks to the right of the road uplifted relative to sedimentary rocks to the left.**

the channelized-flow phase of the Flood. Such an endeavor is speculative and open to future revision. The origin of Grand Canyon can be approached by the necessity to solve several problems: (1) the flow reversal from east-flowing sheet currents to west-flowing channelized currents, (2) the initial canyon cutting through the Kaibab Plateau at an intermediate altitude, (3) the great erosion along the southeast edge of the Kaibab Plateau, (4) the formation of Grand Canyon along the southwest edge of the Kaibab Plateau perpendicular to the southwest topographic slope, (5) the diversion of the Canyon south along the eastern Shivwits Plateau, and (6) the canyon's 135° turn around the southern Shivwits Plateau.

## The Great Erosion

As stated in Part IV, the Great Denudation was the first of two erosional events on the Colorado Plateau recognized by geologists (Oard, 2010d). The Great Denudation eroded great sheets of sediment but left few canyons. On and near the Hualapai Plateau, there are a few generally northeast-trending canyons, partially filled with sediments, cobbles, and boulders deposited by northeast-flowing water. The Hualapai Plateau is located south of western Grand Canyon. These canyons could have been carved by the first erosional event, representing local channelization during the Great Denudation. Peach Springs Canyon is possibly one of these canyons (Figure 1). It is also possible that these canyons were carved at the same time as Grand Canyon.

Following the Great Denudation, most canyons were cut during the next erosional event, which Clarence Dutton called the *Great Erosion*, an event that exhibits very little sheet erosion. Ironically, the successive events that are so congenial to the Flood paradigm continue to frustrate mainstream geologists. As quoted in Part IV, Ranney (2005, pp. 67–68, emphasis mine) stated:

> He recognized that strata composing the Grand Staircase (a name he invented), once covered the Grand Canyon region, only to be stripped away in what he called the Great Denudation. He theorized a later period of canyon cutting, which he termed the Great Erosion. Dutton therefore, was the first geologist to differentiate between two cycles of erosion: one that created the Grand Staircase by the *lateral* stripping of strata and one that created the Grand Canyon through *vertical dissection*. These two very different periods of erosion led to the landscape seen today.

Ranney (2005, pp. 24, 47, emphasis mine) puzzled over Dutton's two different erosional processes that occurred in the same area but at different times.

> It may not be readily apparent to the non-geologist that these flat, highly elevated plateaus [of the Grand Staircase] are worthy of discussion but it is likely that they formed at a *different time* under *different erosional processes* than the deep canyons that dissect them. What sequence of geologic events could have produced such a strikingly different set of landforms so close to one another? … Erosion at that time [during the first phase] must have been *much different* than what we see today. Broad, planar erosion most likely removed thick sheets of sedimentary strata that used to sit upon the plateau surface above Grand Canyon.

## The Carving of Grand Canyon

But how exactly did Grand Canyon form? We will probably never fully understand every detail because no one observed it, and it cannot be replicated in the laboratory. But now that we understand that it was most likely carved at the *end* of the Flood by high-velocity flow in confined channels, we can begin to add detail to our model.

### The Tide Turns

As shown in Part IV, paleocurrent indicators make it clear that the Great Denudation was accomplished by broad sheet currents flowing toward the east to northeast and eroding thousands of feet of sedimentary rock across the region (Oard, 2010d). The Rim Gravel probably represents the last strong east to northeasterly current, since it covers the planation surface on the southwest rim of the Colorado Plateau.

Grand Canyon is distinct in two ways. First, it was carved by currents flowing west, and second, the erosion was focused downward, and not spread across a broad area. Therefore, there had to be a paleocurrent *reversal* in the Floodwater flow. Such a reversal would fit well with the transition from sheet flow to channelized flow. What caused that turnaround?

Geologist Elliot Blackwelder (1934) proposed that the uplift of the Rocky Mountains was the key factor leading to the carving of Grand Canyon. Powell (2005, p. 169) wrote:

> Without the Rocky Mountains, there would be no Colorado River and no Grand Canyon. Thus, prior to the uplift that created the Rockies, the river could not have existed. Blackwelder saw evidence that the final uplift of the Rockies, which brought them above the elevation necessary for a perennial snowcap, had happened relatively recently.

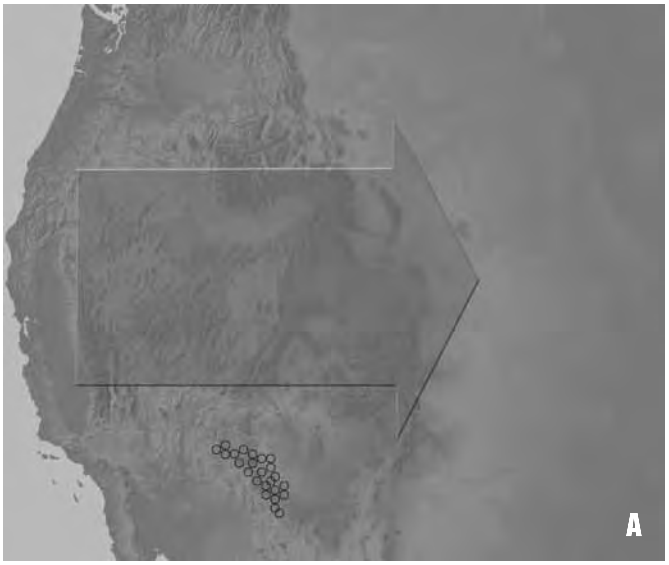
In typical uniformitarian fashion, Blackwelder, and most geologists after him, thought that the rising Rocky Mountains caused precipitation to increase on the western side of the mountains. Increasing rain and snow led to large rivers that carved Grand Canyon. So, the northeasterly flowing streams during the Great Denudation, according to uniformitarian belief, were reversed and perhaps enlarged by the rise of the southern Rocky Mountains.

While Blackwelder is probably correct that the rising mountains helped create Grand Canyon, he failed to comprehend just how it worked. He was thinking in uniformitarian terms, while Grand Canyon was catastrophically eroded. In the Flood, the rising Rockies created a flow barrier that caused the broad Flood currents to reverse themselves, and flow back toward the Pacific Ocean (Figure 2). As the flow reversed, there was a period of time when the current energy diminished, much like slack water between tides. For a brief time, the Colorado Plateau would have appeared to be a giant lake or inland sea with mountain ranges rising out of the Floodwater, mainly to the east. At this time, practically all the southwest United States was still underwater.

### Through the Kaibab Plateau

How did the Colorado Plateau "lake" lead to a breach in the Kaibab Plateau and channelized flow that carved Grand Canyon? For simplicity, let us assume that the relative topography of the Colorado Plateau was similar to that of today. With the uplift of the Rocky Mountains, Floodwater began to turn west towards the subsiding Pacific basin (Psalm 104:6–9). It seems reasonable that the Colorado Plateau was rising beneath the rapidly shallowing waters without major deformation at this time. Compared to other geomorphological provinces in the western United States, the Colorado Plateau is little deformed.

Given similar topography, the submerged Kaibab Plateau would have been already higher than the Marble Platform and would thus become a *barrier* to westerly flow. The fact that the Colorado River runs parallel to the Butte Fault and the East Kaibab Monocline between Nankoweap Canyon and the canyon of the Little Colorado River verifies this deduction (Oard, 2010b, Figure 2). This coincidence could not occur



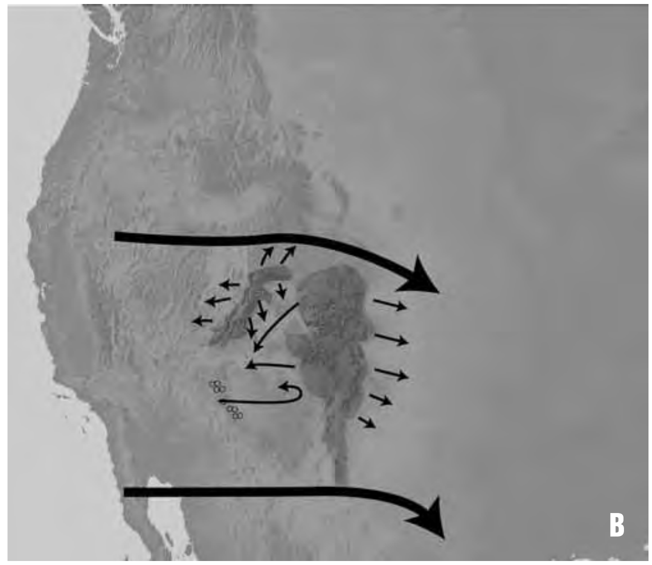





**Figure 2. Schematic of the transformation from west to east sheet flow in the southwest United States to more east to west channelized flow, which eroded the Grand Canyon: (A) aerial view showing west to east sheet flow with deposition of erosional boulders as Rim Gravel on the southwest Colorado Plateau; (B) the Southern Rocky, Uinta, and Wasatch Mountains become exposed above the Floodwater, breaking up the sheet flow (thicker arrows are areas of stronger flow); (C) channelized flow toward the Pacific Ocean west of the Rocky Mountains, with a convergence of two (or possibly three) main currents carving Grand Canyon across the plateaus. Drawing by Bryan Miller.**

unless the Kaibab Plateau uplifted *before* the Grand Canyon in order to guide the path of the eroding current.

The relative topography of the Colorado Plateau (Figure 3) helps us visualize Floodwater runoff. As the plateau began to emerge, water would form two broad channels converging on the southern part of the Kaibab Plateau. Current 2 would have been flowing toward the southwest, from south of the Uinta Mountains and the western slopes of the southern Rocky Mountains. This current would have been diverted from its westerly path by the rising Wasatch Mountains and the high plateaus of south central Utah. Current 1 would have been flowing northwest through the Little Colorado River Valley from high terrain in New Mexico. The Mogollon Rim would have formed the southwest perimeter of the channelized flow. Current 1 was probably stronger because there was nothing to slow and/or partially block its flow. Current 2, however, had to adjust to a number of terrain features perpendicular to its flow.

As these two currents set up, their convergence would have produced incredibly powerful flows. This maelstrom probably initiated the scour of the shallow Kaibab Plateau. The unique combination of these factors at that point in the Flood caused erosion to begin where the flow velocity was the most powerful, at the intermediate altitudes of the southward sloping Kaibab Plateau (Figure 4).

Once an initial erosional notch formed, that bathymetric irregularity would cause water flowing through it to *accelerate*. As the notch grew, that tendency would increase, and so would erosion, increasing a perpetuating cycle. Thus, the initial erosion occurred at intermediate altitudes on the Kaibab/Coconino Plateau, 1,200 to 2,000 feet (366 to 610 m) above the low points. It does not matter what the depth of low spots was on the Kaibab/Coconino Plateau, when the area was

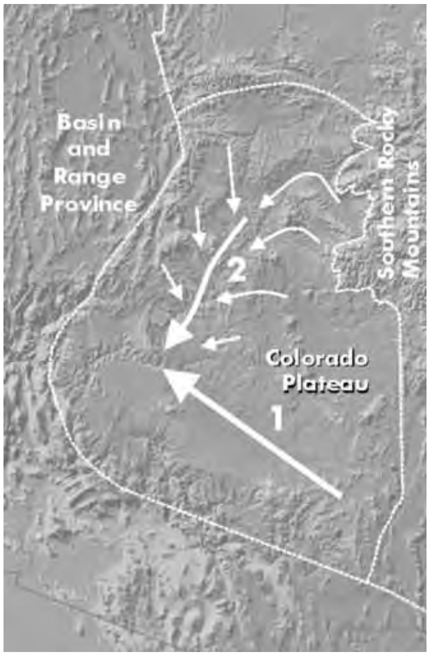



**Figure 3. Topographic map of Colorado Plateau and southern Arizona showing two broad channels converging on the southern Kaibab Plateau with northwest flow in the southern Colorado Plateau (current 1) and southwest flow in the northern Colorado Plateau (current 2). Map background provided by Ray Sterner and drawn by Peter Klevberg.**

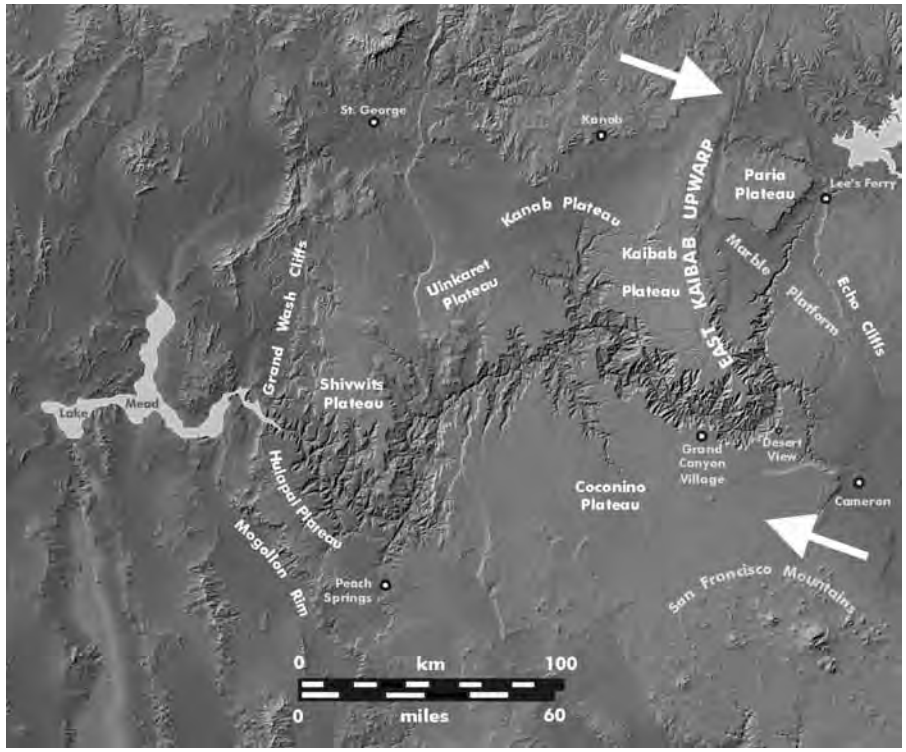



**Figure 5. The Grand Canyon and the surrounding area with the main plateaus and prominent topographic features. The low point of about 5,750 ft (1,753 m) of the northern Kaibab Plateau and the low point a little above 6,000 ft (1,829 m) on the eastern Coconino Plateau marked by arrows. Map background provided by Ray Sterner and drawn by Peter Klevberg.**

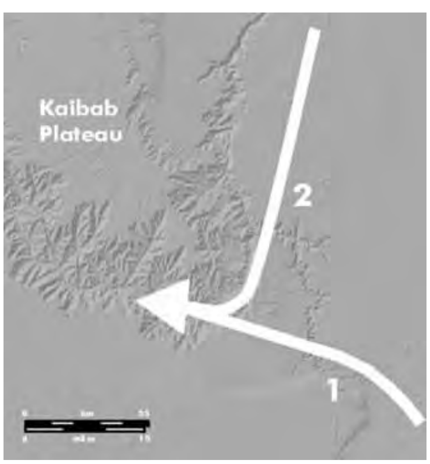



**Figure 4. The converging currents eroding a notch at intermediate levels of the Kaibab Plateau. Map background provided by Ray Sterner and drawn by Peter Klevberg.**

almost entirely flooded; low spots are not necessarily favored for erosion and the carving of a canyon. Low altitudes on the Kaibab Plateau would have only weak, westward-flowing currents. Of the catastrophic models available, I believe this one provides the most reasonable explanation for the location of Grand Canyon on the Kaibab Plateau.

This phenomenon is not restricted to Grand Canyon. Other water gaps are commonly cut at *intermediate elevations* or *at the top* of the highest point in a barrier, for instance, the Arun River that cuts through the Himalaya Mountains along the axis of a former north-south anticline (Oberlander, 1985). The initial breach dictating the location of a water gap depends on a complex interplay of flow, topography, uplift, rock type, initial configuration of the barrier, and faulting in the area.

## Hydraulics Solves Two Major Problems

Take a close look at a map of the Grand Canyon and the topography (Figure 5). Once past the barrier of the Kaibab Plateau, the canyon was not eroded down the topographic slope, which is to the southwest. If a river really had carved Grand Canyon, its course should have run southwest toward Havasu Canyon. Instead, the present canyon is oriented *perpendicular* to the topographic slope, "hugging" the southwest edge of the Kaibab Plateau and trending northwest. As we noted earlier, this course was not controlled by faulting. If it was neither faulting nor topography, then what did

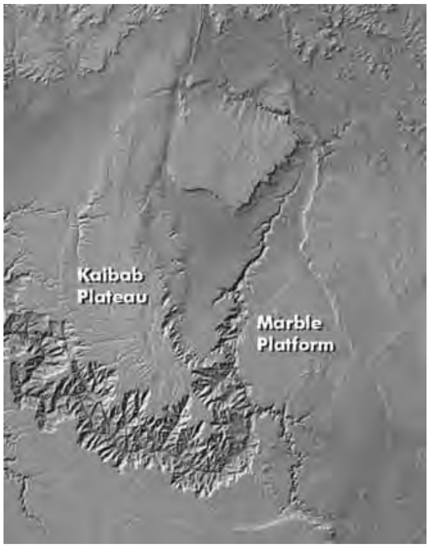



Figure 6. Close up of topo map showing great erosion of southeast Kaibab Plateau and little erosion of adjacent marble Platform. Map background provided by Ray Sterner and labeled by Peter Klevberg.

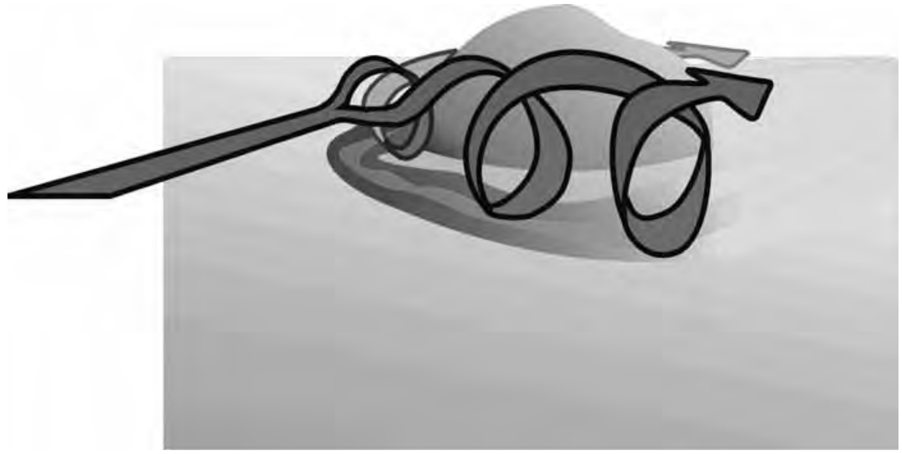


Figure 7. Diagram of spiraling vortices causing a horseshoe-shaped furrow around a rock in a current. Drawn by Mrs Melanie Richard.

control the path of the canyon? This is the second major problem that must be solved by any successful model.

A third problem is the significant erosion of the southeast Kaibab Plateau (Figure 6), which is an area showing only minor drainage today. Hardly any erosion occurred along the edge of the adjacent Marble Platform. None of the uniformitarian hypotheses or the creationist dam-breach hypothesis can answer these mysteries.

However, the late-Flood model can and does provide reasonable answers to both problems. The secret lies in underwater hydraulic processes; when water is diverted around a solid object, such as a large rock, it is typical for the flow to accelerate at the *upstream* end of the obstacle and along its edge. You can observe this by watching the water flow around a piling or rock in a stream. Like the airflow around an airplane wing, the obstacle increases the flow path, causing the water to flow faster (Karcz, 1968; Richardson, 1968; Russell, 1993; Tinkler and Stenson, 1992; Werner et al., 1980). If you watch carefully, you will see a horseshoe-shaped furrow form in *front of and along the sides* of the obstacle (Figure 7).

Figure 8 shows lens-shaped erosion on the southeastern Kaibab Plateau and Grand Canyon cut along the southwest edge of the plateau. Picture the Kaibab Plateau as an obstacle in a giant stream flowing northwest. After the initial breach caused an erosional notch (Figure 4), the fastest currents were directed northwest since there were no barriers in the direction of the Little Colorado River Valley. With the acceleration of the northwesterly flow, a horseshoe-shaped erosional pattern formed on the southwest side of the Kaibab Plateau "obstacle." The erosion at the northeast side of the Kaibab Plateau was less energetic and died out quickly going along the northeast edge of the plateau, likely because the second major current converging from the northeast would have disrupted erosion (Figure 8). So both the orientation of Grand Canyon and the erosional pattern on the southeast end of the Kaibab Plateau are consistent with hydraulic-flow principles operating at a very large scale, like that of the Flood.

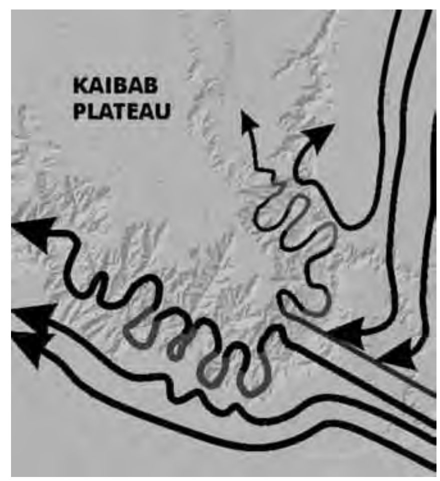



Figure 8. Similar to flow around a rock, turbulent flow impinging on the southeast Kaibab Plateau erodes a "furrow" on either side. Because of interference from current 2 coming from the north, the strongest flow and erosion will be on the southwest edge of the Kaibab Plateau. Map background provided by Ray Sterner and drawn by Peter Klevberg and Mrs Melanie Richard.

## The Grand Canyon Just West of the Kaibab Plateau

The Flood hypothesis has already provided reasonable solutions to several insurmountable problems for the other hypotheses. Now it must address the orientation of Grand Canyon west of the Kaibab Plateau. In order to do so, we must consider other Flood processes that would have influenced landforms in the southwestern United States.

The Flood was a complex event, and our model must reflect that complexity. First, we must note that volcanism was ongoing in many parts of the western United States, including the edge of the Colorado Plateau and the Basin and Range Province. Volcanism may have formed barriers that would have diverted retreating Floodwater. Second, rapid topographic changes were underway, with mountain ranges rising and basins sinking. The southwestern edge of the Colorado Plateau lies about 0.6 mile (1 km) above the sediment-filled Grand Wash trough and is separated by the Grand Wash fault (Oard, 2010a). If we exclude the sedimentary fill of Grand Wash trough, the actual throw on the fault is closer to 2.5 miles (4 km) (Faulds et al., 1997). This fault had the most displacement associated with any fault on the Colorado Plateau by far. In addition to the Grand Wash Fault, the Hurricane Fault displaced rocks by 1,300 to 1,640 feet (396–500 m) down to the west, and Toroweap Fault did likewise by 580 to 1,200 feet (177–366 m) (Karlstrom et al., 2007). These north-south faults mark the transition zone between the Colorado Plateau and the Basin and Range Province. These faults were probably active when the Imperial Valley rift zone was subsiding—more than 20,000 feet (6,096 m)!

So, at the time Grand Canyon was forming, Grand Wash trough and the whole area of southeast California was rapidly sinking, creating a rapidly changing bottom and influencing the flow of water off the Colorado Plateau. As the Colorado Plateau continued to become more exposed above the Floodwater, the currents would have become more and more channelized and their flow more energetic for a time. Because of these complexities, any model of the origin of western Grand Canyon is certainly open to further refinement, but we can make an educated guess as to why the Canyon follows its present course.

Figure 9 shows a convergence of currents from the east, north, and south, just to the west of the Kaibab Plateau. The channelized current from the north flowed off the Grand Staircase of south central Utah, eventually forming the deep Kanab Canyon. The channelized current from the south was caused by water flowing north down the topographic slope of the Coconino Plateau, eventually carving the deep Havasu Canyon tributary. These two currents collided with the channelized current forming the Grand Canyon on the southwest Kaibab Plateau. Furthermore, the Grand Wash trough was sinking. These converging currents would combine and force the water to flow toward the west between two high areas to the north and south. The high area to the north was due to volcanism on the Uinkaret Plateau (Oard, 2010a, Figure 5).

The tributary Kanab and Havasu Canyons are typical of tributaries that formed at the same time as the main channel, in this case Grand Canyon. It is typical for water eroding into a flat surface to carve a main trench as well as tributaries that intersect at the same level (Thornes, 1990). So the pattern of Grand Canyon fits observed drainage patterns but at a much larger scale.

What role did volcanism play? Little volcanism was occurring during the Great Denudation because few if any volcanic rocks are found in the true Rim Gravel. However, volcanic activity must have increased afterwards because volcanics are common as exotic rocks mixed in with the reworked Rim Gravel later deposited at lower altitudes (Oard and Klevberg, 2005). This was still late in the Flood, given the scale of the redistribution of the Rim Gravel and its occurrence on Flood-eroded pediments below the Mogollon Rim (Oard, 2004). Faulting and volcanism would be expected to occur at the same time; tectonic disruptions in the crust would encourage magma migration to the surface. Thus it is likely that both volcanism and faulting were ongoing while Grand Canyon was being carved. Volcanism continued after the Floodwater drained off the area, as shown by basalt flows that cascaded down into the canyon (Figures 10 and 11).

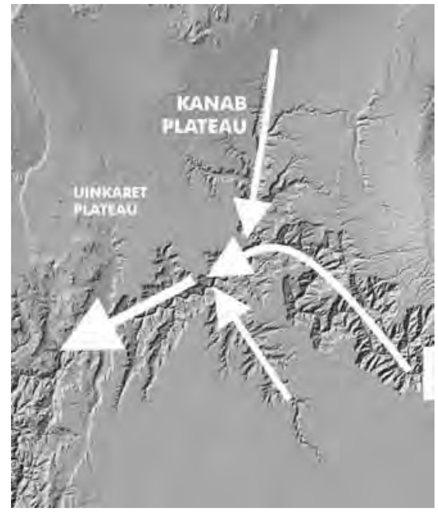



**Figure 9. Convergence of currents west of Kaibab Plateau, from Kanab Plateau, and Coconino Plateau overlaid on current relief. Map background provided by Ray Sterner and drawn by Peter Klevberg.**

## Grand Canyon around the Shivwits Plateau

Volcanism on the Shivwits Plateau could have forced the main channelized current to change directions from flowing west to flowing south (Figure 12). Another high area of sedimentary rocks, the northern extension of the Aubrey Cliffs and the southwest edge of the Coconino Plateau, would lie east of this southerly flow. This path is west of the Hurricane Fault, the southern extension of which is Peach Springs Canyon (Figure 1). It is interesting that Grand Canyon did not follow the Hurricane Fault.

**Figure 10. Basalt lava that has descended the northwest wall of Grand Canyon clear to the Colorado River.**

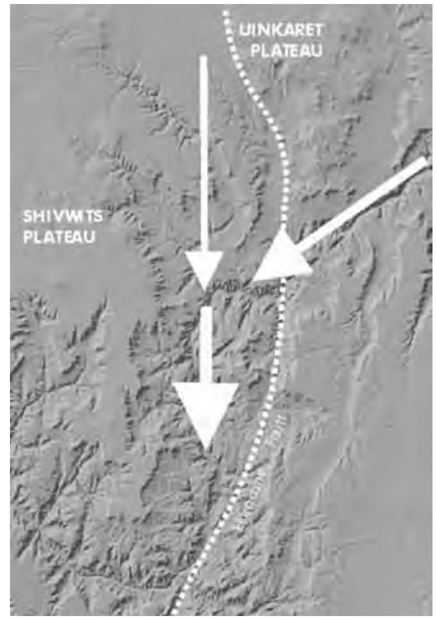



**Figure 12. The main channelized current is diverted south between the high volcanic area on the Shivwits Plateau and the high northern extension of the Aubrey Cliffs. The path of the Grand Canyon was not carved in location of Hurricane Fault, shown to the east of the Grand Canyon. Map background provided by Ray Sterner and drawn by Peter Klevberg.**

The next question to answer is why Grand Canyon took a 135° turn around the southern Shivwits Plateau. Why didn't the Grand Canyon continue southwest through the Peach Springs Canyon and Truxton Valley to enter the Basin and Range Province? This never happened, since Peach Springs Canyon and Truxton Valley contain deep debris fills in places with northeast-directed paleocurrents, just like other canyons on the Hualapai Plateau (Young and Brennan, 1974; Young, 2001).

There are two possible factors that could have turned the main Flood current to flow toward the northwest. One factor could have been the rise of the terrain south and southeast of Peach Springs Canyon, such as the Aquarius Mountains, Cottonwood Mountains,

**Figure 11. Basalt lava flow remnant at river level to the left.**

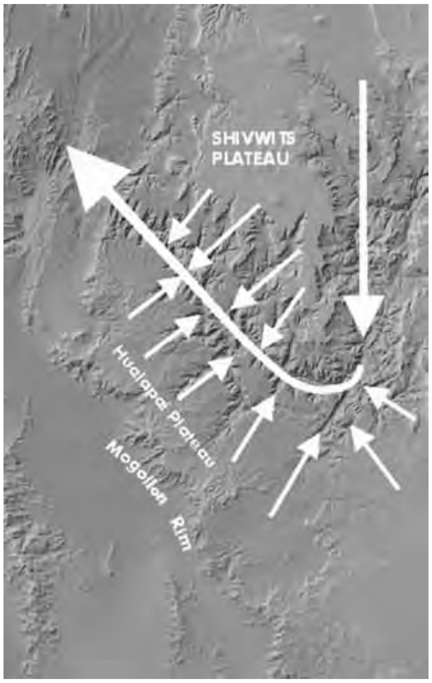



**Figure 13. The diversion of the channelized flow toward the south to flowing northwest because of volcanism and the rise of higher terrain south and southeast or Peach Springs. Northwest flow enhanced by the sinking of the Grand Wash trough and the uplift of the southwest edge of the Hualapai Plateau. Map background provided by Ray Sterner and drawn by Peter Klevberg.**

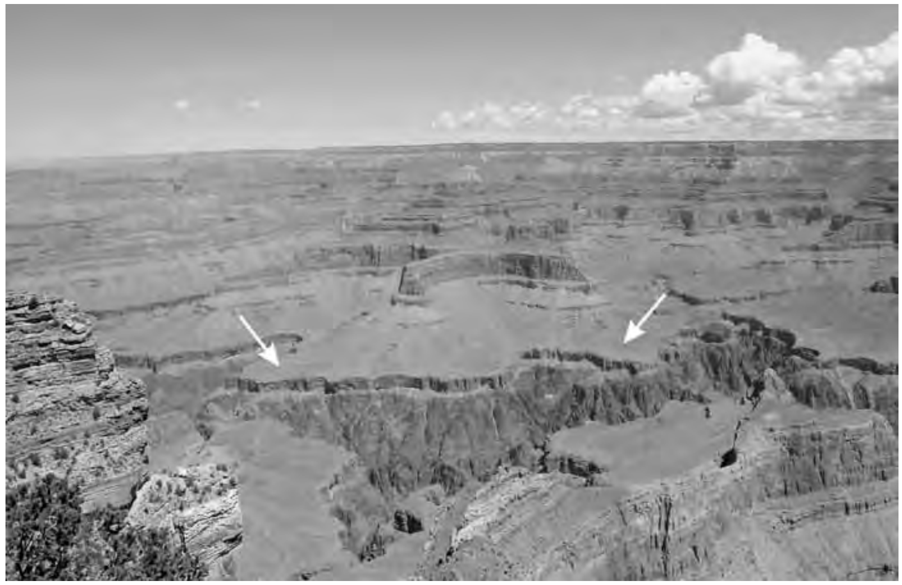


**Figure 14. Picture of Tonto Platform (arrows) from Powell Point, South Rim.**

and other mountain ranges (Figure 13). Since these are volcanic mountains, volcanism could have blocked the current flowing toward the south between the Aubrey Cliffs and the Shivwits Plateau, causing it to flow west. Some of these mountains are over 6,500 feet (1,981 m), while the town of Peach Springs at the top of Peach Springs Canyon is only 4,800 feet (1,463 m).

A second factor could be an increasing current flowing northwest between the Shivwits Plateau and the southwest Hualapai Plateau. As mentioned above, the rapid sinking of the Grand Wash trough and the tilt of the Hualapai Plateau toward the northeast could have started a local channelized flow toward the northwest (Figure 13). Channelized tributary flow would also have flowed off the Shivwits Plateau and the southwest Hualapai Plateau to add to the northwest-flowing current speed. It could be at this time that other canyons, such as Milkweed and Peach Springs Canyons that trend northeast, were carved on the Hualapai Plateau (there are complications with this interpretation, however).

Once the channelized current spread west past Grand Wash Cliffs, the current would have entered the tectonically active Basin and Range Province. The westward momentum of the water could have resulted in the several water gaps observed through north-south mountain ranges west of the Grand Wash Cliffs. Eventually, the current would have been diverted to flow south because of the deep rifting of southeast California and adjacent Arizona.

## Narrowing of the Canyon with Depth

Besides the path of Grand Canyon, a few other questions remain to be answered by any successful model.

In viewing Grand Canyon, one notices that it is wide at the top and very narrow at the bottom. There are two wide benches eroded in the canyon. One is the Esplanade (Roy, 2004; Scarborough, 2001) in the western Grand Canyon, and the other is the Tonto Platform in the eastern Grand Canyon (Figure 14). The narrowing with depth and the formation of benches could easily be explained by narrowing channelized currents as Floodwater drained off the continent. It is typical of channelized currents in floods to narrow with depth; this occurred in the Lake Missoula flood in the forming of Palouse Canyon (Figure 15; see also Oard, 2010c, Figure 7). Erosion began as a broad current over the top of the ridge between Washtucna Coulee and the Snake River Valley, resulting in wide erosion. As the canyon deepened, it also narrowed.

The Tonto Platform could have formed by the wide erosion that reached the resistant Tapeats Sandstone, which forced the current to erode a narrow Canyon through the Tapeats Sandstone and the igneous and metamorphic rocks

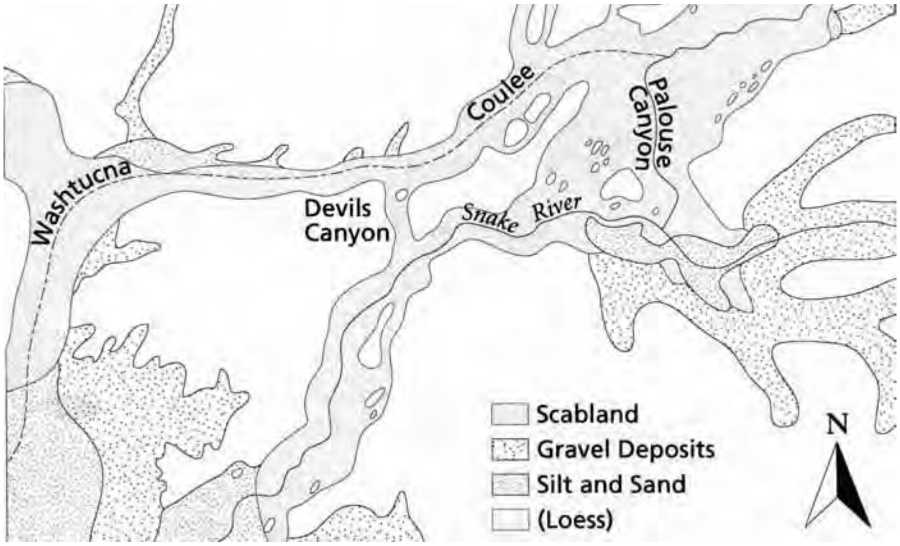



**Figure 15. Map of ridge between Washtucna Coulee and the Snake River, showing Palouse Canyon and Devils Canyon carved during the Lake Missoula flood (redrawn from Bretz, 1928, p. 205 by Mark Wolfe).**

below. The current flowing in an arc around the southern Shivwits Plateau could account for the wide erosion that created the Esplanade platform (Roy, 2004). During erosion, the unresistant Hermit Shale could easily have been eroded, but erosion could have been arrested when the harder Esplanade Sandstone of the Supai Group was reached just below the Hermit Shale.

### Meanders

During erosion of Grand Canyon, the channelized current could create the meanders we observe in the canyon's course. Meanders are common features of channelized flow, forming in everything from rivers to submarine fans (Oard, 2008). Many rivers, valleys, and canyons across the globe exhibit meandering, and many of these (especially in water gaps) formed late in the Flood (Oard, 2008). Gentle meandering also formed when Palouse Canyon was eroded during the Lake Missoula flood (Figure 16). Meanders normally form during low current velocities. It is probable that the meanders in the Grand Canyon were caused by the lower current velocities while flowing over the plateaus west of the Kaibab Plateau. These plateaus are generally at the same elevation and so would favor slower currents.

### The Formation of Marble Canyon

Remember that there were two converging channelized currents that cut the initial notch through the Kaibab Plateau (Figure 9). As the water level fell, these two currents would become more channelized and end up carving a deep, narrow canyon west of the Kaibab Plateau. As the eroding current narrowed in the closing stages of the Flood, the northwest-flowing water (current 1 in Figure 4 from the Little Colorado River Valley) would be forced to cut a narrow notch through the Blue Moon Bench, forming the present narrow canyon in the lower Little Colorado River (Oard, 2010b, Figures 7 to 10). Current 2 coming from the northeast would also narrow and erode a narrow canyon in the Marble Platform, despite the fact that this platform slopes northeast. This is the main extension of the Grand Canyon through the Marble Platform.

As the depth of water continued to decrease east of the Kaibab Plateau, channelized currents would tend to form, flowing downslope east off the Kaibab Plateau and northeast off the Marble Platform. Such currents would end up causing side canyons to the Colorado River on the Marble Platform that would enter the Grand Canyon at an angle greater than 90°. Tributaries normally enter a main channel at angles less than 90° because both the slope of the river and the terrain are in the same direction. So, the tributaries to Marble Canyon are considered "backwards" but are a result of the downward slope of the Marble Canyon toward the northeast.

## Summary

Uniformitarian geologists have studied Grand Canyon for over a century and have failed to credibly explain its origin with any of their hypotheses. None of those ideas account for all of the field data, and none of them can even provide reasonable answers to the major enigmas surrounding the canyon. The scientists in question are intelligent, they have received ample funds to conduct numerous studies, and more than enough time has passed to work the problem. The most reasonable explanation for their failure is that they are trapped in a paradigm that cannot be squared with observations in the field.

Creationists offer a better paradigm; a catastrophic origin offers a better framework to resolve many longstanding mysteries. But initial efforts to explain Grand Canyon as an artifact of a post-Flood flood caused by the failure of natural dams falls short of the full potential offered by the paradigm. A model that utilizes the full power and energy of the Flood offers a much more reasonable explanation. A global flood, especially one receding from the continents, would have supplied more than enough water

**Figure 16. Entrenched meander and underfit in Palouse River in a 500-foot (150 m) deep gorge downstream from Palouse Falls, southeast Washington, formed during the Lake Missoula flood.**

for the sheet erosion of large regions and for the channelized erosion of deep canyons. A rapidly sinking ocean bottom and the tectonic uplift of the continents would have added tremendous energy to that water. The mystery of the two-stage erosion event, the Great Denudation followed by the Great Erosion that formed the canyon systems, is entirely congruent with the two phases of the retreating stage of the Flood.

The Great Denudation was caused by sheet flow toward the east and northeast. The rise of the Rocky Mountains caused that flow to reverse and begin forming channels. Grand Canyon was carved by channelized flow to the west that increased in velocity as the relative water level fell. Strong flow from converging currents cut a notch in the Kaibab Plateau. The northwesterly current (number 1 on Figure 4) eroded the southeast Kaibab Plateau and the northwest trending run of Grand Canyon along the southwest edge of the Kaibab Plateau. That channel continued west, then south, then back to the northwest before exiting the Grand Wash Cliffs, based on topography, volcanism, and faulting. As the water level continued to fall, the eroding currents narrowed, forming the Esplanade and the Tonto Platform and the slotlike canyon of the inner gorge. The narrowing currents also carved the Little Colorado River Canyon and Marble Canyon with its backwards tributaries.

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