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EROSION OF THE GRAND CANYON OF THE COLORADO RIVER
Part III—Review of the Possible Formation of Basins and Lakes on Colorado Plateau and Different Climatic Conditions in the Past

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Abstract

The possible formation of basins and lakes on the Colorado Plateau is discussed. The likelihood of different climatic conditions (more precipitation) in the past is explored. All of these factors are related to a post-Flood model of the formation of the Grand Canyon of the Colorado River.

Introduction

The antecedent Colorado River hypothesis in relation to the formation of the Grand Canyon was presented in Part I (Williams, Meyer and Wolfrom, 1991, pp. 92-98). Also the postulation was offered that the major cause in the formation of the Canyon was the erosive work of large quantities of rapidly-moving water laden with abrasive matter in a relatively short time span. The river capture and ancestral river hypotheses were discussed in Part II (Williams, Meyer and Wolfrom, 1992, pp. 138-145). Also piping on a large scale as a mechanism of formation of the Grand Canyon was reviewed.

The possible formation of vast basins and lakes on the Colorado Plateau is explored in this paper. Also the possibility of a more moist climate in the past is considered. These conditions, coupled with the possi-

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bility of extensive post-Flood volcanic activity, could have provided considerable water necessary to carve large canyons in a relatively short amount of time. In mentioning time estimates, the authors are quoting the opinions of the various workers involved. We do not subscribe to the standard geologic timetable.

Basins and Lakes

Several geologists have proposed the formation of lakes in the desert basins as the Rocky Mountain region was uplifted. Essentially the rivers, if they existed, were blocked in their path to the Gulf of California or to the Gulf of Mexico so that large lakes formed as the influx of water was greater than the evaporation from the lakes. Then as a lake rose, it eventually overflowed the rim of the impoundment, or possibly the natural dam was breached due to further uplift or some other tectonic event causing the dammed water to surge into another basin and erode canyons in its travel to lower elevations. Creationists could postulate vast lakes remaining after the Flood, trapped by the uplifting of land masses in the western United States, and eventually overflowing or breaching a dam sending considerable high-velocity water into lower elevations. It is instructive to read Henry Morris' comments concerning enclosed basins in relation to the retreating Flood waters (Whitcomb and Morris, 1963, pp. 313-317).

Newberry (1861, pp. 19-20) postulated basin filling and erosion of encircling mountains as a mechanism for the formation of short canyons that connected the basins below the Grand Canyon. Dutton (1882, pp. 216-217) stated that the formation of lake beds in a newly-emerging country was inevitable and the plateau country formed one continuous lake south of the Uinta Mountains. Dutton envisioned a process of slow erosion (p. 218) which he referred to as the great denudation forming the Grand Canyon (p. 77). He noted that the former presence of ample water in the western United States was indicated by evidence that deserts in that region were once covered with abundant grasses (p. 78).

Blackwelder (1934, p. 562) speculated that as the Rocky Mountains were uplifted:

> . . . local streams on the higher, and more northerly, mountains extended themselves, forming lakes in the nearest desert basins. As this influx exceeded evaporation—and the rate of evaporation must have been reduced in the cooler climates of the elevated region—the lakes rose until they overflowed the lowest points of their rims and spilled into adjacent basins. In time, enough excess outflow may have developed to fill a series of basins all the way to the Gulf of California, thus forming a chain of lakes strung upon a river.

One of the great hindrances to the postulation of large lakes in the west is, as Blackwelder noted, that during the subsequent erosion cycle as canyons were being cut, any "unconsolidated lake deposits in the former basins . . . were rapidly excavated and removed" (p. 563). He continued:

> In time all vestiges of the earlier lakes were erased by erosion, unless in some places the deposits were below grade. The rapidity of the processes that effect such changes is illustrated by the fact that the terraces that occupied Death Valley in late Pleistocene time have already been obliterated except at a few widely separated points.

He believed that the path of the Colorado River was determined by the process of basin overflow and/or capture through headward erosion as the uplift continued. Hunt (1969, p. 66) at one time considered basin filling and overflow as a means of integration of the drainage area in which the Colorado River flowed but he felt that the path of the river was antecedent across the Colorado Plateau. We strongly urge those who are interested in the erosion of the Grand Canyon and the development of the Colorado River to consult the excellent review (Hunt, 1969) of suggested hypotheses up to the late 1960's.

Gregory (1947, p. 703) speculated that the post-Miocene uplift brought the high plateaus "within the range of heavy precipitation." Considering the topography of the areas along with rain and melting snow, the streams forming on the plateau tops found a "resting place in the structural lowlands in the approximate position of the present Grand Canyon and the synclinal Little Colorado Valley" and the stream convergence

> locally expanded into lakes descended from one to another plateau block over high cliffs and thus developed energy rarely acquired by running water (p. 703).

Hamblin (1976, p. 142), in discussing volcanism in the western Grand Canyon claimed:

> that volcanic activity exerted a profound influence on the recent history of the Grand Canyon in that lava flows formed great barriers or dams across the Colorado River, and backed up water to form temporary lakes upstream.

In the area of Prospect Canyon, Hamblin (p. 161) stated that a lava dam 2,300 feet above the present river level ponded the waters of the Colorado River within the Grand Canyon. He postulated that erosion largely destroyed this and the other dams generated by lava flows. Note Figure 1.

Lucchitta (1988, p. 15) thought that between 5.5 and 17 m. y. a.* preexisting drainage patterns were interrupted by fast-moving faults in the Basin and Range Province and closed basins were formed. In 1964 a conclave of geologists, working with the information available at that time, concluded that pending may have occurred in three places. (McKee et al., 1967, pp. 56-58) in possibly late Miocene and early Pliocene times:

1. Around the Muddy Creek Formation in the Grand Wash trough and adjacent areas to the west.
2. At the Willow Springs deposit in the Peach Springs-Truxton area.
3. At the location of the lower member of the Bidahochi Formation in northeastern Arizona.

See Figure 2 for these locations.

Walter Brown (1989, pp. 74-75, 83) proposed a catastrophic mechanism for the erosion of the Grand Canyon in relation to the Genesis Flood. As the earth

*m. y. a. —million years ago.

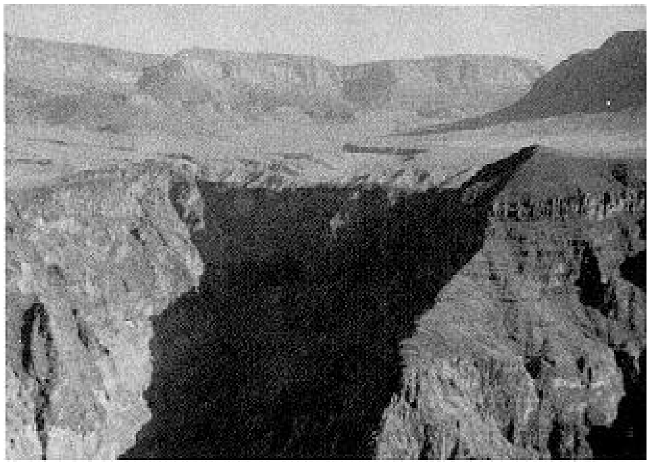


Figure la. As an indication of volcanic activity in Grand Canyon area, note the cinder cone across from Toroweap Overlook, western Grand Canyon (view to the south). Photograph by Glen Wolfrom.

lb. Looking upriver at Toroweap Overlook, western Grand Canyon. Colorado River is in lower center of view. Photograph by Emmett Williams.

began its recovery phase from the Flood, the rapid uplift of mountains occurred and the drainage of water from the higher elevations "left every continental basin filled to the brim with water" (p. 75). If these lakes gained more water than they lost by evaporation, they would overflow their rims at the lowest point.

> Just the slight erosion of the rim allowed more water to flow over it. This eroded it even deeper and caused even more water to cut it faster. Thus, the downcutting process accelerated catastrophically. Eventually, the entire lake dumped through a deep slit which we today call a canyon (p. 75).

By continuing this sequence of events: 1. basin formation, 2. rapid erosion from overflow and/or dam breaching, canyon after canyon was formed in the canyon country of the west. Brown (p. 83) proposed that there were two large lakes, the Grand and the Hopi that eroded the Marble and Grand Canyons (Figure 3). Marble Canyon was eroded from the waters of Grand Lake, whereas the Grand Canyon was eroded by the waters from both Grand and Hopi Lakes by the processes just described.

> The catastrophic dumping of Grand Lake took place through what is now the gap between Echo Cliffs and Vermilion Cliffs. Before the rapid erosion of this natural dam, those two cliffs were a single face of a block faulted mountain (Brown, 1989, p. 83).

Brown briefly discussed the erosion of soft, recently-deposited sediments as well as of harder material and he suggested how the barbed canyons along the Grand Canyon developed. Possibly this total erosion cycle was enhanced by a moist climate in the canyon country due to the presence of lakes in the basin areas. Interestingly, Dutton (1882, p. 218) claimed that the passage from brackish water to a freshwater condition was quite sudden as a considerable number of large lakes were being formed. Considering a Flood model, during the post-Flood "recovery period," did ample rainfall as well as precipitation of salts from the lake waters cause a rapid reduction of salinity?

Clifford Burdick (1974, pp. 26-27) also discussed a catastrophic origin of the Grand Canyon in relation to the Flood. He stated that the canyon is similar to a giant roof sloping in a north-south direction with the apex being miles north of the North Rim. When the uplifting occurred and the Kaibab anticline developed, the weakest point was at the apex of the fold. The uplifted anticlinal structure fractured at the apex in an east-west direction. Then surging or retreating Flood waters moved "down the newly formed Rocky Mountains at the Continental Divide, and when this Kaibab Anticline rose, it may have dammed up the water . . ." (p. 27). The waters from this lake emptied very rapidly (as they either overflowed the rim or breached the dam at the weakest point?). The erosion cycle occurred rapidly with sufficient, high-velocity water doing the work. Cunningham (1977, p. 2) suggested that the Colorado River may have followed a fault to form the Grand Canyon. The faulting would have occurred during uplift. He implied that the sedimentary strata may not have been consolidated when the uplift occurred. A fault may have developed at the apex of the uplift in the soft material and the waters of an

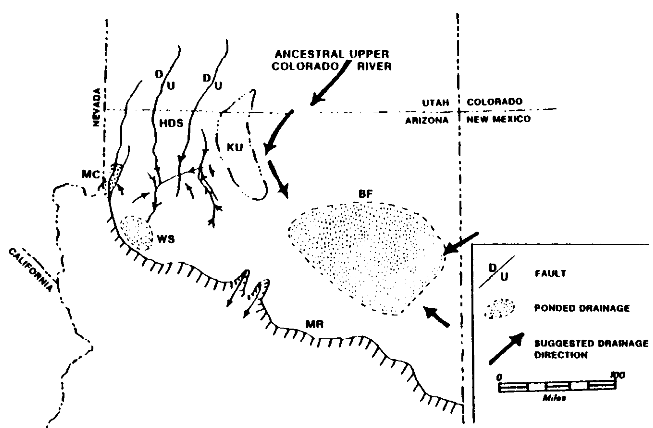


Figure 2. Suggested drainage patterns in northern Arizona during late Miocene and early Pliocene times (after McKee, et al., 1967) Drawing by Martha Smith. BF—Lower part of Bidahochi Formation, HDS—Hualapi drainage system, MC—Muddy Creek Formation, KU—Kaibab Upwarp, MR—Mogollon Rim, WS—Willow Springs Formation.

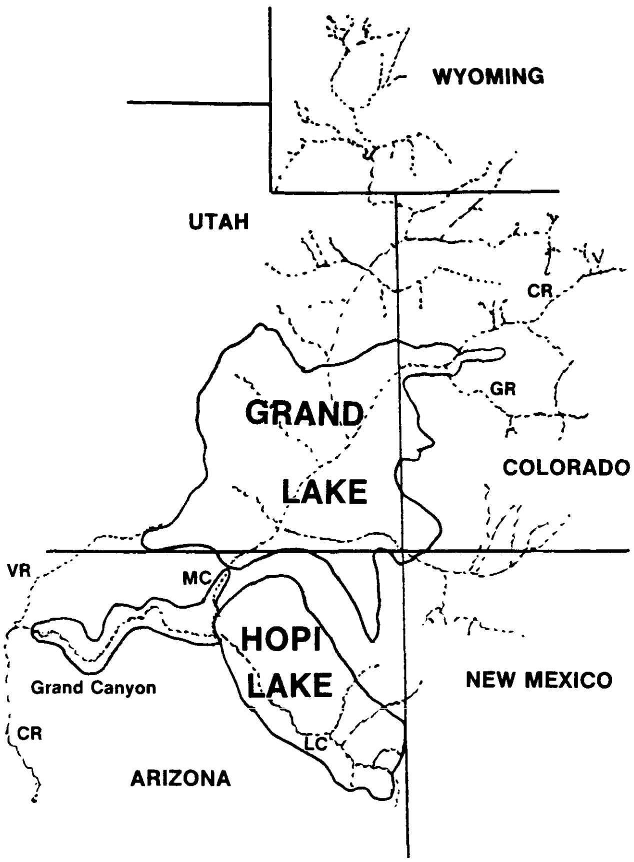


Figure 3. Map showing the area of the former Grand Lake and Hopi Lake. Once the dams holding the waters overflowed or were breached, catastrophic flow of high-speed water laden with abrasive material could have eroded the Grand and Marble Canyons (after Brown, 1989). MC—Marble Canyon, GR—Gunnison River, CR—Colorado River, LC—Little Colorado River, VR—Virgin River.

impounded lake poured through the fault eroding the landscape into the Grand Canyon.

In the finest creationist monograph (Austin et al., 1992) written on the Grand Canyon Steve Austin discussed the possible formation of lakes on the Colorado Plateau. (See pages 77-87 particularly.) He suggested "that Hopi Lake, a large Pliocene lake existed at high elevation east of the Kaibab Upwarp" (p. 80) in the area of the present Little Colorado River drainage basin. The Bidahochi Formation (see Part II of this series) was deposited by this lake. Austin speculated "that Hopi Lake overtopped a low point in the Kaibab Upwarp near Grand Canyon Village in the extreme eastern Grand Canyon area" (p. 86).

Also Austin related:

> North of Hopi Lake, separated from Hopi Lake by the Echo Cliffs Monocline, was Grand Lake. It occupied a major area of the upper Colorado River drainage basin, including parts of the Green, Gunnison and San Juan Rivers. It appears that the catastrophic drainage of Hopi Lake caused the dam for Grand Lake formed by the Echo Cliffs Monocline to fail probably by piping (p. 86).

This thesis postulated by Austin is quite plausible. If a dam for Grand Lake existed near the Echo Cliffs and Vermilion Cliffs gap around the Lee's Ferry area, the presence of the easily erodable Chinle Formation at the base of these cliffs on top of the Marble Platform, (Figure 4) could have provided a "piping" path for any impounded water causing a catastrophic failure. The surging high-velocity, abrasive particle-filled waters could have carved an immense canyon in a short amount of time. Austin considered a third lake, Lake Vernal, north of Grand Lake in the Green River drainage (northeastern Utah):

> Drainage of Grand Lake could have initiated failure of the dam holding Vernal Lake. The breach through the Book Cliffs would have lowered the elevation of the upper Green River and caused downcutting in Flaming Gorge in Utah and Wyoming. (pp. 86, 87)

Austin claimed that the breached dam theory for the origin of the Grand Canyon could be placed within a Flood Model (p. 87). He has developed an all-encompassing, reasonable model for canyon formation in the Colorado Plateau in a short span of time. As can be noted by the opinions of Austin, Brown, Burdick and Cunningham, creationists prefer post-Flood basin and lake formation. The dam overflow or breaching sent rushing waters over the Colorado Plateau carving the Grand Canyon.

Different Climatic Conditions

Canyon cutting would have been enhanced if there were more water present through increased rain and snowfall at sometime in the past in the Rocky Mountains and in the canyon country of the west. Blackwelder (1934, pp. 558-559) noted that ". . . the western interior of the United States became more arid during late Tertiary times . . ." Longwell (1946, p. 830) felt that ". . . a fairly moist climate prevailed in the western United States during early Tertiary epochs . . ." Gregory (1947, p. 700) stated that in the Colorado drainage basin

> . . . the former low altitude, arid surface was uplifted (late Miocene or early Pliocene), . . . and that in its newly attained lofty position a humid climate made possible the development of fully-organized river systems. (Parenthesis added)

Then he assumed that these "favorable conditions" (along with the elevations from which the water had to fall, plus the rock systems encountered by the moving streams) caused the erosion or canyon-forming cycle (pp. 700-701). Hunt (1956, p. 87) postulated that the hastening of erosion was primarily due to a climatic change. Dutton (1882, p. 222) thought that the canyons and cliffs in the Grand Canyon area may have developed in a moist climate and that the climate appeared to have changed from moist to arid. He stated that the climate had become more arid in the 10 to 12 years before 1882 (p. 79).

Whitcomb and Morris (1963, p. 314) noted that in many parts of the world, including the western United States, the climate would have been more moist immediately after the Flood. Note their comments concerning a post-Flood climatic change (pp. 303-311). Walter Lammerts considered the lessening of rainfall with time in the western United States since the Flood.

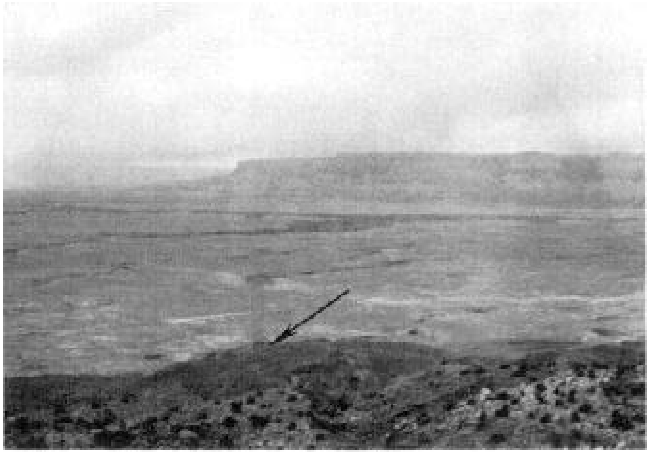
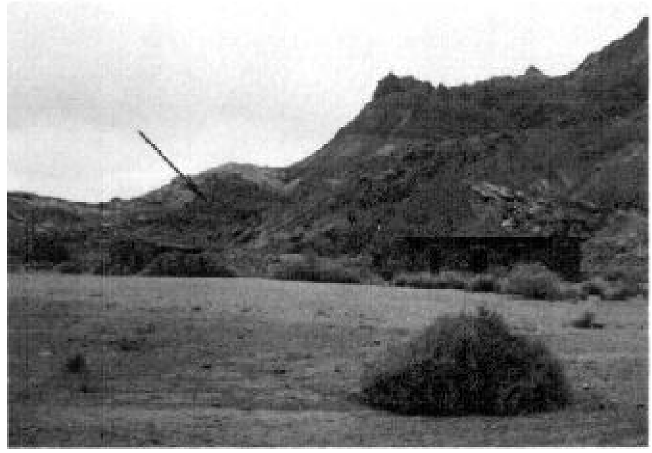
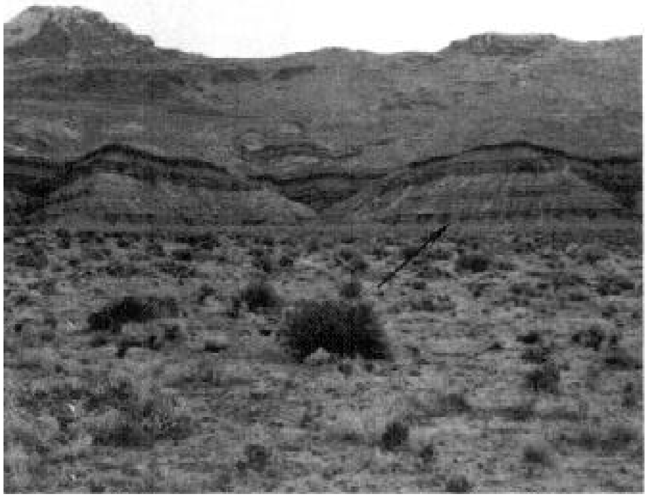


Figure 4a. Photograph from Echo Cliffs. Easily-erodable Chinle Formation seen in foreground indicated by arrow. Marble Platform and Marble Canyon seen in center of photograph. Vermilion Cliffs can be seen in the background.



4c. Outcrop of Chinle Formation behind buildings at Lee's Ferry.



4b. Outcrop of Chinle Formation at base of Echo Cliffs.

4d. Outcrop of Chinle Formation at base of Vermilion Cliffs across Colorado River from Lee's Ferry. Photographs by Emmett Williams.

He postulated a recent origin for the Pacific southwest deserts (Lammerts, 1964, p. 54; 1971, pp. 50-54; 1978, pp. 6-7). Daly (1973, pp. 216-217) and Oard (1979, pp. 30-35) discussed climate changes in relation to a post-Flood ice age. Nash (1987, p.13) implied how a mountain uplift could affect climate in the western United States and speculated on possible climatic changes in the past. Also see Howe, 1987, pp. 9-12 for documentation of this change. In a recent monograph, Oard (1990, p. 78), in relating the ice age to a Flood model claimed:

> In the post-Flood climate, heavy precipitation would occur south of the ice sheets, in the Northern Hemisphere. Overwhelming scientific evidence is found for a wet climate, in regions that are now desert and semi-arid. Large lakes filled the basins of the arid southwestern United States . . .

These creationist interpretations of a post-Flood climatic change deserve serious study.

Evidence for much of the volcanic activity around the Grand Canyon area (for instance, see McKee and McKee, 1972, pp. 1928-1930; Young and Brennan, 1974; Hamblin, 1976; Pewe and Updike, 1976; Austin, 1988) has been studied. From the creationist perspective, it is likely that much of this volcanic activity was post-Flood which would have encouraged more precipitation, maintained a more moderate climate and prevented excessive evaporation of possible Flood waters, even adding to them as a result of the eruptions. See Whitcomb and Morris, 1963, pp. 311-313; Oard. 1979, p. 30; 1990, pp. 33, 67-70. Considering the possible post-Flood climatic effects, residual Flood waters and tectonic activity, there likely would have been ample water available in the canyon country for rapid erosion as the water moved to lower elevations.

Remnants of Peneplanation?

In the late nineteenth century, the well-known W. M. Davis of Harvard developed a model of evolving landscapes by erosion which he labeled the cycle of erosion. Foster (1973, pp. 204-207) handled the ideas of Davis nicely from what has been observed in the erosion of landscapes. He suggested ". . . that the Davis cycle is not only a special case but an oversimplification as well" (p. 207). In this postulated erosion cycle the final stage of the landscape is an almost flat surface condition referred to as a peneplain.

In the early 1900's some geologists studying the Grand Canyon area attributed the remnants of an erosion surface found under Tertiary basalt flows near the southern end of the Colorado Plateau as peneplanation before plateau uplift. McKee and McKee (1972, p. 1923) state that the later discovery of channels partly filled with gravel deposits in the walls of Oak Creek Canyon and the lack of soil on the erosion surface caused geologists to give up the peneplain explanation. Blackwelder (1934, p. 558) noted that if the Colorado River had developed on an extensive peneplain in the Tertiary period, ". . . it ought to have had a broadly extended system of tributaries." Since there is no trace of the tributaries or any valleys eroded by them, he dismissed the explanation of peneplanation. Longwell (1946, p. 833) postulated that if the uplifted plateau surface was a peneplain, the new drainage channel from the Colorado River would have started from this surface. In answer to this suggestion, Hunt (1969, p. 118) bluntly stated that it is known that there was no peneplain.

Interestingly the present landscape of the Grand Canyon area is thought to be youthful when considering the supposed cycle of erosion.

Conclusions

Why is it that there is so much diverse opinion about the origin of the Colorado River and of the Grand Canyon? It is not only the obvious differences of opinion between creationists and uniformitarians but also between uniformitarians themselves. In 1947 Gregory noted that often diverse views of geologists concern ". . . the same formation in a small part of the Colorado Valley" (p. 695). Blackwelder (1934, p. 554) offered an explanation for the confusion.

> The Colorado River is in many ways an anomalous stream, but perhaps in no respect more so than in the course which it pursues. Rising in the high mountains of Wyoming and Colorado, it traverses a series of wide basins, each of which seems to be an entity almost unrelated to the others. It cuts through the Uinta Mountains and the Colorado Plateau in deep canyons and repeats the act on a smaller scale several times between the mouth of the Grand Canyon and the Gulf of California. It runs nearly south for hundreds of miles, then for no obvious reason turns abruptly west, crosses northern Arizona, and again turns due southward in an erratic course. It enters the long Salton trough, the southern part of which is occupied by the Gulf of California, not at the upper end of the trench but at one side; and it shows its lack of genetic relation thereto by building a delta out into the trough, thus forming the basin which is now occupied by the Salton lake.

Further he noted that the profile of the Colorado does not reflect an old age and it does not have a meandering channel or a wide flood plain except in places where weak rocks lead to rapid erosion.

Of course in dealing with historical geology or any so-called historical science, the interpretation offered will depend often on the preconceived notions of the geologists doing the field work. Collier (1980, p. 6) explained that:

> Geologists must often satisfy themselves with abstract solutions to equally abstract problems . . . Geology is more often a cerebral exercise than many people may realize.

Obviously what is involved is the building of a model constructed from the field evidence, often scanty and open to interpretation, in line with the preconceived notions of the field worker. Confusion and vast differences of opinion should be expected. Also any model may not satisfactorily account for all aspects of a natural situation or landscape. The complexity of the area may defy explanation and since no man was present when the landscape developed to *observe* the details of formation, conjecture is the only possible avenue of "reconstructing the past." Thus geological models of earth history can consist of 5% evidence and 95% speculation.

We tentatively adopt a working hypothesis of rapid erosion of the Grand Canyon by large quantities of water flowing at a high velocity over consolidated and unconsolidated sediments in the latter stages of uplift or shortly after uplift when they were in a relatively unstable condition. Involved in this model are the assumptions of ample available water to perform the task, a moist climate and a tectonically active landscape with uplift and much volcanic activity as the area adjusted to post-Flood conditions. Other factors in the formation of the Canyon will be considered in later papers but the authors believe that high-velocity water laden with abrasive material accomplished most of the erosion. As an example if water were dammed by natural means and a leak developed under 500 feet of impounded water, the initial water escaping at the 500 feet depth-level could flow away from the dam at a velocity of approximately 180 ft/s assuming all of the potential energy is converted into kinetic energy. Such high velocity water is capable of vast damage and scour, particularly if it contained abrasive particles. The area of the Grand Canyon is fascinating and as field workers uncover more evidence, new interpretations of its origin may develop. How the Canyon was eroded and when it was eroded definitely is not a closed subject.

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PANORAMA OF SCIENCE

Reserved for Fire

The same paragraph in 2 Peter 3 that contains the uniformitarian prophesy (verse 4) also speaks of the next global destruction being by fire (verse 7). For several decades many have thought that the fire might be from a nuclear holocaust. It need not be by natural or man-made causes because God is quite capable of using supernatural means. Indeed, the verse also speaks of the present heavens being included in that fire. Even so, we have a tendency to speculate, based on the physical world that we can study with our science.

The Voyager space probes to the outer planets have revealed details that were not predictable from any of the theories of solar system evolution. It is as if God purposely placed those features there by design to point out to us our ignorance and limited imagination. Many moons of the outer planets have a very low density, indicative of a composition more of ice than rock. Furthermore, some of the ices may not be from frozen water but from other substances. Those bodies, along with comets and perhaps some asteroids, are sometimes referred to as "dirty snowballs."

In some recent speculation I wondered if one or more of the small bodies could be made of frozen methane (natural gas) ? What if such an object collided with the earth as it fell toward the sun? How large would it have to be to totally consume all atmospheric oxygen when it burned? Simple chemistry reveals that 16 kg of methane burns with 64 kg of oxygen to yield 44 kg of carbon dioxide, 36 kg of water, and an abundance of energy. Using the average atmospheric pressure at sea level, the area of the earth's surface, and 0.23 fractional weight of oxygen in the atmosphere, a mass of atmospheric oxygen of 1.17×10^{18} kg is obtained. The appropriate methane mass is therefore 2.9×10^{17} kg. At a density of 0.466 at its -164°C melting point, a sphere of that mass would have a diameter of 10.6 km (6.6 statute miles).

That is not very large by planetoid standards. It might appear as a comet as it approached the earth, but we would have only a few months of advance warning. It would be sufficient to incinerate the entire earth's surface and asphyxiate all air-breathing life that might survive the fire. It would certainly make a loud noise and fulfill much, but not all, of the prophecy of 2 Peter 3:10. This speculation is therefore inadequate as an explanation of prophecy, but it shows how vulnerable we are to such a natural disaster. Just as most people were unable to predict and identify the precise events of Christ's first coming, so all such speculations about the special effects accompanying his second coming are certainly filled with error.

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