The Origin of Grand Canyon

Part IV: The Great Denudation

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Abstract

The Great Denudation is the uniformitarian name for the massive erosional event that stripped tremendous volumes of sedimentary rock from the surface of the Colorado Plateau. Like the origin of Grand Canyon, this event remains inexplicable to uniformitarian geology. However, any hypothesis of the origin of the Canyon must account for the conjunction of these two very large-scale, yet very different events. The Great Denudation was accomplished by east to northeast flowing sheets of water, which left a cobble and boulder lag—the Rim Gravel—on the southwest Colorado Plateau. Uniformitarians propose erosion by northeast flowing streams, but there is no sedimentary evidence for their depositional activity, and the sheet-like erosion is not consistent with observed styles of fluvial erosion. However, the Great Denudation can be easily explained by the sheet-flow phase of the Flood, which occurred early in the retreating stage. Evidence for a single, great, and rapid erosional event is found in the nature of the rocks capping the top two stairs of the Grand Staircase.

Introduction

The origin of Grand Canyon has puzzled geologists for nearly 150 years. Uniformitarian hypotheses—which all assume that the present or a past river eroded the Canyon—have proven unable to explain field observations. Understanding the genesis of the Canyon requires two assumptions not commonly held. The first admits the possibility of catastrophic erosion of the Canyon independent of the Colorado River, and the second recognizes that the problem is ultimately one within the discipline of geomorphology.

Having shown all three uniformitarian models fail to account for the evidence, this series has examined popular creationary models centered around the catastrophic emptying of post-Flood lakes upstream of the Canyon. These models rely on dam breaching of natural barriers and implicitly draw on the analogy of the well-studied glacial Lake Missoula flood that carved the Channeled Scabland of the Pacific Northwest. However, the field data from that area are not matched by similar features on the Colorado Plateau. The absence of sedimentary and geomorphological evidence for the lakes and the necessity of widespread and simultaneous erosion of Grand Canyon and its tributaries strongly suggest that these dam-breach models do not provide adequate explanation for the Canyon's origin.

A better explanation is found in the two-phase action of retreating Flood-

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Figure 1. Planation surface of the Grand Canyon area. View is north northeast from the top of Red Butte. Notice the North Rim of the Kaibab Plateau in the background and how the Coconino Plateau slopes up toward the east with the North Rim disappearing.

water during the last half of the Flood. Clearly, the retreat of the Flood off of the continents would have eroded significant amounts of sediment and sedimentary rock. From a geomorphological perspective, many landforms of Earth's surface, including water gaps such as Grand Canyon, can be related to the two phases of the Flood (Oard, 2008). The retreating stage of the Flood can be divided up into the sheet-flow phase and the subsequent channelized-flow phase. Before examining the erosion of the Grand Canyon during the channelized-flow phase, we must understand the broader erosive phase during the sheet-flow phase. That event is what the uniformitarians call the "Great Denudation."

Phase I: Sheet Erosion of the Colorado Plateau

The Grand Canyon is a stark testimony to the power of moving water, especially once it becomes clear that it formed catastrophically. It is staggering to realize that between 6,000 and 10,000 ft (1.83–3.05 km) of sedimentary rock was eroded from the southwest Colorado Plateau *before* Grand Canyon was cut! Even more staggering is the fact that the entire Colorado Plateau was stripped of an average of 8,200 to 16,400 feet (2.5 to 5.0 km) (Schmidt, 1989). No one observed the process, but we can infer much of what happened by examining the remnant—a nearly flat planation surface in the Grand Canyon area (Figure 1).

Even though this initial large erosion surface has since been warped by broad uplifts and subsidence—forming the Kaibab and Coconino plateaus, the Marble Platform, and the other smaller plateaus—all geologists who have investigated this region agree that this large-scale planing of the Colorado Plateau occurred. They refer to this erosion as the *Great Denudation*, a term coined by Clarence Dutton in 1882. Dutton was one of the early geologists to study the Colorado Plateau and its denudation. Denudation has a wider meaning than erosion, including all the processes that result in the wearing away or the progressive lowering of Earth's surface by weathering, mass flow, and transportation. Powell (2005, p. 219) summarized: "One fact on which Grand Canyon geologists have always agreed is the reality of Dutton's 'Great Denudation.'" It was only after the Great Denudation that Grand Canyon and other canyons were cut in the second phase of erosion in what Dutton called the *Great Erosion*. Both the Great Denudation and the Great Erosion are based on reasonable deductions of observational evidence.

The Great Denudation

Creation scientists agree with Powell's assertion, since the field evidence is overwhelming. The Great Denudation can be best seen as sheet erosion, since it was so laterally extensive. Based on the gently northeastward dipping strata of the erosional escarpment of the Grand Staircase (see Figure 3 in Oard, 2010a), as much as 10,000 ft (3.05 km) of strata were eroded, roughly as a sheet, from the area around Grand Canyon, leaving a large, flat planation surface that forms the top of Grand Canyon (Figure 1). Since strata can vary in thickness over

Figure 2. Recently formed Providence Canyon, Georgia.

an area, the total amount of erosion is unclear, but a conservative estimate would be 6,000 ft (1.83 km). Thus, a greater thickness of sediment was eroded *as a large sheet* than was eroded when Grand Canyon was cut.

In fact, the volume of strata removed during the Great Denudation was *100 times* that removed from the Grand Canyon itself (Potochnik, 2001). The sheet erosion left only a few remnants, such as Red Butte south of Tusayan, at about 7,370 ft (2.25 km) msl (Figure 3), Cedar Mountain at 7,053 ft (2,150 m) msl on the East Kaibab Monocline (Figure 4), and Shinumo Alter on Marble Platform east of the Colorado River, at 6,520 ft (1.99 km) msl (Figure 5). All these erosional remnants are about 1,000 ft (305 m) above the surrounding planation surface. Erosional remnants only 1,000 ft (305 m) high remained after eroding over 6,000 ft (1.83 km) only because sheet erosion was so pervasive and the tops of the erosional remnants are capped by hard rock. Red Butte is capped by a local or regional lava flow above the hard Shinarump sandstone and conglomerate, while the other two are capped by the Shinarump sandstone and conglomerate.

Similar large-scale sheet erosion occurred over other areas of the Colorado Plateau, but the term "*the Great Denudation*" refers to the Grand Canyon area. Ranney (2005, p. 67–68, emphasis mine) summarizes the horizontal style of erosion during the Great Denudation followed by the vertical dissection during the Great Erosion:

> [Dutton] 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.

It is important to distinguish between the two cycles of erosion. The initial phase of sheet erosion did not carve the canyons. In fact, Grand Canyon may not have existed after the Great Denudation, although some geologists think that canyons on the Hualapai Plateau, the southwest plateau of Grand Canyon, and Peach Springs Canyon were cut during this time (Graf et al.,

Figure 3. Red Butte, South Rim, as seen northeast from Forest Road 320 a little east of Highway 64.

1987). William Morris Davis, the father of geomorphology, who wrote in the early 1900s, agreed with Dutton on this two-phase erosional cycle. He called the first phase the "plateau cycle" and the second phase the "canyon cycle." Similarly, Morris understood that the plateau cycle resulted from lateral erosion, while the canyon cycle resulted from vertical dissection. Herbert Gregory (1950), an early investigator of the Colorado Plateau in the twentieth century, also agreed with this two-stage erosional pattern. As with subsequent researchers, Gregory could not help adding new names for the two phases. He called the two cycles the "precanyon cycle" and the "canyon cycle," and attributed both to regional uplift.

Uniformitarian geologists have never been able to reasonably explain the differences between these two cycles. After all, if both were caused by the same mechanism, then why were the results so radically different? Another problem is the violation of the uniformitarian principle by the first phase of large-scale sheet erosion. Erosion in the present happens by the dissection of landscapes by streams and rivers (Figure 2). Planation surfaces also are not being formed today. Ranney (2005, p. 24, 47, emphasis mine) puzzles 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*

Figure 4. Cedar Mountain on the East Kaibab Monocline (view east from Desert View overlook).

Figure 5. Shinumo Alter on Marble Platform (view south from Highway Alt. 89, milepost 554).

> *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.

It is interesting to note that the episode of sheet erosion occurred only after significant thicknesses of strata, labeled Paleozoic and Mesozoic by uniformitarian geologists, had been laid down over a large region. What makes the Great Denudation even more intriguing is that there are extremely few indications of erosion *within* the beds of these thick strata or at their contacts. This is seen in the horizontal strata along the walls of Grand Canyon (Vail et al., 2008). Despite the fact that these contacts are interpreted to show millions to tens of millions of missing years according to the geological timescale, the physical evidence of any erosion is missing and likely never happened.

Proposed Uniformitarian Mechanism for the Great Denudation

Uniformitarian geologists are not even sure of the timing of the erosional event. It is placed in the early Cretaceous by Potochnik (2001), but in the early Tertiary by Ranney (2005). Davis also believed the Great Denudation was in the early Tertiary (Ranney, 2005). Gregory (1950) set it in the middle Tertiary, with the canyon-cutting cycle in the late Tertiary. It is obvious that much of the Great Denudation occurred during the "Tertiary" because there are several eroded anticlines on the Colorado Plateau that cut Tertiary strata, especially the Grand Staircase and the north limb of the San Rafael Swell.

Working within their uniformitarian paradigm, geologists attempt to explain the Great Denudation by modern processes—invoking ordinary streams flowing *northeastward* (Potochnik, 2001; Ranney, 2005). Today, however, erosion by streams and rivers is predominantly vertical. As exhibited by the cutting of modern canyons and valleys, today's erosional processes do not erode in sheets, creating planation surfaces. Planation surfaces of more than a few tenths of a square mile do not form by stream erosion (Crickmay, 1974; Oard, 2008). Only rarely, and on a very small scale, a river will overflow its banks in a flood and truncate tilting strata (Crickmay, 1974).

So, the Great Denudation and the formation of planation surfaces go against the uniformitarian principle. Unless such present-day river erosion of tilted strata can be scaled up to that of existing planation surfaces (sometimes more than 1,000 mi^2 [2,590 km^2] in area), some other mechanism is needed to explain these surfaces. Another important piece of field evidence is the northeastward flow during the Great Denudation, reinforced by paleocurrent indicators in the Rim Gravel. Furthermore, the reason why erosion should be so different in the two phases remains unexplained. If regional uplift was the cause of both, why was one phase so much different from the other? Although uniformitarian hypotheses have no answer, a Flood model answers these questions with its two-phase retreat of water off of the continent.

The uniformitarian principle is also violated by the necessity of a tremendous volume of water to erode and plane the Colorado Plateau and then to carve Grand Canyon. Despite the arid nature of the region today, it was once the home to vast amounts of running water.

As geologists starting with Newberry showed, erosion by running water has produced the topography of the Southwest, with its high plateaus and deeply etched canyons (Powell, 2005, p. 221).

If erosion really occurred by streams operating over long periods of time, we should see remnants of their erosional products on the Colorado Plateau in the form of stream terraces, flood plains, and ancient lakes. We should see a huge amount of eroded sediment east of the Colorado Plateau in the Midwest. However, there is little Cenozoic strata on the Colorado Plateau (Potochnik, 2001), which makes it extremely difficult to discuss details of what happened during and after the Great Denudation. The Cenozoic strata of the High Plains are mostly volcaniclastic debris, reworked by water and wind. Carlson (1993, p. 48) stated in regard to the Cenozoic deposits in Nebraska and the High Plains, "However, the majority of the material was provided by numerous volcanoes active over western North America." So, the absence of the sedimentary load of the Great Denudation suggests that it was swept *off* the Colorado Plateau and probably *off the continent*, since it is not found on the continent. That missing sediment is likely part of the very thick sedimentary rocks in the lower Mississippi River Valley and the continental margin of the Gulf of Mexico. This may not be consistent with the uniformitarian model, but fits well with the Flood model.

The Rim Gravel Shows Flow Direction Toward the East to Northeast

The Rim Gravel, composed predominantly of exotic cobbles and boulders, is found on the highest terrain of the southwest edge of the Colorado Plateau, called the Mogollon Rim (Figure 6). The boulders were rounded by water during a large-scale erosional event south and west of the present Mogollon Rim (Oard and Klevberg, 2005). Boulders are generally found on ridge *crests* at elevations of 6,900 to 7,900 ft (2.1–2.4 km) (Scarborough, 1989). It is worth noting that the Rim Gravel is probably also found *north* of the Grand Canyon (Elston and Young, 1991; Lucchitta, 1989), indicating that the canyon did *not* exist when it was deposited. However, Hill and Ranney (2007; 2008) dispute this claim and state that the quartzite cobbles and boulders north of Grand Canyon are from quartzite outcrops to the west in the Basin and Range Province. Since Hill and Ranney were trying to justify an old paleo-canyon, it is reasonable that they would argue against a widespread distribution of the Rim Gravel. Until more evidence for their position is presented, it is likely that the Rim Gravel originally was deposited as a sheet over the entire southwest Colorado

Figure 6. Mogollon Rim in background east northeast across the Verde Valley from the Black Hills west of the old mining town of Jerome, northeast of Prescott.

Figure 7. Quartzite boulder with abundant percussion marks just south of the Mogollon Rim, 4.5 miles (7 km) south of Arizona highway 260 on forest road 512, southwest of Heber, Arizona.

Plateau, but has since been reduced to scattered remnants by later erosion.

The Rim Gravel includes rocks eroded from the nearby sedimentary formations, as well as *exotic* rocks transported from a moderate distance, such as quartzite, granite, and gneiss. The quartzite boulders contain percussion marks (Figure 7), indicative of high-speed turbulent flow (Klevberg and Oard, 1998; Love et al., 2007). The most amazing aspect of the Rim Gravel is that the exotic rocks came from the west or the south—areas of significantly lower elevation today! The present topography of the area was much different when the Rim Gravel was deposited.

We know the origin of the rocks from current direction indicators found in the gravel and from examining the nearest source of the exotic gravel. Since the Mogollon Rim is an erosional feature rather than a structural feature, we know that the terrain to the west and south has been eroded even more than the southwest Colorado Plateau. The elevation difference was not caused by faulting because the Mogollon Rim is an erosional scarp, not a fault scarp. Since the deposition of the Rim Gravel was the last event in the Great Denudation, leaving behind a capping of cobbles and boulders on the southwest rim of the Colorado Plateau, this massive erosion must have occurred from the west and southwest by massive currents flowing toward the east to northeast. Even if the quartzite gravel north of Grand Canyon is not true Rim Gravel, but originated from the west, the deduction of east-flowing currents still stands. Furthermore, the velocity of these currents was high enough to transport boulder-size clasts and create percussion marks on hard quartzites. Interestingly, this direction is consistent with the tendency of Flood currents to flow from west to east in the Northern Hemisphere due to the spin of the Earth, according to Baumgardner and Barnette (1994).

The Great Denudation by the Sheet-Flow Phase of the Flood

The Great Denudation with its Rim Gravel remnants is not only difficult for uniformitarians to explain, but the scale, water velocity, and extent of erosion are contrary to uniformitarianism. Great amounts of strata were literally stripped from large areas of the Colorado Plateau (and even more were eroded from areas to the southwest). It appears that this episode was one event, since the Rim Gravels speak of synchronous deposition. If the currents deposited the gravels at the same time, then the same currents probably eroded the area at the same time too.

So once we peel away the uniformitarian assumption, the field evidence speaks of a catastrophic erosional event over a large area, removing thousands of feet of sedimentary rock far away and leaving a lag of gravels at the highest elevations of the plateau. The remains of the eroded sedimentary rock are seen in the Grand Staircase, and in the Vermillion and Echo Cliffs northeast and east of the Kaibab Plateau.

The lateral extent of the erosion is seen by erosion to the south and west of the Mogollon Rim, and similar erosion on the northwest Colorado Plateau along the edge of the Roan and Book Cliffs in northeast Utah, north and east of the San Rafael Swell (see Figure 4 in Oard, 2010a). On the northern limb of the San Rafael Swell, approximately 14,000 to 17,000 ft (4.3 to 5.2 km) of sedimentary rock was eroded, up to and including the "Tertiary" Green River Formation (Oard and Klevberg, 2008). Although uniformitarians are puzzled by the scale and extent of erosion, it fits well within the predictions of the Genesis Flood. As an aside, the erosional pattern strongly suggests that the Green River Formation was deposited during the Flood.

Another indication of regional- to continental-scale water flow is seen in the absence of the eroded sediment. If not deposited nearby, then it must have been transported far to the east—probably even into the Gulf of Mexico. There is no conceivable manner by which this could have happened by lowenergy streams operating over millions of years. But this is consistent with the regional-scale currents of the retreating Floodwater—first as large sheets and then as discrete channels.

The Rim Gravels show that these sheets were flowing east to northeast during the Great Denudation. The depth of erosion and the size of the boulders in the Rim Gravel give an indication of the high current velocities. Another indication of these Flood currents is found in the presence of vast amounts of sediment deposited at the continental margins—exactly where their transition to deeper water and slower velocities would cause the deposition of large, seaward thickening wedges of sediment.

Walker (1994) described the retreat of the Flood in two phases: the sheet-flow phase and the channelized phase. This is exactly what we see in the field evidence of the Colorado Plateau. Flood currents would cause sheet erosion and carry the resulting debris to the margin of the continent, forming the continental shelf and slope. Erosion from these large sheets would be laterally extensive, not narrow, and thus would form planation surfaces, not valleys and canyons. This is precisely what uniformitarian geologists have described in the Great Denudation. Early in the retreating stage of the Flood, prior to significant exposure of mountains and high plateaus, Flood currents would generally be moving from west to east on the Northern American continent due to the Coriolis force (caused by Earth's rotation), according to Baumgardner and Barnette (1994).

Baumgardner and Barnette (1994) showed that the Coriolis effect would produce strong, large water currents of 90 to 180 mph (40–80 m/sec) over submerged areas greater than 1,560 miles (2,500 km) in diameter and shallower than about 5,000 ft (1,525 m). The water currents were mostly moving counterclockwise in the Northern Hemisphere. This experiment was quite simple in that it was performed on a totally flooded earth with one large continent. The idea of one continent may not apply. In a more realistic Flood scenario with more chaotic bottom depths, always changing due to tectonics, erosion, and sedimentation, and variable sizes of shallow submerged areas, the currents likely would be more chaotic and of significantly less velocity. However, in a similar experiment Prabhu et al. (2008) showed a considerably different result with currents over shallow ocean bottoms moving clockwise with less than half the current velocity as in Baumgardner and Barnette's experiment. The radical difference in the results of the two studies has not been resolved (personal communication with Baumgardner). Regardless, the principle still applies that over large, relatively shallow areas currents would be generally strong during the Flood.

Figure 8 shows an example of these high-speed currents on the Northern American continent while the continent was submerged at less than 3,280 ft (1,000 m), according to Baumgardner and Barnette's (1994) model. Although the currents are generally flowing from west to east, some currents move toward the southeast and some toward the northeast. So in the area of the modern Colorado Plateau, sheet erosion probably occurred as the region was rising early in the retreating stage of the Flood. It is possible that the planation surfaces cut in the southern and central Rocky Mountains (Madole et al., 1987) occurred at the same time of the Great Denudation.

The continental extent of these Flood sheets is seen in the same west-to-east flowing sheets evidenced in the northwest United States by the erosion of quartzites and their spread eastward into Wyoming, Montana, and adjacent Canada (Oard et al., 2007). This transport started from west of the present-day continental divide and ended well east of the divide, indicating that today's continental divide had not yet formed. Thus, the west-to-east currents also would have been controlled by the Coriolis force during the sheet-flow phase of the Flood. The subsequent

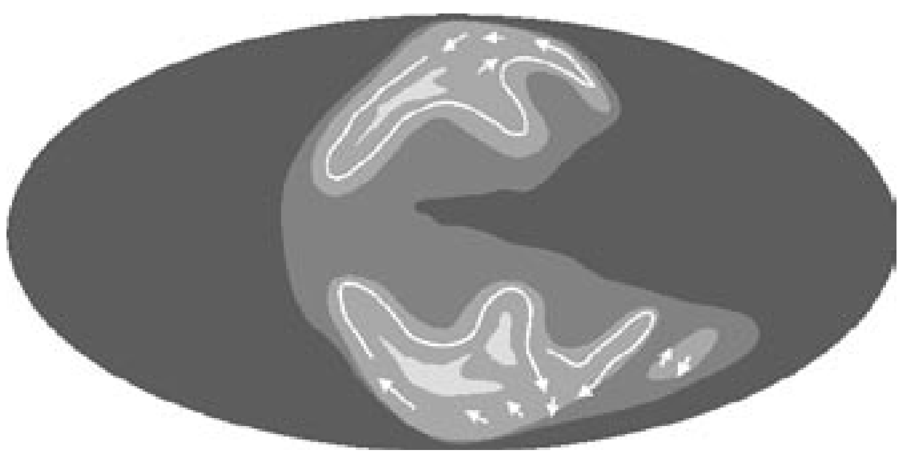

Figure 8. Strong currents on flooded "continents" at an initial depth of 1,640 feet (500 m). The "ocean" depth is 13,054 ft (3.98 km) and the water starts with no motion. This snapshot shows current velocities up to 136 mph (219 kph) in 30 days caused by earth's rotation. The current is wavy with generally west to east flow at mid latitudes. The light colored pattern in the middle of the velocity loops (troughs) shows where the water level dropped to the bottom of the continent. Drawing by Peter Klevberg from Baumgardner and Barnette (1994, p. 80).

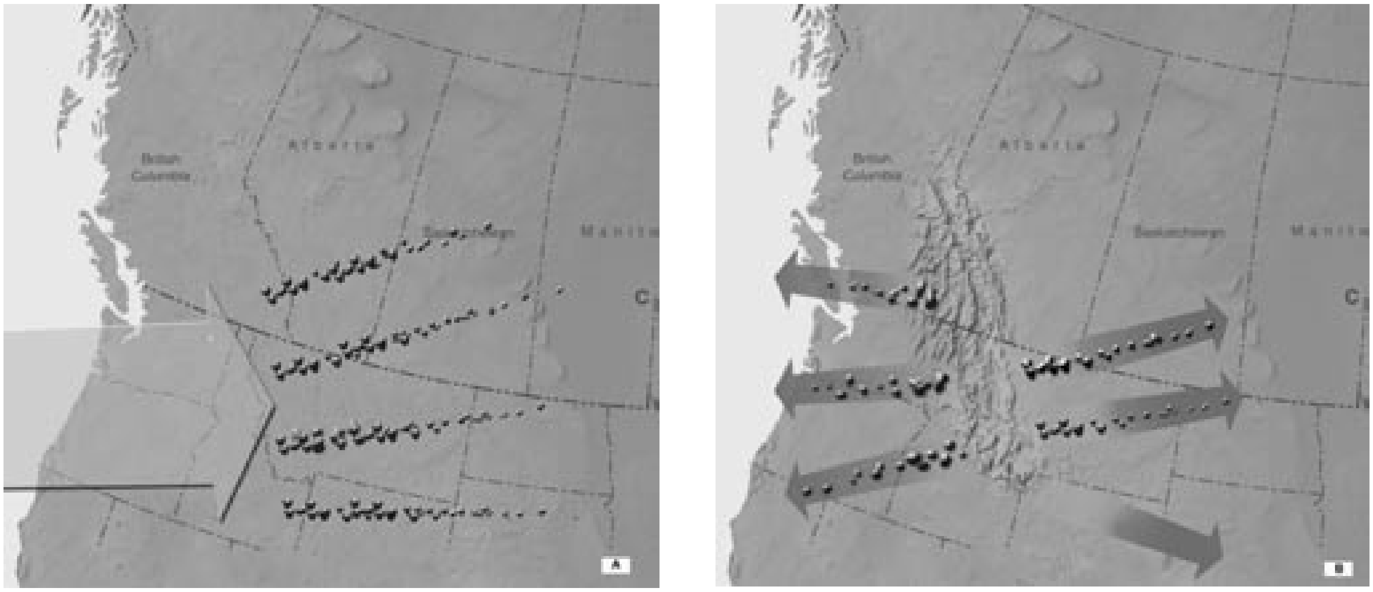

Figure 9. Source and distance of transport of quartzite rocks from the western Rocky Mountains west of the Continental Divide. Note that the size of the rounded quartzites decreases down current toward the east (A), and that once the Rocky Mountains are exposed above the Floodwater, quartzite cobbles and boulders are spread both east and west (B). Drawing by Bryan Miller.

uplift of the Rocky Mountains broke up the currents, which would then be diverted to flow perpendicular to the new continental divide. Because the water level was continually moving lower, the sheets would transform into broad channels as they encountered terrain obstructions that they could no longer plane (Figure 9).

Evidence of Rapid Erosion

Another evidence for the Flood model is found in the evidence for rapid erosion during the Great Denudation. This evidence is found in the rock capping the stairs of the Grand Staircase. The Grand Staircase is composed of a series of plateaus, separated by escarpments—hence its name, the *Grand Staircase*. The highest elevation is found on the Aquarius Plateau, at about 11,300 ft (3.44 km) msl, which then descends down to the plateau just north of Grand Canyon (see Figure 3 in Oard, 2010a). Crickmay (1974, p. 238) noted the perplexing erosional relationships between the strata capping the Table Cliffs Plateau, the second highest plateau, and the amount of erosion in the area:

> For example, nothing strikes a visitor more than the preservation of upland surfaces in the High Plateau country of Utah; particularly, the vertical succession of survivals. One of the highest is the Aquarius Plateau, formed on top of about 600 m [1,965 feet] of resistant lavas. But, protruding from below these volcanics, stands the Table Cliffs Plateau composed of the erodible [sic] Wasatch formation, from which the resistant capping of volcanics has been stripped; nevertheless the unresistant formation has maintained a plateau form while the surrounding country, over vast areas, has been lowered another 1200 m [3,930 feet] or more.

If we closely follow what Crickmay is saying, we see that the hard lava of the Aquarius Plateau eroded first, exposing the soft strata of the Wasatch Formation (now the Claron Formation). Then about 4,000 ft (1.21 km) of strata below the Claron Formation was eroded to the south, while the *soft* Claron Formation capping the Table Cliffs Plateau was hardly eroded. Greater precipitation at higher elevations should have favored the erosion of the soft strata at the higher elevation of the Table Cliffs Plateau. Figure 10 shows the Aquarius and Table Cliffs plateau from Bryce Canyon National Park, and Figure 11 shows the sequence of events as seen by Crickmay. The only way such an erosional pattern can occur is if erosion of the lava happened *rapidly* and not over many tens of millions of years, as envisioned by uniformitarian geologists. This implies that the entire Grand Staircase was eroded rapidly.

Another indication of rapid erosion for the Grand Staircase and Grand Canyon area (the southwest Colorado Plateau) is the existence of Navajo Mountain near the Utah/Arizona border about 82 miles (131 km) northeast of Grand Canyon. This mountain stands 10,388 feet (3,048 m) above sea level. It is a volcanic mass that formed

Figure 10. Aquarius and Table Cliffs Plateaus. The Aquarius Plateau is to the left on top of the dark colored volcanic rocks (arrow). The Table Cliffs Plateau is to the right and is on top of the white colored band (arrow).

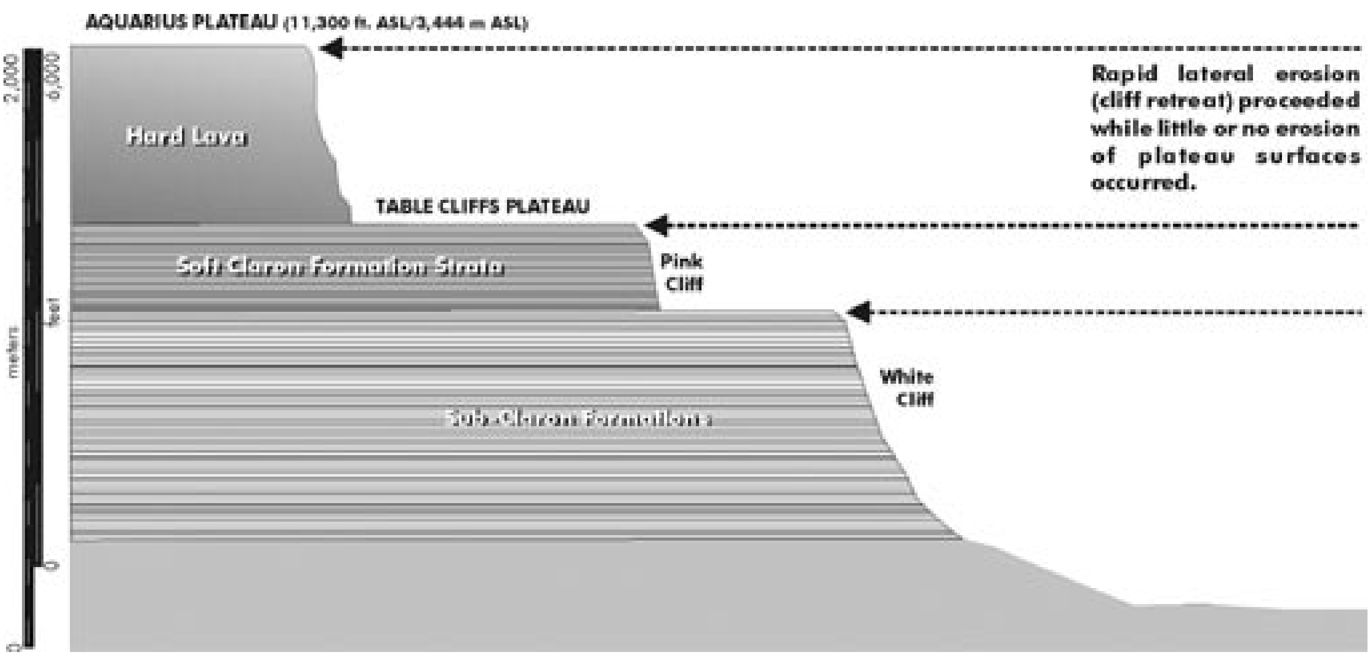

Figure 11. Diagram showing the erosion of the Grand Staircase, south-central Utah. The 2,000 feet (600 m) of lava rocks on top of the Table Cliffs Plateau eroded northward, while the soft Claron Formation underneath hardly eroded downward. The only way this can happen is if the erosion of the lava rocks were rapid, implying that the Grand Staircase was eroded rapidly. Drawn by Peter Klevberg.

within sedimentary rocks but now stands about 6,000 feet (1,829 m) above the surrounding sedimentary rocks, which have eroded away. This erosion must have been rapid, or else Navajo Mountain would not be left standing, since mountains erode much faster than a rolling plateau.

It is interesting to speculate why the Flood sheet currents deeply eroded the area around the Grand Canyon but did not erode as deeply in the area of the Grand Staircase. Could it be that the strata of the Grand Staircase were protected by the hard lavas that capped a wide area, of which the Aquarius Plateau is an erosional remnant? Another possibility is that high north-south mountains in central Nevada and southwest Utah could have caused the Flood currents to flow with less power and erode less to the north. It is probably that a stronger eastward flowing current flowed north of the Grand Staircase to erode the San Rafael Swell. The terrain over southern California and Nevada also could have been lower than the Grand Staircase area and central Nevada, allowing stronger and more erosive Flood currents from the west.

Summary

An average of 8,200 to 16,400 ft (2.5–5.0 km) of erosion occurred on the Colorado Plateau, which includes 6,000 to 10,000 ft (1.83–3.05 km) of erosion in the Grand Canyon area. This amazing episode has been named the Great Denudation by uniformitarian geologists, but they are hard-pressed to explain it. The event was of regional scale, requiring sheets of water flowing at relatively high speeds and transporting the eroded detritus far from the Colorado Plateau. When combined with the completely different erosional event that cut the canyons, a uniformitarian explanation appears impossible. The Great Denudation was caused by east-to-northeast flowing water, as shown by the current direction indicators of the Rim Gravel, which was a depositional lag at the end of the sheet erosion episode. True to their paradigm—even at the expense of the evidence—geologists propose that the event was caused by northeast-flowing streams. But if this were the case, the erosional debris, dated as Tertiary, should be found either on the Colorado Plateau or to the east. It is missing and probably forms part of the continental margin sediments of the Gulf of Mexico.

The scale of the currents required by the Great Denudation and lack of debris on the continent can readily be explained by the sheet-flow phase of the retreating stage of the Genesis Flood (Walker, 1994). Because of earth's rotation, generally west-to-east currents likely would have swept across the western United States when the continent was totally or mostly flooded. The speed could sometimes exceed 100 mph (161 kph) as shown by the work of Baumgardner and Barnette (1994). Such a current easily would be capable of doing the work required by the Great Denudation. Evidence for rapid erosion was shown by the rocks capping the top two stairs of the Grand Staircase just north of Grand Canyon and the existence of Navajo Mountain. The lateral stripping of hard volcanic rocks from the Table Cliffs Plateau with hardly any erosion of the soft Claron formation that caps the plateau, while 4,000 ft (1.22 km) of erosion occurred around the area, can best be explained if erosion was rapid.

Part III of this series proposed that the Grand Canyon was cut late in the Flood, based on geomorphological considerations (Oard, 2010b). Therefore, the Great Denudation would have occurred immediately prior to the canyon-cutting erosional event. This is exactly what is predicted by the two-phase retreat of the Flood from North America. The Great Denudation would have occurred during the sheet-flow phase. After the Great Denudation, the next episode of erosion cut canyons. Again, this is exactly what is expected by the Flood model. Flowing sheets of water would have become channels, steadily decreasing in size as the rising terrain dissected the Floodwater. The erosion of Grand Canyon fits well with the second phase—the channelized-flow phase. The final part of this series will describe how Grand Canyon was carved by that event.

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