The Origin of Grand Canyon

Part I: Uniformitarianism Fails to Explain Grand Canyon

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Abstract

This is the first of a five-part series on the origin of Grand Canyon. It will address numerous uniformitarian problems. Despite nearly 150 years of study, uniformitarian scientists remain mystified as to its origin. Part of their difficulty stems from the necessity of explaining both the canyon and its geological context within the surrounding Colorado Plateau. Data gathered at present do not support any uniformitarian hypothesis. The three most credible uniformitarian hypotheses all can be shown to create intractable problems. These are: (1) the old antecedent stream hypothesis, (2) the stream piracy hypothesis, and (3) the revived lake spillover hypothesis. None are viable. Thus, any reasonable earth scientist should be open to exploring the possibility of a recent catastrophic origin.

Introduction

Grand Canyon is considered a showcase for uniformitarian geology and against the Flood paradigm (Strahler, 1987). It also lies within the frontlines of competing ideas on its origin:

> The famous landscape of the Grand Canyon lies along the front lines of competing scientific and non-scientific [i.e., creationary] views of Earth's antiquity and evolution (Pederson et al., 2008, p. 1,634b, brackets added).

Therefore, it is important for uniformitarian scientists to develop a viable theory for the origin of Grand Canyon (Figure 1).

I am aware that most mainstream scientists consider themselves "actualists" and not uniformitarians. Actualism is similar to uniformitarianism, except that the former believe in a few large catastrophes sprinkled throughout earth history, such as meteorite impacts. They also admit that the present is not necessarily the key to the past but that geology must always believe natural processes operated in the past. I believe this philosophical point of view (i.e., naturalism) can be used as an excuse when deductions from the rocks and fossils are contradicted by present processes. But since few people understand the distinction between actualism and uniformitarianism, I will continue using the term "uniformitarianism," especially since this latter doctrine was the philosophical principle used in geology to throw out the Flood.

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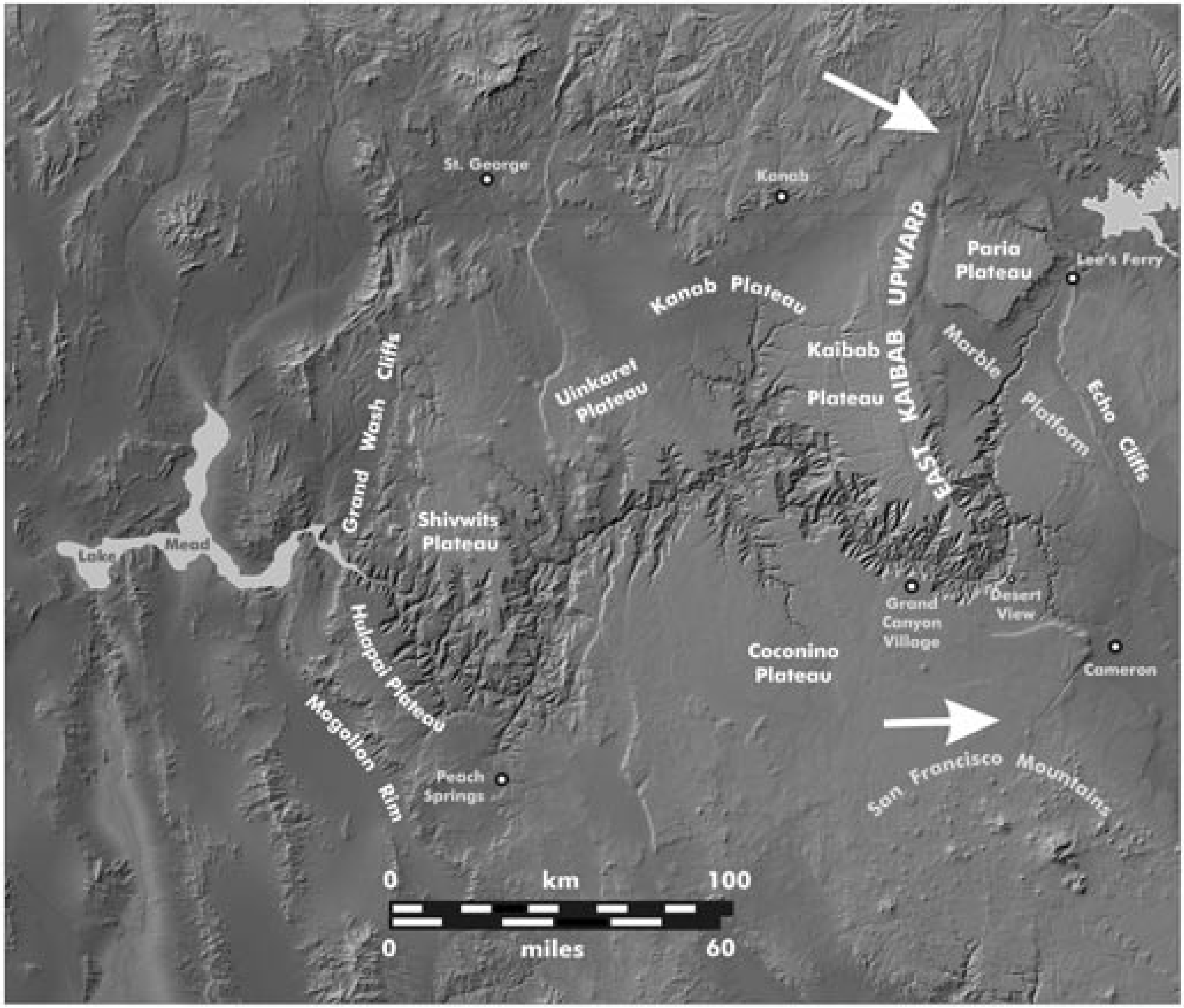

Figure 1. The Grand Canyon and the surrounding area with the main plateaus and prominent topographic features. The low point of about 5,750 ft (1,753 m) of the northern Kaibab Plateau and the low point a little above 6,000 ft (1,829 m) on the eastern Coconino Plateau marked by arrows. Map background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

Uniformitarian Scientists Mystified

One would think that uniformitarian geologists would easily be able to figure out how Grand Canyon originated—if uniformitarianism is the correct starting point. They have spent an inordinate amount of effort to do so, ever since John Wesley Powell's (1961) first courageous trip down the Green and Colorado Rivers in 1869. However, their hypotheses have come and gone—none fit the data. Despite great advances in knowledge, the origin of Grand Canyon is still a major mystery of geomorphology, the study of the surface features of the earth.

> Regional geological knowledge of the Grand Canyon is especially rich and detailed, but it is already prone to unnecessary controversy and is frustratingly difficult to synthesize and communicate to the public (Pederson et al., 2008, p. 1,634b).

In a popular book on the geology of Grand Canyon, Greer Price (1999, p. 7) admits: "But while the principles of erosion, like so much of geology, are simple, the detailed history of the Colorado River and its canyons remains elusive and difficult to grasp." In another recent

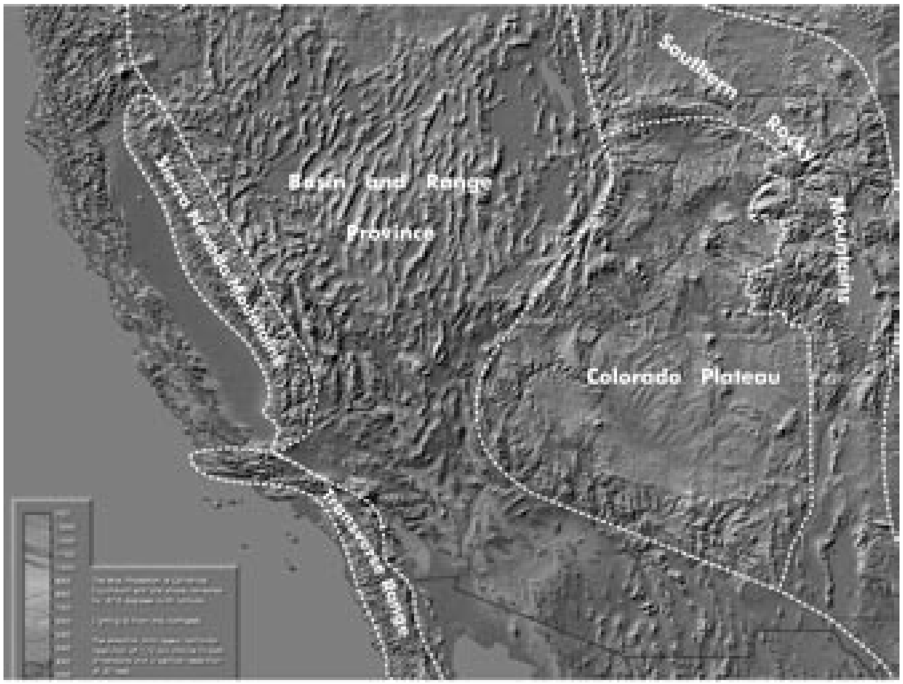

Figure 2. The Colorado Plateau with its adjacent geomorphological provinces of the southwest United States. Map background provided by Ray Sterner and figure drawn by Peter Klevberg.

book, Wayne Ranney (2005) repeatedly notes how little is actually known about the origin of Grand Canyon.

> The canyon's birth is shrouded in hazy mystery, cloaked in intrigue, and filled with enigmatic puzzles. And although the Grand Canyon is one of the world's most recognizable landscapes, it is remarkable how little is known about the details of its origin (Ranney, 2005, p. 11).

The Colorado Plateau

The Grand Canyon is cut through the high southwest edge of the Colorado Plateau, a roughly circular area (Figure 2) that covers southeast Utah, southwestern Colorado, northwestern New Mexico, and northern Arizona. The plateau has an area of about 148,000 mi^2 (383,000 km^2). The altitude is nearly all above 5,000 ft (1,524 m) msl with precious little vegetation. The Colorado River drains about 90% of the area.

The Colorado Plateau has sharply defined boundaries that separate it from neighboring provinces (Graf et al., 1987). On the west it is separated from the Basin and Range Province by faults and perimeter volcanic plateaus. The Grand Wash Fault forms a vertical cliff about 3,500 ft (1 km) high along the western edge of Grand Canyon. The Grand Wash Fault becomes the Hurricane Fault in south central Utah, separating the Colorado Plateau from the Basin and Range in Utah. The eastern boundary is the Rocky Mountains and the northern boundary is the Uinta Mountains.

To the south, the boundary is formed by the Mogollon (pronounced: muggy-yohn) Rim that stretches from northwest Arizona, east-southeast, into north central New Mexico. The Mogollon Rim is generally linear, although it is scalloped and rather ill defined in northwest Arizona. It is a spectacular escarpment up to 2,000 ft (610 m) above the streams just to the south. North of the Mogollon Rim, the land dips gently north. The Mogollon Rim is *not* the result of faulting but is an erosional escarpment (Holm, 2001; Patton et al., 1991; Williams et al., 1999). The Mogollon Rim runs into the Grand Wash Fault in northwest Arizona.

The Colorado Plateau is only slightly deformed into gentle folds with near-horizontal sedimentary rocks compared to the surrounding provinces. Since the area is so large, these gentle folds result in great, eroded upwarps, such as the San Rafael Swell and the Monument Upwarp. The upwarps are separated by deep basins filled with sedimentary rocks, such as the San Juan and Uinta Basins (Baars, 2000; Hunt, 1956; Rigby, 1976; 1977). Steeply inclined beds are limited to a few great monoclines that border several uplifts. The exposure of strata and the unique landforms make the Colorado Plateau home to eight national parks, many national monuments, and abundant state parks.

The landscape is strongly stepped in places, consisting of cliffs called escarpments, separated by wide, gentle slopes—all the result of differential erosion and *not* faulting (Patton et al., 1991). The Grand Staircase, located north of Grand Canyon (Morales, 1990) and forming the northwest edge of the Colorado Plateau, is the most significant example (Figure 3). The height of the plateaus range from the lava-capped Aquarius Plateau on the northeast at about 11,400 ft (3,475 m), to the Kanab and Uinkaret plateaus just north of Grand Canyon. The Kaibab Limestone is exposed over most of the area around Grand Canyon. In the Grand Staircase, the strata above the Kaibab Limestone are about 10,000 ft (3,048 m) thick and dip gently to the north (Baars, 2000; Rigby, 1977).

The Colorado Plateau shows evidence of significant erosion. Based on geological clues, mainly the amount of measurable erosion on anticlines or large uplifted areas, an average of

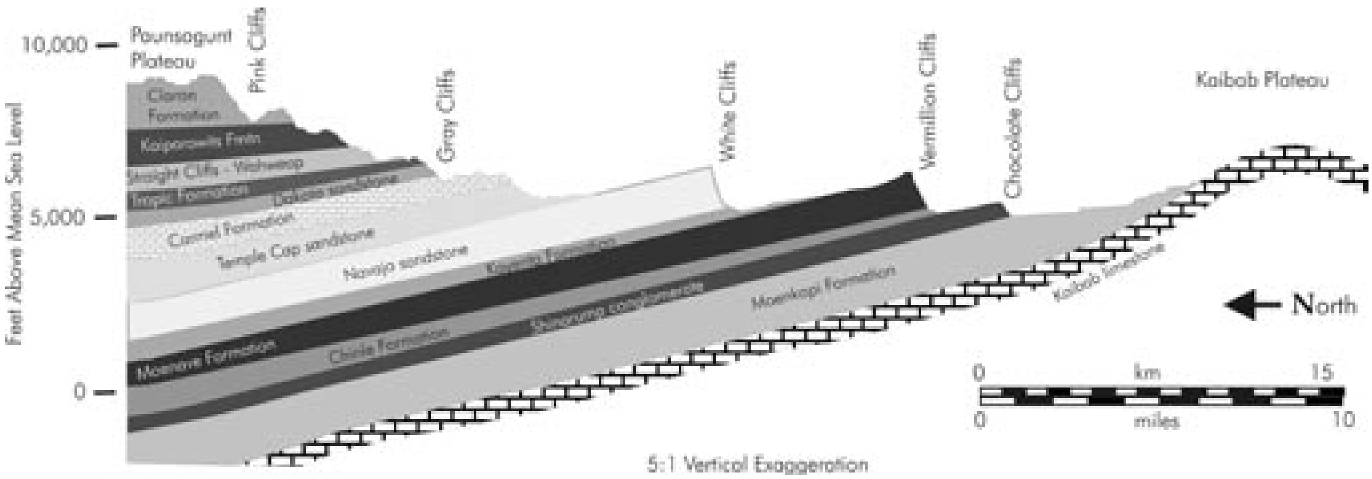

Figure 3. The Grand Staircase north of Grand Canyon showing the five prominent cliffs formed by erosion. The slope of the sedimentary rocks is north to north-northeast at less than 3 degrees. Vertical exaggeration is 5:1. Drawing by Peter Klevberg.

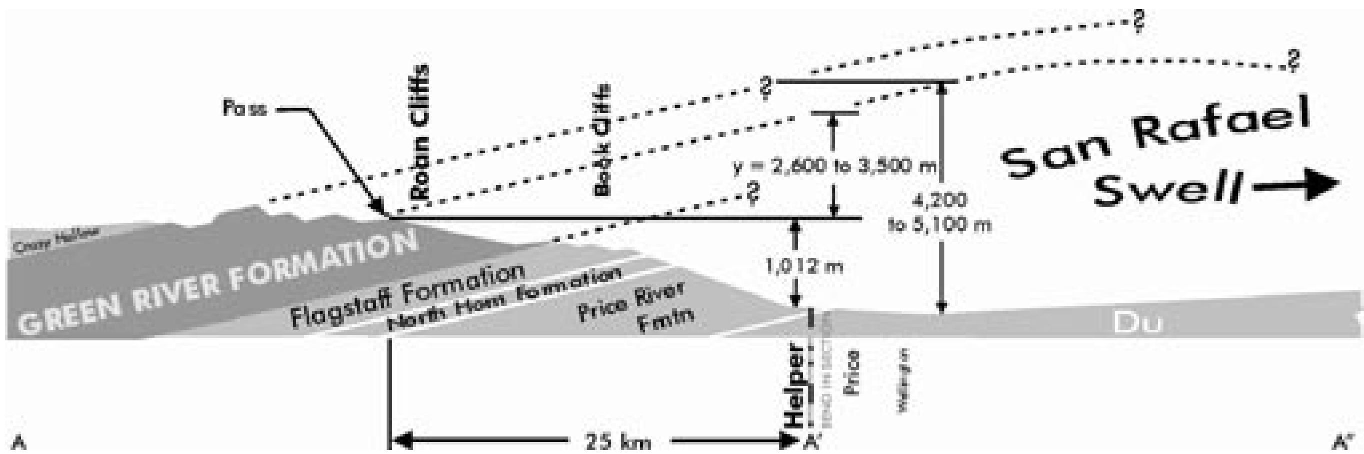

Figure 4. Cross-section of the sedimentary rocks of the north limb of the San Rafael Swell. Dashed lines with question marks show the strata projected up over the San Rafael Swell, assuming no change in thickness. Du means diluvial undifferentiated. Note that the total erosion is about 14,000 to 17,000 feet (4.2 to 5.1 km). Drawing by Peter Klevberg.

8,000 to 16,000 ft (2.5 to 4.9 km) of erosion has occurred over the *entire* Colorado Plateau (Schmidt, 1989). Up to about 17,000 ft (5.2 km) of erosion has occurred on the north limb of the San Rafael Swell (Figure 4). The uppermost remaining formation beneath this erosional surface is the Green River Formation, strongly suggesting that the Green River Formation is a Flood deposit (Oard and Klevberg, 2008). This tremendous erosion has created unique landforms, creating perplexing courses for all the major rivers of the Colorado Plateau. Uniformitarian scientists place nearly all this erosion in the Cenozoic, the last major era of the uniformitarian geological timescale.

The Grand Canyon

Grand Canyon is perhaps the most spectacular canyon readily observable anywhere in the world (Vail, 2003; Vail et al., 2008). The Grand Canyon section of the Colorado Plateau consists of relatively small plateaus, which comprise one large plateau (Austin, 1994a). North of Grand Canyon, running from west to

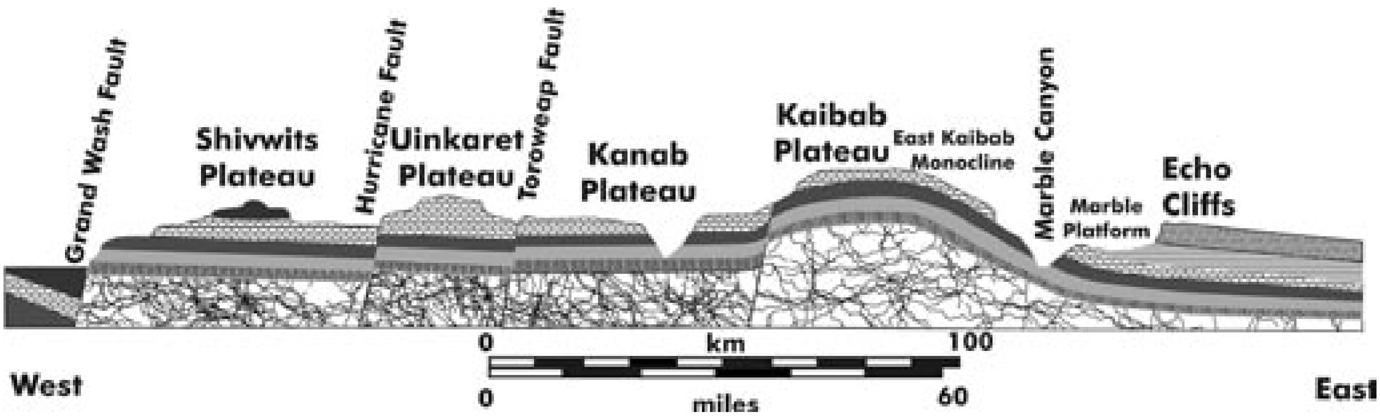

Figure 5. East-west cross section showing faults and monoclines. Drawing by Peter Klevberg.

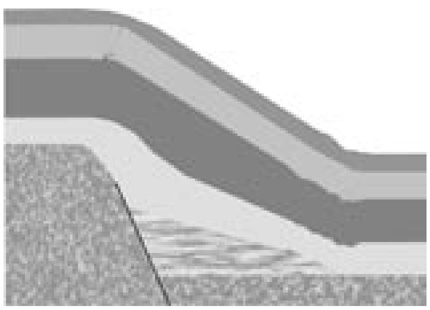

Figure 6. A monocline in which the beds bend downward. Monoclines are often cored by faults in the subsurface.

east, these small plateaus include the Shivwits, Uinkaret, Kanab, and Kaibab Plateaus (Figure 1). South of the canyon are two plateaus: the Hualapai Plateau in the extreme west and the Coconino Plateau over the rest of the area.

The small plateaus are generally bounded by faults on their western sides and monoclines on the eastern boundaries (Figure 5). A monocline is a local or regional steepening in the dip of sedimentary beds due to folding (Figure 6). The East Kaibab Monocline forms the east boundary of the Kaibab Plateau and has a vertical drop of about 3,000 ft (914 m). Faults are present throughout the region. From west to east, the major faults include the Grand Wash Fault that forms the western boundary of Grand Canyon, the Hurricane Fault that stretches northwest as far as Utah, and the Toroweap Fault that merges with the Sevier Fault in Utah.

The elevations of the plateaus range from about 5,000 to 9,000 ft (1,524 to 2,743 m). Volcanism has spread late Cenozoic lavas over the plateau surfaces in some areas, especially south of Grand Canyon. The San Francisco volcanic field is located near the Mogollon Rim, and other fields exist on the northwest rim of the Grand Canyon.

Grand Canyon is 277 river-miles (446 km) long, if the 60 miles (97 km) of Marble Canyon are included. Its depth varies from 3,000 to 6,000 ft (914 to 1,829 m), and its average depth is 5,280 ft (1,610 m). The canyon's width from rim to rim (Figure 7) ranges between 4 and 18 miles (6.4 to 29 km). The total amount of rock eroded from the canyon was 800–1,000 mi^3 (3,335–4,168 km^3) (Austin, 1994b; Potochnik, 2001; Ranney, 2005). There is no main fault parallel to the Grand Canyon that would have aided erosion, contrary to the opinion of Burdick (1974). There are, of course, minor faults, mostly perpendicular to

Figure 7. Grand Canyon (view north from Mather Point). The inner canyon is at the bottom foreground. Bright Angel Canyon is to the lower right.

the Grand Canyon, which could have aided erosion.

The highest plateau in the region is the Kaibab Plateau, located near the eastern Grand Canyon, which exceeds 9,000 ft (2,745 m) msl. This is important because before Grand Canyon was carved, this plateau would have blocked the Colorado River. Uniformitarians believe the Kaibab Plateau is about 70 million years old. Evidence that the plateau existed before the carving of Grand Canyon will be presented in Part II. In every uniformitarian terrestrial scenario, the Kaibab Plateau should have diverted the Colorado River. Before Grand Canyon was carved, the south side of the Kaibab Plateau sloped gently downward toward the south and included the eastern Coconino Plateau south of Grand Canyon. But one mystery of the canyon's origin is that the Colorado River appears to have cut right through the south side of the Kaibab Plateau at an *intermediate* altitude (Austin, 1994a, p. 85).

The Grand Canyon cut through the Kaibab Plateau at about the 8,000-foot (2,438 m) level on what is now the North Rim and at the 7,300-foot (2,225 m) level on what is now the South Rim. This is *not* the logical path for water to have taken across the plateau. The lowest path across the plateau is a little more than 5,700 ft (1,737 m) well north of the highest point (see arrows on Figure 1). Another reasonable path is south of the current canyon, which is a little above 6,000 ft (1,829 m) msl. The river in the eastern Grand Canyon is at 2,400 ft (732 m) above msl. Why was the Grand Canyon eroded at an *intermediate* altitude? This is the major problem.

Marble Platform, shown in the middle background of Figure 8, is the eastern extension of the lower part of the East Kaibab Monocline. Marble Platform is deeply incised by Marble Canyon and its several deep side canyons. Marble Canyon is generally considered the north to northeast extension of the Grand Canyon. Interestingly, Marble Platform slopes northeast and downward toward Lee's Ferry, where rafters put in to float the Colorado River. But the Colorado River flows southwest—*opposite* the slope of the top of the Marble Platform.

Looking toward the northeast in Figure 8, the 2,000-ft (610 m)-high Vermillion and Echo Cliffs can be seen. Vermillion Cliff is the lower part of the Grand Staircase, composed of a series of cliffs and plateaus north of the Grand Canyon area. The sedimentary rocks seen in Vermillion Cliff, as well as the Grand Staircase, at one time stretched south over the Grand Canyon area before being eroded away. Up to 1.5 miles (2.4 km) of these sediments were eroded in a sheet fashion prior to canyon formation. This event is called the Great

Figure 8. Marble Platform from Point Imperial with the 2,000-foot (610 m) high Vermilion and Echo Cliffs in the background. The dissection of the Marble Platform by Marble Canyon seen in the middle. Photo courtesy of Tom Vail.

Denudation and is described in Part IV of this series.

Uniformitarian Speculations Abound

Information provided at Grand Canyon National Park relates the origin of the canyon to erosion by the Colorado River over millions of years. The essence of this hypothesis is uniformitarianism—present-day rates operating over eons. This can be called the *little-water-over-a-lot-of-time* hypothesis. (The recent and speculative spillover hypothesis described below would be considered a legitimate actualistic example and exception to this description.) This axiomatic aspect is, in fact, the only thing about which uniformitarian geologists agree regarding the origin of Grand Canyon (Ranney, 2005). On the actual details of the canyon's origin, it seems that no two geologists agree (Powell, 2005).

However, even their foundational premise of extended, low-energy erosion by the Colorado River presents numerous insoluble problems for uniformitarian scientists. Given the supposed open-ended nature of science, these difficulties should open the door to alternative ideas—even those advocating a catastrophic option—the *lot-of-water-over-a-short-time* hypothesis (Austin, 1994a; Vail, 2003; Williams et al., 1991). However, since uniformitarianism is a philosophical commitment before it is a scientific principle, geologists dismiss these options a priori, in spite of the fact that a catastrophic origin is usually the *first* thought that comes to people's minds when they first see the Grand Canyon (Powell, 2005; Ranney, 2005).

The local geology of the Colorado Plateau presents what is perhaps the most fundamental question that *any* theory must address. That is: Why does the Colorado River flow through the high plateaus on the southwest Colorado Plateau rather than around them? There was no fault system that forced the canyon's path, except possibly for short segments such as the section of the canyon southeast of the Shivwits Plateau that may have been influenced by the Hurricane Fault or an offshoot of this fault. It is no trivial matter that the river breaches the high Kaibab Plateau.

A related problem is the fact that Grand Canyon is *not* located at the lowest point through the plateau but at an *intermediate* altitude, as discussed above. Ranney (2005) described the puzzle:

> Oddly enough, the Grand Canyon is located in a place where it seemingly shouldn't be. Some twenty miles east of Grand Canyon Village the Colorado River turns sharply ninety degrees, from a southern course to a western one and into the heart of the uplifted Kaibab Plateau… It appears to cut right through this uplifted wall of rock, which lies three thousand feet above the adjacent Marble Platform to the east. (p. 20)

Furthermore, at this point, the Marble Platform is over 3,000 ft (914 m) higher than the Colorado River. This leads to another fundamental question: which came first, the canyon or the river?

Geologists have developed three explanations for the origin of the Grand Canyon: (1) the antecedent stream, (2) stream piracy, and (3) lake spillover (Austin, 1994a; Douglas, 1999; Hunt, 1976; Powell, 2005; Ranney, 2005; Williams et al., 1991; 1992; Young and Spamer, 2001). Early on, a few geologists thought it might be explained by superimposition—the hypothesis that rivers maintain their course while eroding vertically down through underlying rocks (Figure 9), resulting in a river flowing through ridges and mountains. This idea was quickly discarded.

Geomorphologically, the Grand Canyon is a water gap. A water gap is defined as "a deep pass in a mountain ridge, through which a stream flows; esp. a narrow gorge or ravine cut through resistant rocks by an antecedent stream" (Bates and Jackson, 1984, p. 559). This definition applies to any perpendicular cut through any topographical barrier, including a plateau (Douglas, 2005). Many geologists examine the canyon through the lens of sedimentary or structural geology. As we will see, it is vital to maintain a geomorphological focus.

Each of the three explanations for the origin of Grand Canyon has flaws that render it highly improbable. We

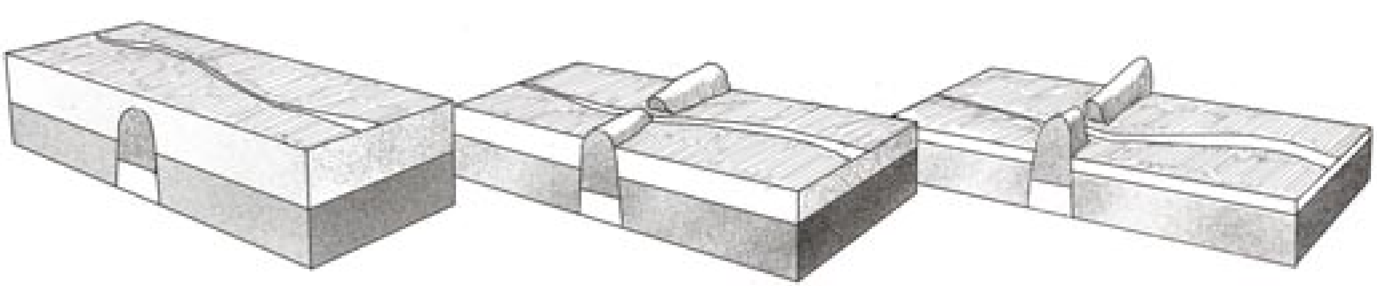

Figure 9. Block diagram of the superimposed stream hypothesis. The stream maintains its same course as most of the cover-mass (top layer) is eroded. Drawing by Bryan Miller.

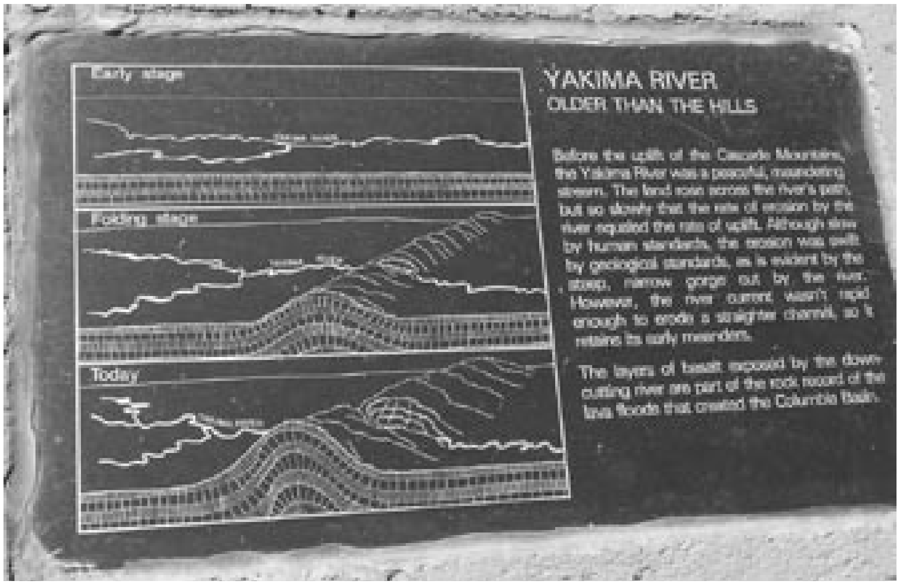

Figure 10. The antecedent stream hypothesis from a plaque near one of the Yakima River water gaps, Washington. The stream is first established, then the ridge slowly uplifts while the stream is able to erode through the barrier.

will now examine each of the three main hypotheses and demonstrate those flaws.

Powell's Antecedent Stream Hypothesis

John Wesley Powell (1961), who was wedded to the uniformitarian paradigm, simply explained the Grand Canyon (as well as the Green River water gap through the Uinta Mountains) as a result of an antecedent river that had existed for many tens of millions of years "before" the uplift of the Colorado Plateau. An antecedent stream is technically defined as "a stream that was established before local uplift began and incised its channel at the same rate the land was rising; a stream that existed prior to the present topography" (Bates and Jackson, 1984, p. 22). In other words, there was a river in place *before uplift* of a landscape of low relief (Figure 10). Then a barrier, such as a mountain range or plateau, rises in the path of the stream, but does so at such a slow rate that the stream or river maintains its course by eroding down at the same rate as the uplift of the rising landscape. Powell was convinced the Colorado River was able to maintain its present course for tens of millions years while the mountains and plateaus slowly uplifted across its path. Powell and other early advocates of this hypothesis were *dogmatic* in their insistence on this hypothesis, despite the absence of evidence (Powell, 2005). Their conclusion was a logical but arbitrary deduction based on their uniformitarian model.

The antecedent stream hypothesis is thought to account for perpendicular gaps across great mountain ranges (water gaps) that were uplifted late in geological time. These include the Himalayas, the Alps, and the Cascade Mountains of the northwest United States. In fact, most mountain ranges are believed to have been uplifted late in the Cenozoic (Ollier and Pain, 2000), so this hypothesis *should be* widely applicable. Furthermore, since uniformitarians see vertical earth movements as generally quite slow, rivers should be easily capable of rapid vertical incision (Small, 1978), if uniformitarianism were true. Antecedence applies mainly to *large* rivers, because only large rivers seem to have enough erosive power to keep up with uplift (Ahnert, 1998).

Serious Problems with Antecedence

In spite of its superficial plausibility, and in spite of its congeniality with the uniformitarian paradigm, the mechanism of antecedence is now considered *rare* (Twidale, 1976). Geologists shy away from this hypothesis because it has encountered many difficulties since it was formulated (Oard, 2008). If geological evidence suggests that the barrier is "older" than the river, clearly the hypothesis cannot be applied. Furthermore, uplift must be so slow that the river's course is not deflected (Ranney, 2005). This requires a *special conjunction of time and erosion*. If the river is flowing through an enclosed basin and the mountains rise too fast, a lake should form with lake-bottom sediments, shorelines, etc. These features are not found near Grand Canyon.

If a water gap through one barrier is difficult to achieve, *aligned water gaps* through multiple ridges in a generally straight line is that much more improbable. It is notable that many water gaps first explained by the antecedent stream hypothesis have been "reinterpreted" as additional data are collected. Other mechanisms are now suggested, replacing the antecedence hypothesis, indicating that there was little or no evidence for it all along. Twidale (2004) admitted that in reality antecedence was difficult to demonstrate.

> It is fair to state that though many rivers of tectonically active regions are probably of such an origin [antecedence], but like warping in relation to river capture, it is difficult to prove. The ages of the river and of the implied tectonism have to be established, and this is rarely possible. (p. 193)

Antecedence Does Not Work for the Grand Canyon

In the mid and late 1800s, antecedence was asserted to be the mechanism for the origin of the Grand Canyon. It was widely accepted for about 60 years—until a more detailed examination forced its rejection (Austin, 1994a; Lucchitta, 1990; Morris and Austin, 2003). The problems were not limited to Grand Canyon; geologists have encountered many problems with the antecedence hypothesis in general (Austin, 1994a; Powell, 2005; Ranney, 2005; Williams et al., 1992).

The fatal flaw of this hypothesis in regard to the Grand Canyon is that uniformitarian dating methods claim that the Colorado River is much younger than the plateaus that it bisects. Many years ago, geologists thought that the canyon was 70 million years old; now they accept an age of only 5–6 million years. They base this conclusion upon dates of the Muddy Creek Formation and the overlying Hualapai Limestone. These strata are several thousand ft (about 1,000 m) thick and are visible just west of the mouth of Grand Canyon. Since there is no evidence of the Colorado River ever flowing through these formations (Longwell, 1946), the river must be younger than 6 million years old, assuming the uniformitarian dating system. Lucchitta (1990) concluded:

> The establishment of through-flowing drainage along the lower Colorado River in its Basin and Range course occurred between four and six million years. No lower Colorado River existed before that date. (p. 328)

Although the eastern Grand Canyon is thought to be older, there is no sedimentary evidence for the earlier existence of the Colorado River in Utah, Arizona, or Colorado (Meek and Douglass, 2001).

Interestingly, the age of the western and central Grand Canyon has recently come under debate. There are several new age estimates of the Canyon that are much older than 6 million years (Oard, 2009). Some scientists now believe that a proto Grand Canyon is about 55 million years old (Flowers et al., 2008). This means that the Grand Canyon could have started eroding by 65 million years ago—a time when the last of the dinosaurs may have seen it, as an Internet science news service stated.

> How could everyone have gotten it so wrong? New research indicates that the Grand Canyon is perhaps 65 million years old, far older than previously thought—and old enough that the last surviving dinosaurs may have stomped along its rim (Berardelli, 2008).

Clearly, the explanations of the origin of Grand Canyon cannot be presented with any certainty if the relative ages of the river and its surroundings cannot be established. It should be interesting to see if the antecedent stream hypothesis makes a comeback, based on these new ages.

But simply increasing the age of the river does not solve all the problems. If both the river and the Colorado Plateau have existed for over seventy million years, their current elevations—and even their very existence—are a puzzle. Over that time, erosion should have wiped away the entire Colorado Plateau! That is because measurable erosion rates would denude all of North America down to sea level in as little as 10 million years or a maximum of 50 million years (Roth, 1998; Oard, 2008). Granting the uniformitarian paradigm, there is no reason why erosion should have been less active in the past. What's more, there are few signs of linear (river) erosion on the plateaus surrounding Grand Canyon; the plateau top is a planation surface caused by sheet erosion. That would require a far more energetic environment, which in turn demonstrates that the surface is probably much younger than seventy million years. This conclusion is supported by digital elevation models that show that the Kaibab Plateau and its margins are geomorphologically *young* (Mayer, 2000).

The Stream Piracy Hypothesis

As a result of the failure of the antecedent stream hypothesis, many uniformitarian scientists have embraced the stream piracy hypothesis. Its acceptance, however, is not based on large amounts of supporting data. Rather, it seems one major reason for its acceptance is simply that there is no other hypothesis, except the spillover hypothesis; and even the revised version of that controversial idea (described below) has not convinced many geologists. Thus, they cling to the stream piracy idea, which is also known as "river capture."

Serious Problems with Stream Piracy

Summerfield (1991, p. 410) explained how stream piracy is supposed to work: "River capture occurs when one stream erodes more aggressively than an adjacent stream and captures its discharge by intersecting its channel." The higher rate of erosion by the capturing or pirating stream is attributed to: (1) a steeper slope, (2) greater discharge, (3) less resistant rocks, and (4) more precipitation feeding the pirating stream than the adjacent stream. Figure 11 shows a schematic of how stream piracy is supposed to work.

The idea seems like a reasonable process given millions of years of denudation, yet in reality it is often more complicated. Many proposed examples of stream piracy have ignited disputes among geomorphologists (Small, 1978). Many assert that the mechanism has been applied too liberally (Small, 1978). Some researchers believe the process is rare and occurs only on a small scale (Bishop, 1995; Pederson, 2001). For instance, the origin of the transverse drainage of the Zambezi River in Africa was once assumed to have been caused

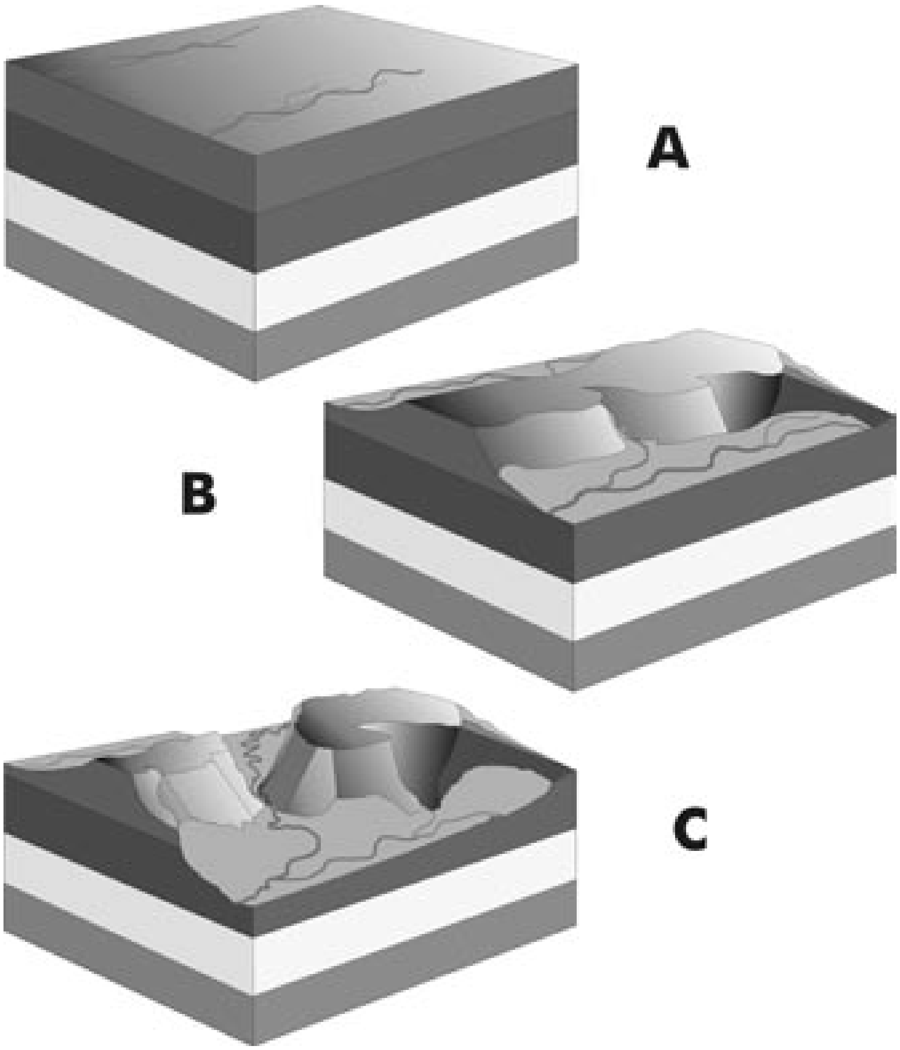

Figure 11. Schematic of stream piracy. Drawing by Peter Klevberg.

by river piracy, but that deduction was largely speculative (Thomas and Shaw, 1992). Ironically, it has since been suggested that this example of river piracy was caused by a catastrophic flood, not by slow processes acting over millions of years. This flood was believed to have been caused by a breached paleolake. In the case of the Zambezi, the spillover hypothesis makes sense, since geological evidence of the paleolake and its breaching exist.

Small (1978, p. 229) stated that rarely is there direct evidence for stream piracy; it is practically always an *inference* from more general features: "It must be apparent from this discussion that the phenomenon of river capture cannot be 'taken on trust.'" Otherwise demonstrating stream piracy requires researchers to show that the pirating stream was incised to a significantly lower level than its victim. But evidence of past erosion is often eliminated by subsequent erosion. Even if the hypothesis is plausible, it does not seem easy to support with field evidence.

Theoretically, stream piracy can occur after the Flood when the divide between two streams is low, for instance the Atchafalaya River would have captured much of the flow of the Mississippi River upstream in northern Louisiana, if the United States Army Corp of Engineers had not intervened. Such instances would be rare after the Flood.

Stream Piracy and the Grand Canyon

The stream piracy hypothesis is problematic when applied to the Grand Canyon (Austin, 1994a; Williams et al., 1992). It asserts that a stream from the uplifted or uplifting Colorado Plateau plunged into the Lake Mead area, eroded headward between *100 to 200 miles (161 to 322 km)*, and then captured the *ancient* Colorado River. But evidence of this "ancient" Colorado River is lacking. Most supporters of this hypothesis think that the ancient Colorado River was flowing east of the Kaibab Plateau. However, two versions of this hypothesis (Hunt, 1976; Lucchitta, 1990) assume that the Kaibab Plateau had already been breached by the ancient Colorado River.

One of the keys to this hypothesis is whether the capture occurred east or just west of the Kaibab Plateau. If it happened to the west, the Colorado River had already breached its highest point—thus the hypothesis *ignores* the most difficult problem. If the capture was to the east of the Kaibab Plateau, the pirating stream would have had to erode eastward through the plateau, including the high Kaibab Plateau, which would take a much longer time than eroding through a flat plateau. Eroding through topographical divides is much slower than away from divides because water flows downhill and there is less water volume available for erosion in the headwaters.

In addition to the apparent impossibility of headward erosion for up to 200 miles (322 km), there seems to be a surprising lack of evidence for such an event on the western edge of the Colorado Plateau. We should see many other long canyons eroded eastward from the western edge of the Colorado Plateau, but we do not. Given an arid to semiarid climate, this scale of erosion seems unlikely.

Also, the slope of the Kaibab and eastern Coconino Plateaus in the vicinity of Grand Canyon is generally southwest, while the "precocious gully" (as dubbed by Hunt, a critic of the hypothesis) had to erode eastward, which is roughly *perpendicular* to the expected surface flow of water. It is not surprising that many other geologists see 200 miles of headward erosion perpendicular to the topography as untenable (Dallegge et al., 2003; Young and Spamer, 2001).

Speculations on the Path of the "Ancient Colorado River"

Another significant problem with the hypothesis is the mysterious "ancient Colorado River." There are differing ideas on the path of the ancient Colorado River and the precise location of its capture by the "precocious gully." Since the Kaibab Plateau is believed to have uplifted 70 million years ago, the ancestral Colorado River east of the Kaibab Plateau theoretically must have existed for at least 60 million years, but there is not a trace of this river (Austin, 1994a). Within the uniformitarian paradigm, the first trace of the ancestral Colorado River is only 10 million years ago in Colorado (Larson et al., 1975). The whereabouts of the Colorado River prior to 10 million years ago is enigmatic.

Another date discrepancy exists. Given the young dates from the western Grand Canyon, advocates of stream piracy must explain how the upstream segment of the Colorado River east of the Kaibab Plateau is ten million years old or more, while the downstream segment is only five to six (Young and Spamer, 2001).

One version of the stream piracy hypothesis speculates that the Colorado River used to flow southwest through Marble Canyon east of the Kaibab Plateau and then turned southeast through the valley of the Little Colorado River to exit into the Rio Grande River. Then a stream that flowed from the east into the Lake Mead area rapidly eroded eastward 100–200 miles (161–322 km) in five to six million years (Ranney, 2005) to intersect the ancestral upper Colorado River, forcing the river to divert west. The slope of the Little Colorado River valley then was reversed to what we see today. Thus, this version would postulate that the terrain in eastern Arizona and New Mexico was once much lower. However, there is a problem. The top of Marble Platform now slopes northeast—the opposite of the claimed flow of the ancestral Colorado River.

A second version of the stream piracy hypothesis suggests that the ancestral Colorado River, instead of flowing southeast through the Little Colorado River Valley, somehow crossed the Kaibab Plateau and then turned northwest through the Kanab Creek Valley into southern Utah (Lucchitta, 1990). But, this idea cannot explain the major problem for the origin of the canyon: How did the Colorado River manage to breach the Kaibab Plateau? Moreover, the slope of Kanab Creek, which starts on the high plateaus of south central Utah, also would have had to reverse, something most geologists do not accept.

A third version speculates on an ancient path that somehow breached the Kaibab Plateau and passed southwest through Peach Springs Canyon to Needles, CA (Hunt, 1976). This hypothesis is also unlikely. Peach Springs Canyon, east of the Hualapai Plateau, is filled with deep deposits of gravel, volcanic ash, and other sediments with paleocurrent indicators showing drainage toward the northeast (Lucchitta, 1972; Powell, 2005; Young, 2001).

Any of these versions of the hypothesis sees the pirating stream eroding eastward from near Las Vegas, NV to the location of the ancestral Colorado River (its pre-capture path is uncertain), diverting it into the current Grand Canyon. Some of the many problems with the stream piracy hypothesis are summarized in Table I (Austin, 1994a; Hunt, 1976; Lucchitta, 1990; Powell, 2005; Ranney, 2005; Spencer and Pearthree, 2001; Williams et al., 1992).

The Lake-Spillover Hypothesis

Geologist Eliot Blackwelder (1934) proposed that the Grand Canyon was eroded by the spillover from a lake northeast of the Kaibab Plateau (Meek and Douglass, 2001). His suggestion remained obscure for many years, but has recently been revived (Douglass,

Table I. Problems with the Stream Piracy Hypothesis for the Origin of Grand Canyon

1	No evidence for ancestral upper Colorado River
2	Headward erosion by a small stream in a semiarid climate is not efficient
3	Not enough time for headward erosion, even by uniformitarian timescale
4	No evidence of other headward eroding streams cutting 100-200 miles into plateau
5	The "precocious gully" supposedly eroded east, but slope of plateau surface is often to south
6	No fault or sag to aid headward erosion
7	Problem of breaching Kaibab Plateau remains
8	Stream capture is rare and usually on smaller scale

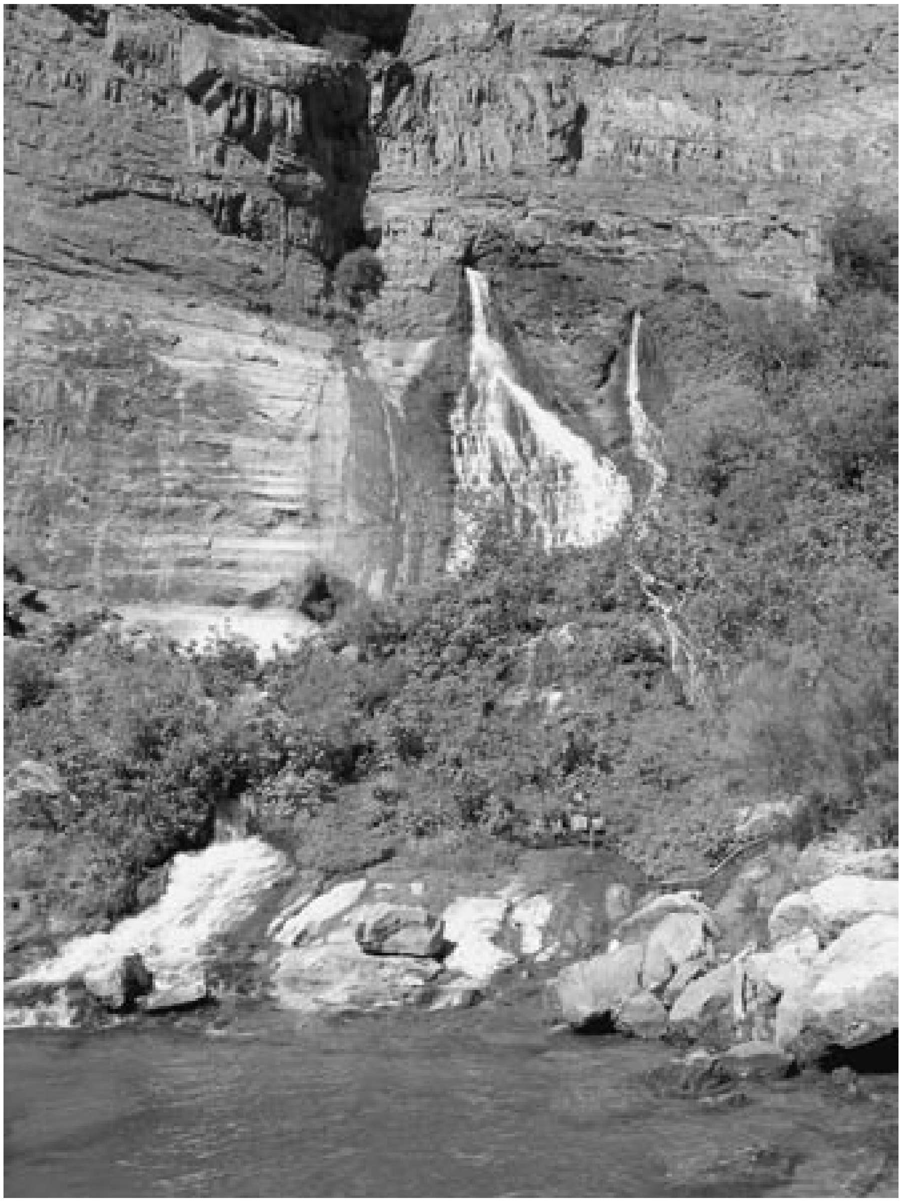

Figure 12. Cave with spring in Redwall Formation just above Colorado River in the Grand Canyon.

1999; Meek and Douglass, 2001; Perkins, 2000; Scarborough, 2001; Spencer and Pearthree, 2001). The hypothesis proposes that a lake called Lake Hopi or Lake Bidahochi developed in the region of the Little Colorado River area, with another lake possibly situated northeast of the Kaibab Plateau. Breaching of these lakes led to a catastrophic spillover, which cut through the Kaibab Plateau to form the Grand Canyon. However, there are also many problems with this hypothesis.

First, there is no evidence for the proposed lakes (Meek and Douglass, 2001). Geologists cite the Bidahochi Formation in the northern and eastern Little Colorado River Valley, but only a part of this deposit is considered lacustrine (Dallegge et al., 2001), and even that interpretation rests squarely on one tenuous piece of evidence—that the sediments are fine-grained (Dallegge et al., 2003). Recent work has reinterpreted these "lake" sediments as *shallow water* sediments formed in an ephemeral desert lake (Powell, 2005; Ranney, 2005). It is not clear how such a small volume of water could have eroded Grand Canyon.

Another serious problem with the hypothesis is that the elevation of the top of Grand Canyon as it runs through the Kaibab upwarp is significantly higher than the spillover point(s) for these supposed lakes. The lowest point of the top of the Grand Canyon through the Kaibab Plateau is 7,300 ft (2,225 m), while the lowest points through the Kaibab Plateau are around 6,000 ft (1,829 m), as discussed above. Again, the major problem is why the Grand Canyon was cut through the Kaibab Plateau at an intermediate altitude, when it should have cut through at points about 1,300 ft (396 m) lower. To get around this difficulty, a few geologists have interpreted caves in the Redwall Limestone in the Grand Canyon (Figure 12) as the remains of subterranean groundwater conduits from "Lake Hopi" which collapsed a preexisting cavern to form the Grand Canyon. This piping would have occurred as the water pressure built up against the barrier that held the lakes, until the pressure was sufficient for the water to be forced through cracks or tunnels. This mechanism of breaching is similar to one version of the creationary dam-breach hypothesis examined in Part II of this series.

Finally, if the lake ever did overtop the Kaibab Plateau, it would not have followed the current path of the Grand Canyon, because that path runs perpendicular to the topography (Hunt and Elders, 2001). Applying simple rules of hydraulics, the water would have run off to the southwest. That is completely at odds with the canyon's turn to the northwest, once past the Kaibab Plateau. Some scientists have suggested the overspill followed a previous channel cut during the period of northeast water flow on the plateaus. In addition to the complete lack of field evidence for this proposal, it would not explain the morphology of the western Grand Canyon.

The overspill hypothesis is admittedly speculative, even by geologists who believe in it (Meek and Douglass, 2001). Powell (2005, p. 228) stated, "Thus, lake overflow and integration appears to be another speculative idea—an educated geological guess—without direct evidence." Table II summarizes five major problems with the spillover hypothesis. One might almost say that the major problem with this hypothesis is that it overlooks the fact that water runs downhill.

Table II. Five Major Problems with the Spillover Hypothesis for the Origin of Grand Canyon

1	No evidence for a lake northeast of the Kaibab Plateau
2	Only a minor portion of the Bidahochi Formation is claimed to be a lake deposit
3	Supposed lake sediments in Bidahochi Formation now seen as formed in a small lake
4	Spillover points across Kaibab Plateau much lower than when Grand Canyon formed
5	Overspilling lake unlikely to have followed course of Grand Canyon

No Viable Uniformitarian Hypothesis

Early geological pioneers thought it would be easy to determine the origin of Grand Canyon. After all, it was supposedly a simple deduction from the uniformitarian principle, which they "knew" was absolutely true. But, in a recent book, Powell (2005) lamented:

> Surprisingly, what had seemed to the pioneers to be an easy geological puzzle to solve proved just the opposite.... Powell and Dutton would have been taken aback to learn that, sixty-five years after the Major's [Powell] maiden voyage, the river's age and history were still open questions. They would have been astounded to find that the origin of the Grand Canyon was the subject of a conference held in 1964, which reached consensus but not unanimity, and that yet another convened in the year 2000, with the *same* result. , (pp. 4–5, 161, emphasis and brackets added)

It is interesting that the 1964 "consensus" is no longer considered valid. One must be careful of scientific consensus, which history shows to be notoriously unreliable (Wells, 2006). The consensus by scientists for historical events is especially unreliable, because it rests on the worldview of those interpreting the evidence.

At present, the antecedent stream theory has been abandoned, and the stream piracy and spillover hypotheses are now competing, although a few investigators favor a combination of both (Young and Spamer, 2001).

Powell (2005, pp. 243–244) optimistically proclaimed that the 150 years of research is bringing geologists "closer" to the solution: "Clearly geologists grow ever closer to finding the solution to their grandest puzzle." He likely believes this for reasons not related to evidence—the axiomatic acceptance of scientific "progress": "Instead, we have to proceed by trial and error, getting a lot wrong and a few things right, slowly advancing science bit by bit" (Powell, 2005, p. 254). That is not the only presuppositional baggage that he brings to the canyon. He believes that sheer human reason, working with the assumptions of deep time and plate tectonics, will inevitably unveil the solution to the problem. But will it? Deep time was accepted when John Wesley Powell braved the Colorado River. The theory of plate tectonics has been with us for over fifty years.

Donald Baars (2000), a longtime researcher of the Colorado Plateau, offers a more realistic appraisal. He believes that plate tectonics is irrelevant to understanding the Colorado Plateau. "There is no need to discuss plate tectonics principles when describing the interior of the continent, as there are no realistic direct relationships to be found" (Baars, 2000, p. x).

If deep time has been a paradigm for nearly two centuries, and human reason has been hard at work for nearly 150 years to unravel the mystery of Grand Canyon, then it appears that Powell's optimism is naïve. A reasonable person might wonder if it is not time to start questioning the assumptions instead of looking for ephemeral data to support the "just-so" stories that pass for geological hypotheses today.

Grand Canyon is one of the most geologically visible features on Earth and one of the most heavily studied over nearly a century and a half, but uniformitarian researchers are no closer to understanding it than John Wesley Powell. They have no viable hypothesis for the origin of Grand Canyon. R.J. Rice (1983, p. 292, emphasis added) admitted: "After a century of study, we seem, if anything, to be *further* than ever from a full comprehension of how the Grand Canyon has evolved." The situation has not changed in twenty-two more years, as Powell (2005) wrote in the introduction to his book on the Grand Canyon.

> The story you are about to read has *no* definitive answer at the end, no "a-ha!" moment. We are frequently left with more questions than answers simply because the river continues to excavate away at the traces of its early history, leaving us behind in bewilderment as we scratch our heads in disbelief. There are few places where one can go to learn how the Grand Canyon formed. There are no interpretive signs inside the park that speak to the idea of how the canyon may have formed and most books say little more than the river carved the canyon (p. 16, emphasis added).

Conclusion

After decades of study by hundreds of geologists spending millions of dollars, uniformitarian interpretations of the origin of Grand Canyon have failed. None will admit the failure, and few seem inclined to see a problem at all! Yet in spite of their repeated and continuing failure, uniformitarian geologists are quick to circle the wagons when the one reasonable conclusion is suggested—that a new paradigm is needed.

If the slow erosion by the preexisting river cannot be made to explain the disparate data, then perhaps it is time to find another mechanism. The first impression of most people is that the canyon had a catastrophic origin. This is supported by analogies of catastrophic canyon formation at Mount St. Helens (Morris and Austin, 2003). Physical evidence supports the idea—the Grand Canyon has vertical walls and lacks talus (Vail et al., 2008). Given the failures of uniformitarian geology, what is wrong with suggesting a catastrophic alternative? Why not consider that the canyon formed with a *lot of water over a short time*?

There is only one real reason that such a possibility is automatically excluded. The worldview commitments of modern geologists cannot admit that the foundation of their historical tale of Earth's past—uniformitarianism—is of no help at their most visible monument. This is especially true since such an admission would open the door to the possibility of the Biblical Flood.

Because, after one considers the field evidence, a Flood explanation makes more sense than anything the uniformitarians have to offer, we will examine this possibility in other parts of this series. At present, there are two creationary hypotheses for the origin of the Grand Canyon. The first is the dam-breach hypothesis, caused by the post-Flood breaching of two or three lakes located east and northeast of Grand Canyon (Austin, 1994a; Brown, 2001; 2008; Vail et al., 2008). This hypothesis was developed in the late 1980s and has spawned three variations to date. However, as we will see in the next paper in this series, that idea is poorly supported by the evidence.

The second catastrophic model is the late-Flood runoff hypothesis. This idea assumes that the canyon was carved by receding Floodwater during the latest stages of the Flood, as the rising continents forced the water into large channels. A few subscribers to creation theory seemed to favor this idea (Gish, 1989; Whitcomb and Morris, 1961) but never developed the hypothesis. However, it is an idea that corresponds well to the available data as will be explained in Parts III–V of this series.

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