Controversy over the uniformitarian age of Grand Canyon

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Despite Grand Canyon being an icon for uniformitarian geology, many aspects of the canyon have been difficult to explain within that paradigm. One of those challenges is the origin of Grand Canyon. A second challenge, the subject of this paper, is the uniformitarian dates assigned to its erosion, assuming the geological column. After believing the canyon was 70 million years old, assuming the antecedent stream hypothesis, the Muddy Creek Formation in the Las Vegas area was subsequently dated to only 6 million years old. But this 'young' date has been recently challenged by researchers using new dating methods, the apatite fission track and the (U–Th)/He thermochronometry methods, both of which have their own methodological challenges. Although the actual dates obtained using these techniques have varied, researchers have concluded that the canyon was mostly eroded around 70 million years ago and that dinosaurs may have seen the canyon. This shocking and contradictory result is being attacked by those who believe that the canyon is much younger. The dispute is described in this paper.

Evolutionary uniformitarian scientists have had great difficulty explaining the origin of one of the world's great geological icons—the Grand Canyon of northern Arizona, USA.[1] Grand Canyon (figure 1) and its surroundings (figure 2) are considered a showcase for uniformitarian geology. However, "The Colorado Plateau, Colorado River system and Grand Canyon are icons of the North American southwest that have motivated over a century of debate regarding the geomorphic, tectonic and geodynamic processes that shape landscapes."[2]

Just as controversial for the past 150 years has been the attempt to date the canyon—without much success.[3] Polyak *et al.* state:

> "Ever since the first geologist known to set eyes on the Grand Canyon, John Strong Newberry in 1858, and the famous John Wesley Powell expedition of 1869 (1), the age and origin of the Grand Canyon have remained a subject of great scientific and popular interest."[4]

John Wesley Powell thought the canyon predated the Laramide mountain uplift and was about 70 million years (Ma) old. He believed the canyon had been carved slowly at exactly the same rate as the plateaus rose over millions of years. This is the antecedent stream hypothesis. With the subsequent dating of the Muddy Creek Formation, researchers were surprised to find that the Colorado River did not exist at its mouth in the Lake Mead, Nevada, area until about 6 Ma ago! The current consensus is that the western and central parts of the canyon, west of the Kaibab Plateau, are only 5 to 6 Ma old, which necessitates a very rapid dissection. The oldest date of the Colorado River east of the Kaibab Plateau is only 10 to 11 Ma,[5,6] so where was the Colorado River for the 60 Ma after the Laramide orogeny?

The new challenge on the age of the canyon

However, in recent years other researchers with new dating techniques have radically challenged the date of 5 to 6 Ma for at least the western Grand Canyon. They have claimed that the western Grand Canyon was carved about 17 Ma, based on the U–Pb dating of cave speleothems.[7] Using the apatite thermochronometry method,[8] another group of scientists dated the canyon at 55 Ma, arguing that it probably started to erode at 65 Ma. A reporter from *Science News* even made statements to the effect that dinosaurs may have seen the origin of Grand Canyon.[9]

The 'entrenched old guard' fights back

It did not take long for the 'old guard' to fight back and claim that the date of 6 Ma is essentially a fact.[10] In a recent Geological Society of America Special Paper, advocates of the young age of Grand Canyon boldly proclaimed:

> "Grand Canyon is one of the premier geologic landscapes in the world. It is a geologically young canyon, carved in the last 6 million years (6 Ma) by the Colorado River and its tributaries."[11]

These researchers claim they have an abundance of evidence for the 6 Ma date. It is interesting that all these dates for the origin of Grand Canyon are so contradictory.

The 'new upstarts' come out swinging

Advocates of the 17–55 Ma date for Grand Canyon have recently published a new report in *Science* with a new and improved apatite thermochronometry method claiming that the western segment of Grand Canyon was carved to within a few hundred metres of its current depth by around 70 Ma.[12] They first calibrated their method to the eastern

Grand Canyon and determined that it underwent substantial incision *after* 6 Ma with a distinct Late Tertiary cooling phase caused by rapid uplift. This young date makes one wonder about the previous 55 Ma date for eastern Grand Canyon.

Given the validation for the eastern Grand Canyon, the researchers applied the same technique to the western Grand Canyon, resulting in the 70 Ma date—a shocking result, suggesting that the western and eastern parts of the canyon are of very different ages. *Science News* reported: "New work suggests the iconic chasm was already in place 70 million years ago—making it far older than commonly believed."[13] Furthermore, the canyon was supposedly carved by a river flowing *northeast*, opposite to the general direction of the Colorado River in Grand Canyon today![14,15] This conjectural river is called the 'California River'. It flowed from California, opposite the current river that has flowed southwest for the past 6 Ma, called the 'Arizona River', which flows out of northern Arizona. The researchers even claim that there is no evidence for the dates suggesting the canyon was carved during the past 6 Ma: "Direct geochronologic constraints demanding post-6 Ma formation of the entire canyon do not exist."[16] This is a bold assertion when a number of radiometric dates on the Muddy Creek Formation west of Grand Canyon show it was deposited at about 6 Ma and there was no Colorado River at that time. These much older dates have shattered the 'consensus', established in 2010, of Grand Canyon being only 5 to 6 Ma old:

> "Dr. Karlstrom of the University of New Mexico is a leader among geologists who have devoted much of their careers to Grand Canyon studies. When reporters called this week, he was prepared with four pages of criticism of the new research. He pointed out that at a meeting two years ago [2010] of the most active Grand Canyon researchers, 'a near consensus view was expressed' in support of the young-canyon hypothesis."[17]

Basis for the new dates

The new dating methods resulting in old dates for Grand Canyon are mostly based on fission track and He dates on apatite crystals.[12] Apatite is the best mineral selected for this type of analysis. In the fission track method, the number of fission tracks in a polished area cut parallel to the c-axis of the crystal are counted to determine a 'thermal history' of the crystal. In the (U–Th)/He thermochronometry method, the He comes from the radioactive decay of Uranium (U), Thorium (Th), and (in small amounts) Samarium (Sm). At one time, dating by the U–He method was considered erroneous, but it is being brought back because of better measurements and understanding of He diffusion.

Both methods depend upon the cooling rate of the rock during the exhumation, assumed to be over millions of years, of the Grand Canyon area. It is assumed that the crystals were buried several kilometres deep and that uplift and erosion slowly decreased the depth and the temperature

Figure 1. Grand Canyon, northern Arizona, USA (view north from Yavapai Observation Station, South Rim). The side Canyon is Bright Angel Canyon, caused by the Bright Angel Fault and down which the North Kaibab trail runs.

Figure 2. The Grand Staircase, erosional remnants of a large anticline, just north of Grand Canyon, showing about 2,000 to 3,000 m of erosion over the whole Grand Canyon area (view north from the northwest slope of the Kaibab Plateau).

over millions of years. The crystals then arrived at the surface, either on the plateaus or within the canyon. The cooling history for the apatite crystals in the rock depends upon the geothermal gradient (the change in temperature with depth) and its change with time, generally assumed to be constant and similar to what we see occurring today. During the ascent of the crystal to the surface, it eventually cools through a 'closure temperature' in which the fission tracks and the (U–Th)/He chronometers start. The closure temperature for fission tracks is assumed to be 110°C and for the (U–Th)/He system around 80°C, but can vary a few tens of degrees. Based on the properties of the apatite, this cooling history can supposedly be determined from the (U–Th)/He system. Between 60°C and 110°C, the fission track length and width partially anneal. Based on the lengths of the various tracks, a cooling history supposedly results. Of course, both methods are 'calibrated' with rocks of 'known' age. Thus millions of years are automatically built in.[18–21]

There are numerous assumptions with the individual methods, and there are many variables that affect the results.[22–27] Only the most significant ones that can produce drastically different dates will be mentioned.

With respect to the fission track method, the closure temperatures depend upon the cooling rates, assumed to be relatively slow and constant over millions of years. However, a fast cooling rate such as with a volcanic ash blasted into air or quickly deposited in water can have a much hotter closure temperature. If the apatite crystals were cooled rapidly and stayed below the closure temperature while being buried, the results would be different. In a Flood paradigm, the temperature of deep burial would be different from the present-day geothermal gradient. In the Flood scenario, rapidly cooled fission tracks could stay below the closure temperature. On the other hand, if the ash was deposited in a basin with hot water, all the fission tracks could anneal at even shallow depths of burial. So, the Flood would significantly throw off the assumptions of fission track dating, and it is difficult to derive much information about Flood burial and erosion from the two dating methods.

Similar to the fission track method, the (U–Th)/He method also depends upon burial temperatures and other assumptions.[28] The ages especially depend upon helium diffusion, which depends upon such variables as the distribution of U and Th, which is often not uniform.[29] Because of this variable, diffusion rates both within and out of the crystal occur. Crystal damage caused by radioactive decay also decreases the diffusion rate in the damage zone, adding to the complications in estimating the diffusion with time.[30–32]

New dating methods challenge again

However, representatives of the majority view have greatly criticized these new 'findings'. The opposition is led by Dr Karl Karlstrom of the University of New Mexico, who indicates that other factors may account for the old ages:

> "The 80–70 Ma Ca [California] paleoriver hypothesis requires reconciliation of the following: 1) Paleoelevation studies are in conflict, but alternative models suggest multi-stage surface uplift rather than a single-stage Laramide surface uplift; 2) A rich dataset of combined Apatite Fission Track and Apatite Helium data indicates that 2–3 km of sedimentary rocks covered much of the Grand Canyon region 60 Ma. [sic] 3) Older cooling ages on upthrown blocks of Laramide monoclines and northerly cliff retreat may explain the observed pattern of Laramide AFT [apatite fission track] cooling ages."[33]

There seems to be many more problems with the fission track and (U–Th)/He dating methods beyond what was summarized above: "Additional studies are needed to reconcile apatite fission-track ages with the U–Th–He ages

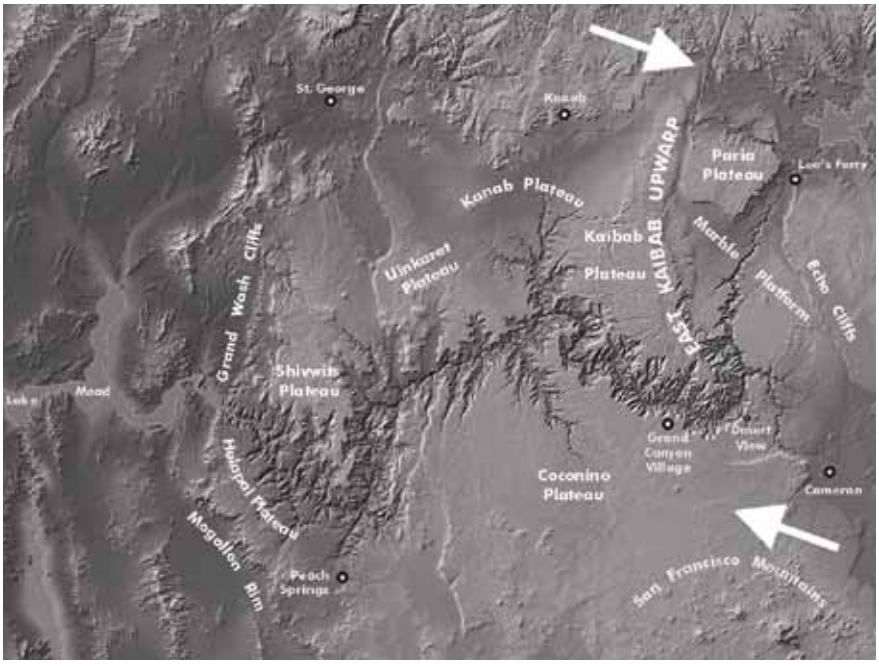

Figure 3. The Grand Canyon and the surrounding area with the main plateaus and prominent topographic features. The low point at 1,753 m on the northern Kaibab Plateau and the low point around 2,000 m on the southeast Coconino Plateau marked by arrows (map background provided by Ray Sterner and figure drawn by Peter Klevberg).

with each other and with other geological constraints."[34] It looks like it is the 'geological constraints' that are driving the attack on the new dating methods.

Newer apatite fission track and (U–Th)/He have even come up with different results on the origin of eastern Grand Canyon.[35] Based on the same methods that claimed that a proto-Grand Canyon existed before the dinosaurs went extinct, the new dates result in the conclusion that there was no early Cenozoic eastern Grand Canyon:

> "The new data suggest that the early Cenozoic landscape in eastern Grand Canyon was low in relief and does not indicate the presence of an early Cenozoic precursor to the modern Grand Canyon."[36]

It is interesting that some of the new dating methods come to opposite conclusions: one saying the canyon is young and the other old.

New ideas on the canyons origin also challenged

All the new dates are coming full circle and causing secular scientists to postulate even more bizarre origins for Grand Canyon. The opinion of most researchers studying the canyon is that a stream eroded from the Las Vegas area about 320 km east through the high Kaibab Plateau to capture the 'ancient' Colorado River east of the Plateau.[37] This is called the stream piracy hypothesis. But Wernicke, who believes in the California River, strongly outlines the main problem with the idea:

> "Headward erosion from the Grand Wash Cliffs raises the question of … why one of a series of small, arid canyons without perennial streams, similar to adjacent canyons now cut into the cliffs, would spontaneously develop into one of the great erosional spectacles of the planet …[references not shown]."[38]

This summarizes the major problem with the stream piracy hypothesis that most geologists believe.

The revival of an old idea, the spillover hypothesis,[39] is not doing well either. This hypothesis postulates lakes trapped east of the Kaibab Plateau that spilled over the plateau cutting Grand Canyon. The spillover hypothesis is increasingly being viewed as unlikely:

> "Any such lake [southeast of the Kaibab Plateau], even if it were as deep and really extensive as would be needed, seems more likely to have drained to the north and south of the modern canyon in avoidance of the structurally high crest of the Kaibab arch … ."[40]

The problem is that Grand Canyon starts at *intermediate* altitudes of the Kaibab Plateau (figure 3) between about 2,200 to 2,500 m (the range in altitudes is because the Kaibab Plateau slopes down to the south). The highest point of the Kaibab Plateau on the North Rim is about 2,800 m, and the lowest point is at the north end at an altitude of about 1,750 m. The lowest spot on the southeastern Coconino Plateau, the southern extent of the Kaibab Plateau before Grand Canyon was carved, is about 2,000 m. How Grand Canyon was cut at intermediate levels is the major problem in determining the origin of Grand Canyon for any hypothesis.

There are numerous other problems with the spillover idea.[41] Some researchers have pointed to the Bidahochi Formation in the northeast part of the basin of the Little Colorado River as evidence of a past large lake, 'Lake Hopi', southeast of Grand Canyon.[42] However, most researchers consider this formation to be mostly volcanic and 'fluvial'; the lake part of the formation is a small part of the formation

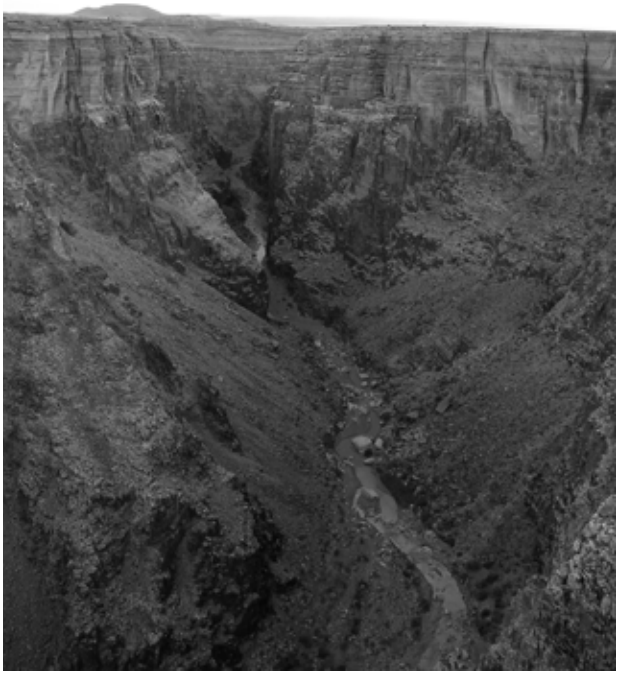

Figure 4. The narrow canyon of the Little Colorado River Valley at a scenic overlook at milepost 285.7 on highway 64. The canyon at this point is a slot canyon about 400 m deep.

Figure 5. The top of the slot canyon of the Little Colorado River Valley at milepost 277.7 on highway 64. It is this canyon that supposedly emptied huge 'Lake Hopi' in the spillover or dam-breach hypothesis.

and is considered deposits from a small, playa lake.[37] If there was a giant Lake Hopi, erosion of the commonly soft sediments in the area should have filled up the basin with bottom sediments tens to hundreds of metres deep before the breaching of the Kaibab Plateau. There is no way to erode these sediments during any supposed lake spillover because the exit of Lake Hopi, the Little Colorado River Canyon just southeast of Grand Canyon, is a slot canyon up to about 1 km deep (figures 4 and 5). Such a narrow canyon could not produce strong enough currents to have eroded the bottom sediments out of the basin (figure 6).

What about the 'California River'?

The age and direction of the river that eroded Grand Canyon, assuming it was a river, has varied considerably since secular geologists first tried to fit the canyon into their paradigm. Carol Hill *et al.* write:

> "The history of Grand Canyon—its age and how it formed as a physiographic unit—has been, *and is*, one of the great unsolved problems of geomorphology. Past workers have hypothesized practically every direction imaginable for the ancestral route of the Colorado River through the Grand Canyon region. They have set dates for drainage through the canyon as early Eocene, late Eocene, early Miocene, Miocene, Pliocene, and Pleistocene. They have described the Colorado River as being wholly, or in part, antecedent, superimposed, subsequent, consequent, obsequent, or resequent. And, they have debated (without resolution) how the disparate geomorphic sections of Grand Canon have evolved together to create the total integrated canyon that we see today [emphasis added]."[43]

The 'California River' supposedly flowed northeast, but where from and where to? A major problem with the 'California River' is that there is no evidence of it in the Muddy Creek Formation, dated at about 6 Ma:

> "If a deeply incised canyon of significant size did exist in western Grand Canyon prior to 6 Ma, it is reasonable to expect that such a canyon would have deposited large volumes of clastic debris in the Grand Wash Trough and its adjacent basins [Las Vegas area]. The sediments in this area are well exposed and well studied and clearly contain only a very limited volume of clastic material (Longwell, 1946). This volume constraint is known as the 'Muddy Creek problem'." [44]

So, it is doubtful that a 'California River' ever flowed northeast, as well as southwest, in the Las Vegas area during deposition of the Muddy Creek Formation. This is reinforced by the lack of Colorado Plateau zircon dates southwest of the Colorado Plateau before 6 Ma.[45]

Recently, James Sears from the University of Montana, Missoula, Montana, stated that the 'California River' flowed north through rift valleys in the Great Basin and northern Rocky Mountains and into northern Montana, where it joined the "ancient 'Saglek Super-River' that flowed east into the Saglek Basin in the western Labrador Sea".[46] This ingenious idea has little, if any, evidence backing it up, as well as few supporters.

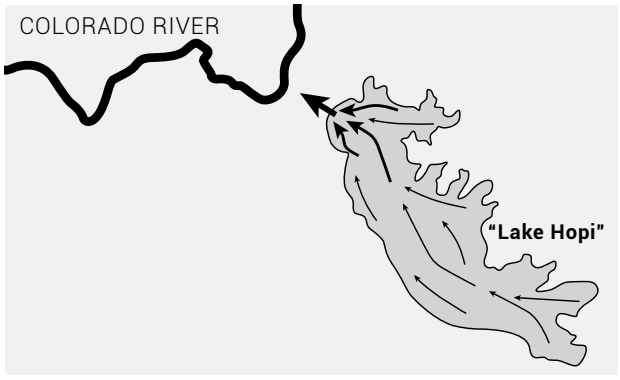

Figure 6. Schematic of theoretical currents in 'Lake Hopi' in the valley of the Little Colorado River (drawn by Peter Klevberg). During the hypothetical spillover or dam-breach, the current would have been strong through the Little Colorado River Canyon, shown by a thick arrow, but it would have been much weaker away from the slot canyon (thin arrows). Hence, little erosion of lake-bottom sediments would have occurred.

What lessons do we learn from the radically different dates?

This dispute over the dating of Grand Canyon, as well as its origin, has a number of lessons to teach us. First, despite all the repeated proclamations that Grand Canyon is a showcase for uniformitarianism, the opposite is true. However, this lesson goes much deeper. On the surface, uniformitarianism, deep time, and evolution appear believable, but when examined deeply in any one area, there are many contradictions, even within their own paradigm. Of course, it all falls apart with a Creation/Flood paradigm.

Second, it shows how different dating methods give different results. Although these dating methods are touted as being very accurate, they are obviously inconsistent. They assume millions of years and are calibrated to other dating methods and dates.

Third, it shows just how attached the uniformitarians are to their dates, which constrains their geological history. For instance, the 5- to 6-Ma dates for the origin of western Grand Canyon result in incision rates that are very rapid within the uniformitarian paradigm. For such a dry area, such incision rates should be a red flag that maybe the dating and/or the concepts are in error. However, most uniformitarians stick to the dates for the Muddy Creek Formation like glue.

Fourth, the dating debate should show us that the uniformitarians, beyond the superficial level, do not have their history nailed down. There is much room for an alternative history based on the biblical worldview.

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