**Van Andel Creation Research Center Field Study Note**

# KANAB CANYON, UTAH AND ARIZONA: ORIGIN SPECULATIONS

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## Abstract

*How Kanab Canyon, a side canyon of the Grand Canyon, may have developed within a young-earth Flood model is discussed. The draining of a lake ponded in southwestern Utah and possibly northwestern Arizona was the major cause for the formation of lower Kanab Canyon. Upper Kanab Canyon has developed since the 1800's because of flooding from thundershower activity. The following phases of erosion are postulated; a. during the retreat of Floodwater, b. draining of a post-Flood lake, c. precipitation during a warm post-Flood ice age, d. recent erosion from thundershower activity. Periods b and c may have overlapped chronologically. Processes such as cliff sapping are necessary to explain some of the topography of the high plateaus region of southwestern Utah.*


## Introduction

Acceptance of a recent Creation and Flood model of earth history implies that many natural events, such as canyon formation, are recognized to have occurred quickly. This necessitates rapid erosion, a topic often discussed in the Quarterly. For instance, three articles (Williams, Meyer and Wolfrom, 1991, 1992a, 1992b) presented various views of the formation of the Grand Canyon of the Colorado River. (Also see Austin, 1984a, 1984b, 1986, 1994a, 1994b; Brown, 1994; Oard, 1993; Williams, 1993.) An introductory study of the erosion of Pine Creek Gorge in Pennsylvania has been published (Williams, Chaffin, Goette and Meyer, 1994).

A discussion of the formation of Bangs Canyon, Colorado was given by Holroyd (1994). The rapid erosion and canyon formation caused by the 1993 Midwest floods was graphically illustrated by Wolfrom (1994). In a 10-year study at Providence Canyon, Georgia, Williams (1995) outlined the effects of recent catastrophic erosion. Speculation on the origin of Santa Elena Canyon in Big Bend National Park have been reported (Williams and Howe, 1996). This treatise on Kanab Canyon is another introductory study reflecting the continuing field work of the Society on the topics of rapid erosion and canyon formation which are important aspects of Flood geology. A glossary of geological terms used in this paper is provided after the acknowledgments.

## Canyon Location

The mouth of Kanab Canyon intersects the Grand Canyon approximately 144 river miles below Lees Ferry, Arizona (Figure 1). Kanab Canyon is one of the larger side canyons of the Grand Canyon of the Colorado River. Kanab Creek flows from the Sunset Cliffs on the western end of Paunsaugunt Plateau in Utah through Kanab Canyon into the Colorado River (Figure 2). The canyon, creek and Paunsaugunt Plateau lie within the western portion of the widespread Colorado Plateau province (Figure 3).

## Kanab Plateau and Lower Kanab Canyon

Gregory (1950, p. 169) estimated that 6,000 to 8,000 feet of rock have been eroded from Kanab Plateau leaving a planar erosional surface with sparse vegetation growing upon it. Hamblin and Best (1970, p. 138) refer to this surface as a pediment. See Appendix I for a discussion of how the estimate of 6,000 to 8,000 feet of eroded rock was obtained.

Gregory noted that after Kanab Creek flows from the high plateaus of Utah (Figure 2) into the flatland at Fredonia, Arizona, the stream passes "...through a profound canyon to its mouth in the Grand Canyon" (1950, p. 10). Kanab Canyon is an impressive canyon in its own right (Figure 4), but it is dwarfed by the Grand Canyon, the major erosional feature of the Colorado Plateau. Below the mouth of Johnson Wash (Figure 2), Kanab Creek flows into lower Kanab Canyon which at its mouth is as deep as the Grand Canyon (Gregory, 1950, p. 164). See Appendix II for a three-dimensional drawing of the mouth of Kanab Canyon.

One of the interesting features of the lower canyon is the presence of incised meanders (Figure 5). Hamblin and Rigby (1969, pp. 56-57) considered these meanders as evidence that the creek is "...as old or nearly as old as the Colorado River" (p. 57). Gregory (1950, p. 157) speculated that such meanders

> ...now deeply entrenched, were left from ancestral streamways on old surfaces where meandering courses were characteristic, and that in consequence of regional uplift they have been incised without much change in form.

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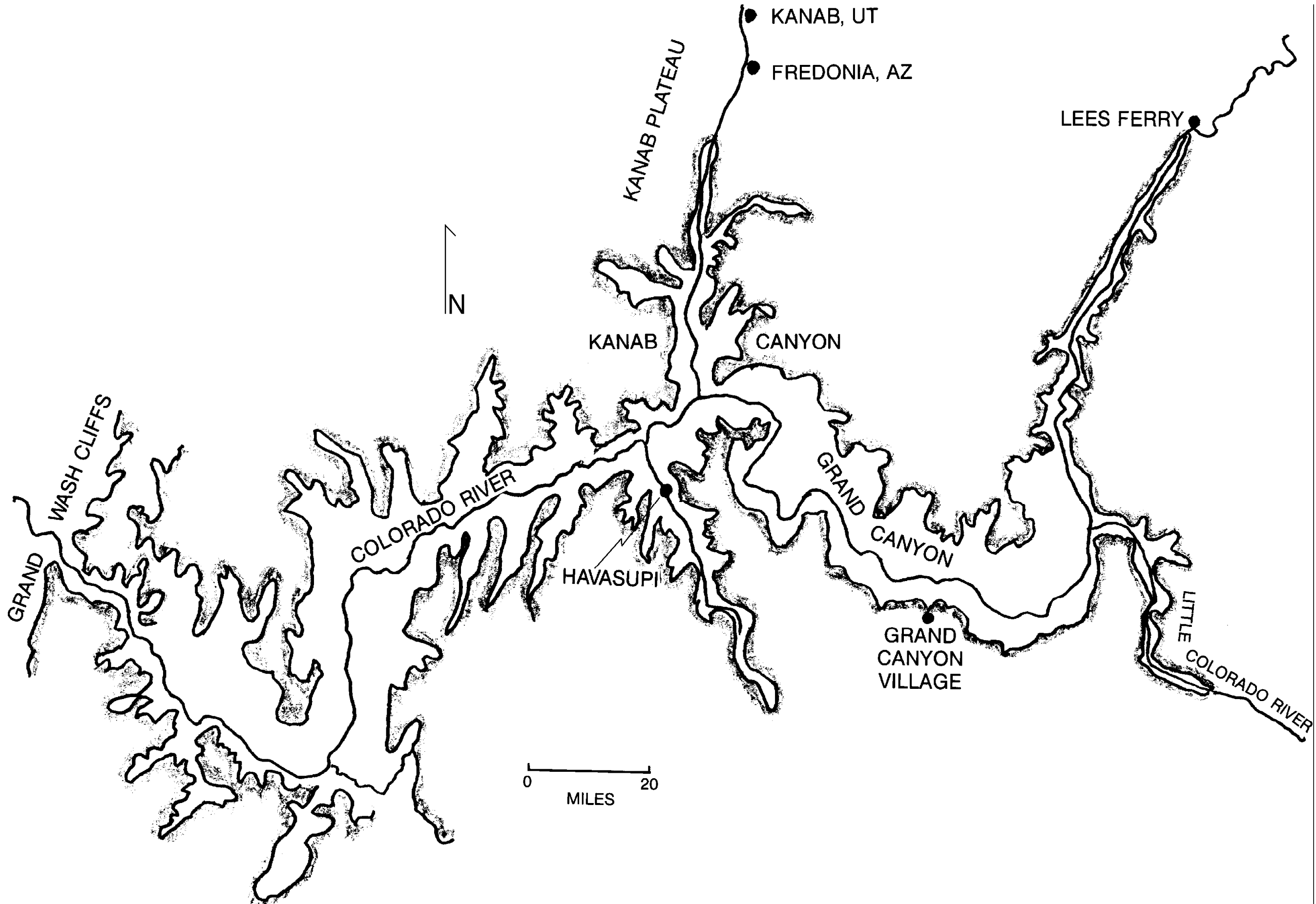


Figure 1. Location of Kanab Canyon and Creek in relation to the Grand Canyon (after Billingsly, 1989, p. 225).

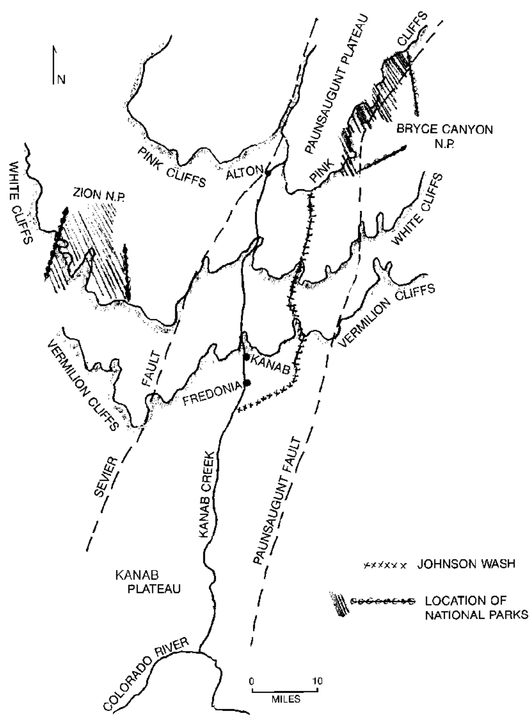


Figure 2. Location of Kanab Creek in relation to the High Plateau region of Utah above Kanab Plateau (after Gregory, 1950, p. 5 and Webb, Smith and McCord, 1991, p. 1) Also see Figure 9, this paper.

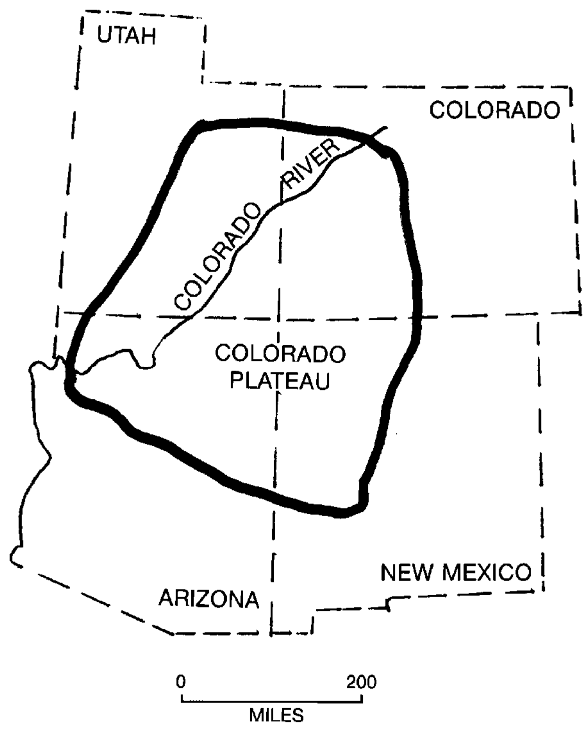


Figure 3. Location of the Colorado Plateau in the western United States (after Huntoon, 1989, p. 73).

Figure 4. Lower Kanab Canyon looking north from Gunsight Point (Robert Goette).

Figure 6. Smaller enclosed meander of Kanab Creek within the larger incised meander of lower Kanab Canyon (Robert Goette).

Figure 7. Sunset Cliffs on the western edge of Paunsaugunt Plateau (Robert Goette).

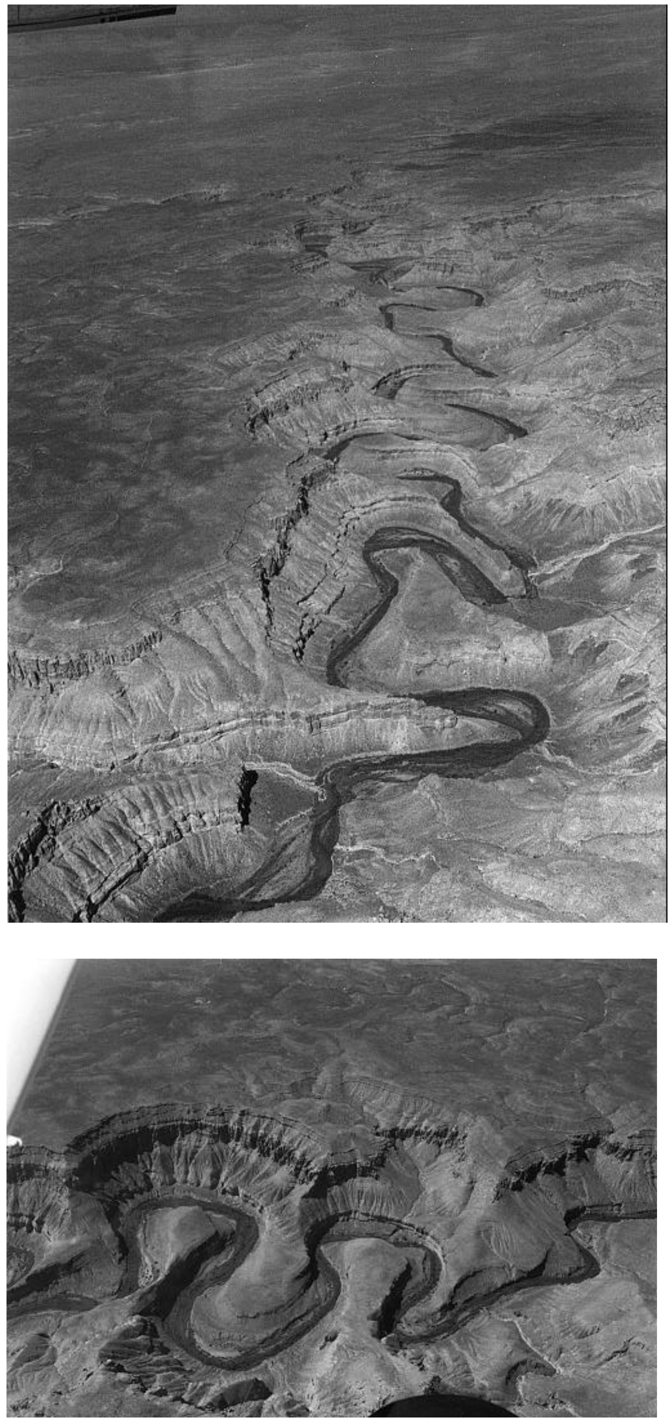

Figure 5. Incised meanders in lower Kanab Canyon (Robert Goette) a. View toward the north, Gunsight Canyon (right center) joins Kanab Canyon. b. Aerial view of meanders north of Gunsight Canyon.

The most penetrating commentary on the presence of incised meanders along canyon walls on the Colorado Plateau was made by Austin (1994a, pp. 98-99), and is applicable to this study. He showed that a high discharge rate of flowing water, coupled with a drop in the regional groundwater table, is able to "...cause meanders to be incised vertically" (p. 98). A rapid discharge of water, created when a dam ponding a lake is breached, would cause meanders to be incised in strata along the flow path of the released water (p. 98). Possibly a lake was located on, or north of Kanab Plateau which could have drained rapidly generating the meanders shown in Figure 5? A complete discussion of stream meanders can be found in Morris and Wiggert (1972, pp. 502-523). They concluded that to form incised or entrenched meanders,

> ...it would seem necessary to postulate much greater volumes of water in the streams than now present, together with much less resistant walls than the rocks of which they now consist (p. 523).

Another interesting feature of the lower canyon is that today the creek is grossly underfit (Figure 4 and 6). Again referring to Austin (1994a, p. 98), this situation indicates that the present stream has a relatively low discharge rate, but in the past "...there was at least one episode of very high discharge" to carve such a large canyon.

### Upper Kanab Creek and the Headwaters of Kanab Creek

The Sunset Cliffs (Figure 7) on the western edge of Paunsaugunt are part of the Pink Cliffs in which the beautiful erosional features of Bryce Canyon National Park are found (Figure 8). As Goode (1966, p. 15) explained, "Kanab Creek heads...under the Pink Cliffs northeast of Alton." (See Figure 2.) Tilton (1991, p. 4) noted, "In the upper reaches, the tributaries of Kanab Creek flow through steep canyons cut into...sandstones and mudstones." Then the creek flows onto the easily erodible mudstones of Tropic Shale and alluvium deposits.

The flow from upper Kanab Creek does not necessarily reach the lower region of the creek. Goode (1966, p. 15) claimed that springs in the lower creek area sustain the flow there. Thus,

> ...although upper Kanab Creek forms continuous drainage with lower Kanab Creek the two portions of the drainage system may be considered separate because the source of the base flow (ground water runoff) for the two sections of the system are different, and normally only spring runoff and flood waters provide a continuous flow of water from the head of Kanab Creek through its lower reaches (Goode, 1966, p. 16).

Woolley (1946, p. 73) observed that Kanab Creek, "At ordinary stages...is in part subterranean sinking into the sand of its bed to reappear only where a ledge of rock rises to bar its way."

Kanab Creek flows from north to south through the Grand Staircase (Figure 9), a series of cuestas; heading below the Pink Cliffs, passing through the White Cliffs and Vermilion Cliffs, then through Kanab, Utah, into the flatlands of Kanab Plateau at Fredonia, Arizona, and finally on to the Colorado River (Figure 2).

### Recent Erosion along Upper Kanab Creek

In the late 1800's, severe thunderstorms caused considerable erosion in the upper reaches of Kanab Creek. For instance, Dellenbaugh (1988, p. 180) commenting in 1908 on the subsequent formation of the canyon near Kanab, Utah, stated:

> While camped below Kanab [in 1872], Clem and I in walking one day saw a place where the creek which flowed on a level with the surroundings suddenly plunged into a deep mud canyon. This canyon has been cut back from far below by the undermining action of the falling water, and it was plain to see that it would continue its retrogression till it eventually reached the mouth of the great canyon several miles above, but I did not dream that it could accomplish this work as rapidly as it actually did years after. During a great flood it washed a canyon not only to Kanab but for miles up the gorge, sweeping away at one master stroke hundreds of acres of arable land and leaving a mud chasm forty feet deep. [ Brackets added.]

Gregory gave a graphic description (1950, pp. 174, 175) of the recent erosion along upper Kanab Creek, employing quotes from the diary of a pioneer, Henry E. Riggs. When the town of Kanab was settled in 1871, the creek flowed weakly and was shallow. During the summer it often disappeared. The stream was bordered by meadows and considerable swamps with vigorous vegetation. "It was almost impossible to ride a horse up the canyon on account of mud holes, quicksands, and brushy thickets" (p. 174). After 1874, the canyon floor was fenced for pasture and farming. With these changes, the creek developed fewer channels with an increased flowrate.

The first sizeable flood was recorded in July 1883.

> It swept away all the farm lands and meadow lands in the canyon as well as field crops just south of the village [Kanab, Utah] and scoured out a broad channel beneath the valley floor (p. 174). [Brackets added.]

Floods occurred daily for about a month in each of the years 1884 and 1885. It was estimated that because of this flooding (1883-1885) "...the stream bed was cut down

**Figure 8. Portion of Bryce Canyon National Park erosional structures on the eastern edge of Paunsaugunt Plateau (Robert Goette).**

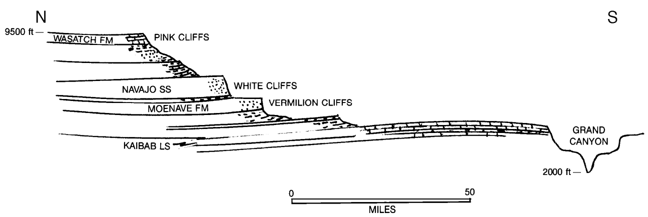


**Figure 9. Cross-Section of the "Grand Staircase" (after Hamblin and Best, 1970, p. 141). Also see Figure 2, this paper.**

**Figure 10. Alton amphitheater as indicated by arrow (Robert Goette).**

about 60 feet beneath the former level, with a breadth of some 70 feet for a distance of 15 miles" (p. 174). Gregory claimed that likely 12 million cubic yards of material were carried into the village of Kanab and south into the flatlands. Woolley (1946, p. 83) presented a slightly different but still violent account:

> On August 30, 1882, a terrific flood swept down Kanab Creek Canyon and literally swamped the town. This was followed by similar cloudburst floods each summer until 1886. In that period of 5 years the creek channel was changed almost beyond the comprehension of even those who saw it. Its depth was increased by 50 feet or more and width by about 200 feet in places.

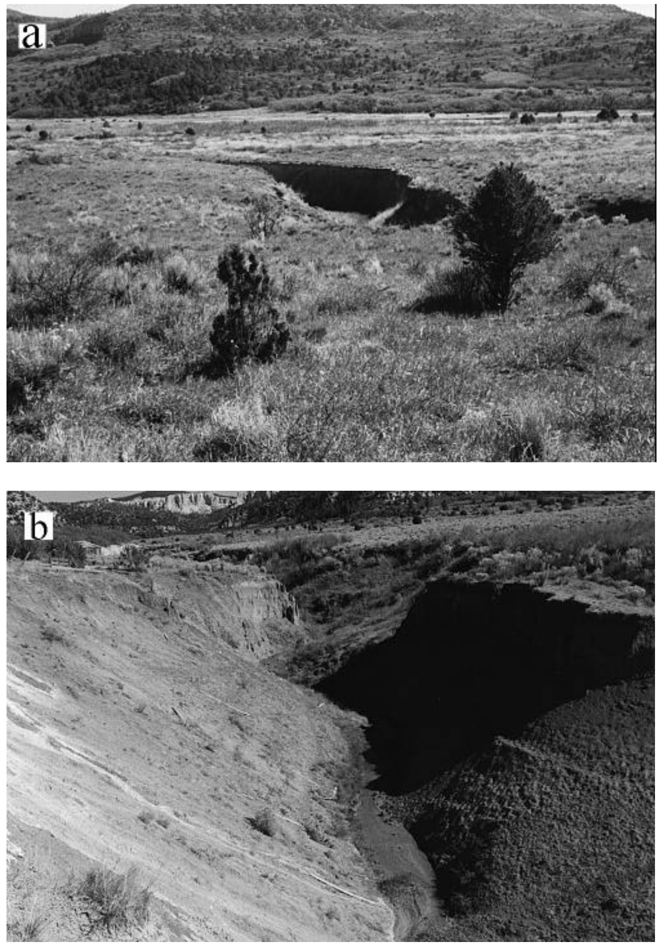


**Figure 11 a. Steep-sided gullies cut by Kanab Creek in alluvium north of Alton amphitheater (Emmett Williams). b. Steep-sided gullies cut by Kanab creek in alluvium (upper center) and in Tropic Shale (foreground). Pink Cliffs are visible in the left background (Robert Goette).**

Possibly the enclosed meanders inside the larger meanders of lower Kanab Creek (Figure 6) were incised because of this recent flooding as the flood waters transported abrasive material that would cut these smaller meanders. See Gregory and Moore (1931, pp. 135ff) for an interesting discussion of enclosed meanders.

### Earlier Erosion in Upper Kanab Creek Region

In observing the physiography of the region just below where Kanab Creek heads, it is obvious that extensive erosion and cliff recession along the edge of Paunsaugunt Plateau has occurred in the past (Gregory, 1951, p. 82; Austin, l994a, p. 99). One of the types of erosional remnants found in the Colorado Plateau was called an amphitheater by the early geologists that studied the region.

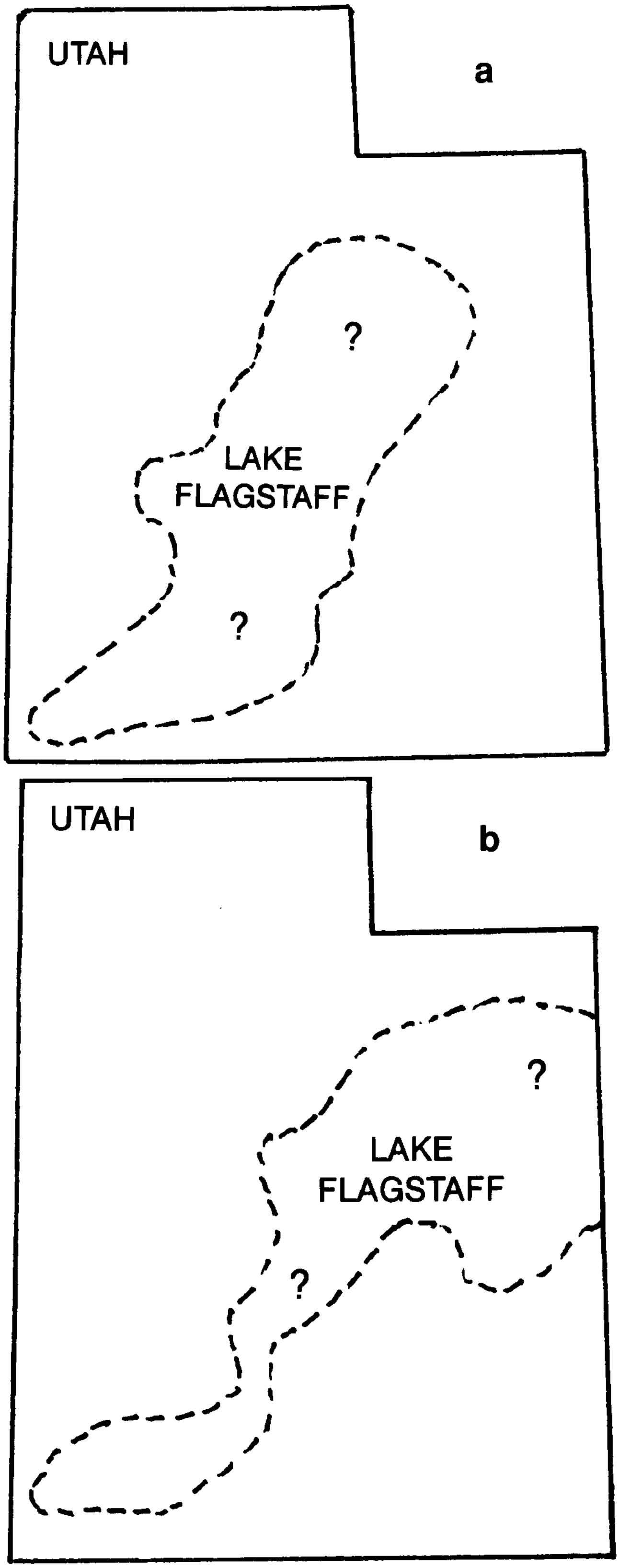


**Figure 12. Suggested boundaries of hypothetical "Lake Flagstaff" in Utah as determined by paleogeographic considerations. a. (after Hintze, 1988, p. 64) b. (after Stokes, 1986, p. 154) Lake extended into Colorado.**

One of these near Alton, Utah is the Alton Amphitheater (Figure 10). Gregory (1951, p. 87) described it as an "erosional indentation in the Pink Cliffs" which is a "broad relatively flat-floored, steep-sided" depression. He listed and discussed seven periods of uplift, deposition and erosion to account for the landforms of the high plateaus from a uniformitarian viewpoint (1951, pp. 82-107). Austin suggested that amphitheaters were formed by the mechanism of cliff sapping due to a catastrophic event (1994a, pp. 99-100).

> If a lake, or series of lakes on the Colorado Plateau rapidly drained, the water trapped inside the rocks along the shore and floor of the lake would escape quickly to the space previously occupied by the lake, we would expect to find large landscape scars and zones of failure, caused by water oozing out of the earth... We immediately recall the severely eroded lip of the plateau [Paunsaugunt] which forms Bryce Canyon, and countless other topographic wonders of Canyonlands in southern Utah (p. 99) [Brackets added].

Also see Froede, 1996a; Williams, 1995. Austin referred to amphitheaters as collapse features (p. 100). Such a process would occur rapidly, thus there would be no necessity to resort to extended periods of time for the development of the landform. If one doubts that the rocks of the Colorado Plateau are capable of holding large quantities of water, he should read Goode (1966) who estimated that the Navajo Sandstone in Kane County, Utah [a county of 4105 square miles in which Kanab and Alton are located], alone probably contains 10 million acre-feet of water.

If cliff-sapping events took place along the edge of Paunsaugunt Plateau, considerable alluvium would be found south of the Pink Cliffs at a later time. The water flow away from the collapsed sediments would transport some of the particulate matter southward. In the upper Kanab Creek region, many of the stream paths have been cut into alluvium (Doelling and Davis, 1989, p. 91; Tilton, 1991, p. 33). Gregory (1951, p. 103), in discussing the streams that head along the Paunsaugunt Plateau such as Kanab Creek, noted that they "...flow between walls of alluvium." See Figure 11. He stated that these streams typically "...occupy a two-storied valley - an inner gorge bounded by walls of alluvium and an outer gorge whose walls are of rock." Employing a young earth Flood model, possibly the first canyon [in rock] could have been cut by retreating Flood water.

The cliff sapping envisioned by Austin along Paunsaugunt Plateau, coupled with the flow of sediment-laden water, southward would have deposited some of the material as alluvium in the upper Kanab Creek region. This alluvium would form the base for the swamps, meadows, mudholes, quicksand, etc. seen by the pioneers when the region was settled. Kanab Creek may have flowed as a braided stream choked with sediments [See Williams, 1995, pp. 33-34],

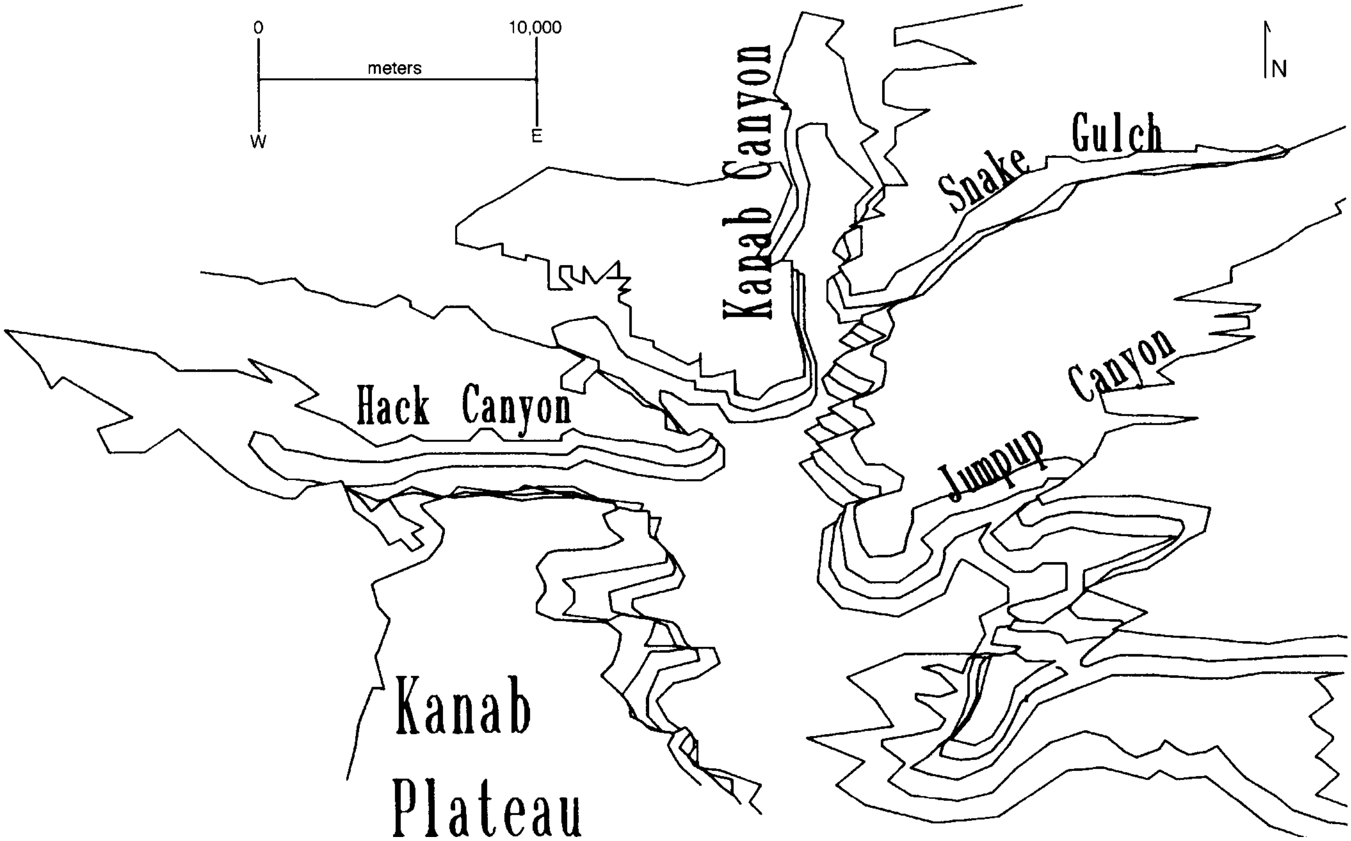


**Figure 13. Three dimensional representation of the mouth of Kanab Canyon where it intersects the Grand Canyon. The scale marks 10,000 meters in the east-west direction. The distances measured in the north-south direction are twice those in the east-west direction, i.e. 1.45 inches equals 10,000 meters east and west whereas 1.45 inches equals 20,000 meters north and south. The depth intervals are recorded in 500 ft. increments. Drawing by Gene Chaffin.**

often "disappearing" into the alluvium during dry periods due to a drop in groundwater level.

Likely upper Kanab Canyon or Creek did not exist until recently. Webb, Smith and McCord (1991, p. 15) commented that no mention was made of crossing Kanab Creek by members of the Dominguez-Escalante expedition of 1776. Thus they claimed "...Kanab Creek apparently did not even have a channel" in 1776. These authors stated that the steep-sided gullies of Kanab Creek near Kanab developed during the series of floods in the 1880's (p. 15). Also they claimed that the gullies near Alton (Figures 1la and b) developed "...in the 1930's during a series of relatively small floods" (p. 24). One of the possible conclusions that can be drawn from the discussions in this and the previous section is that all of these events-canyon formation, cliff-sapping, and gully formation-happened recently, which is why topography of the high plateaus appears so youthful. [See Williams, 1996.] As Gregory (1950, p. 153) said, "In a physiographic sense the region is youthful."

## The Existence of Regional Lakes

Steve Austin has made a good case for the formation of the Grand Canyon by the breaching of dams ponding large lakes on the Colorado Plateau (1994a, pp. 92-107). See Brown (1994, pp. 103-105) for a similar proposal and Oard (1993) for a critique of the presence of lakes on the Colorado Plateau in the past. Also Williams, Meyer and Wolfrom (1992b) discussed the possibility of post-Flood lakes on the Colorado Plateau. Were there other lakes in existence along what is now the headwaters or present path of Kanab Creek which could have drained catastrophically to form lower Kanab Canyon?

The beauty of Bryce Canyon National Park (Figure 8) is derived from the exposure and continued erosion of the pink rocks of the Wasatch or Claron Formation* on Paunsaugunt Plateau. Stokes (1986, p. 162) claimed that "The Wasatch Formation of Southwestern Utah was laid down in a shallow,

*Gregory (1951) employed Wasatch Formation when mapping Paunsaugunt Plateau. It was later called the Cedar Breaks Formation by geologists studying southwestern Utah. Today the Utah Geological and Mineral Survey supports the name Claron Formation because of its regional precedence. See Doelling and Davis, 1989, pp. 86-87; Tilton, 1991, p. 30; Stokes, 1986, p. 161.

oscillating lake." Gregory (1950, p. 112) believed that the sediments in the formation appear "...to have been deposited as limy ooze and silt in shallow lakes, ponds, and bayous and as sand and gravel in the beds and at the mouths of streams." Doelling and Davis (1989, p. 87) conjectured that the formation "...is of lacustrine and fluvial origin." Gregory correlated this formation on Paunsaugunt Plateau with the Wasatch Formation of northern and eastern Utah (1950, p. 112; 1951, p. 52). However this correlation is "very loose" because the Wasatch on Paunsaugunt is almost unfossiliferous (Hintze, 1988, p. 64). Also the rocks at Bryce Canyon National Park are presumed to be equivalent to the Flagstaff Formation of central Utah (Hintze, 1988, p. 65).

Regardless of these name and correlation difficulties, this formation is thought to have been deposited in a lake. See Appendix III. One possibility is that it was part of a postulated body of water referred to as Lake Flagstaff [Figure 12] (Hintze, 1988, p. 64; Stokes, 1986, p. 154). In their discussion of the geology of Kane County, Doelling and Davis (1989, p. 102) noted that the lake from which the "Pink Cliffs" formation was deposited once covered the western half of Kane County and that "...the southern extent of the lake is not known."

## Climate Change on Colorado Plateau: From Wet to Dry

Possible climatic changes in the western United States, particularly on the Colorado Plateau, have been discussed previously (Williams, Meyer and Wolfrom 1992b, pp. 21-22). Lammerts noted the lessening rainfall with time in the Southwest since the Flood and also speculated on the recent origin for deserts in that region (1964, p. 54; 1971, pp. 50-54; 1978, pp. 6-7). Howe (1996), in an excellent review of Wells' work (1985), agreed with Lammerts' contention that the southwestern deserts developed recently. Whitcomb and Morris (1963, pp. 303-311, 314) examined a possible changing climate after the Flood. Oard (1979, pp. 30-35; 1990, p. 78) postulated a post-Flood warm ice age that would have caused wetter conditions in places that are definitely semi-arid and arid now. Oard (1993, pp. 39-40) suggested that the deserts of southwestern United States began to develop at the end of the Ice Age. Also see Nash, 1987, p. 13; Howe, 1987, pp. 9-12.

Concerning the Kanab Creek region, Doelling and Davis (1989, p. 103) argued that there was increased precipitation and lower temperatures during the Pleistocene, followed by dryer conditions in the Holocene. Gregory (1950, pp. 175-177) did not think that past or present eras of increased rainfall could explain the erosional structures observed on the high plateaus of Utah. However Webb, Smith and McCord claim that recent erosion along Kanab Creek likely can be attributed "...to known climatic fluctuations that are related to hemispheric-scale oceanic processes" (1991, p. 24).

As an aside, Gregory (1950, pp. 175-176) as well as Webb, Smith and McCord (1991, p. 24) contend that poor land-use practices by man had an effect on the recent erosion along Kanab Creek in a manner similar to what has been noted at Providence Canyon State Park, Georgia (Williams, 1995) but other factors far outweigh this consideration.

## Conclusions

The erosion of Kanab Canyon is postulated to have occurred as follows.

a. Late Flood Erosion

We suggest that as the Flood waters receded from the continental United States, possibly as much as 6,000 to 8,000 vertical feet of recently deposited sediment were removed from Kanab Plateau.

b. Post-Flood Climatic Conditions

Immediately after the Flood, considerable precipitation fell across the southwestern United States which led to rapid erosion of recently-deposited sediments as well as the formation of lakes in basins.

c. Existence of Post-Flood Lakes

We assume that such lakes existed on the Colorado Plateau. Likely water released from a lake, or lakes, ponded in northern Arizona and southwestern Utah carved lower Kanab Canyon. The timing of this breaching event in relation to the formation of the Grand Canyon is not known. But the lower reaches of Kanab Canyon offer evidence (incised meanders and an underfit stream) for a former episode of very high discharge of water.

d. Early Post-Flood Erosion in Southwestern Utah

Continued erosion of the high plateaus during a postulated wetter period would account for many of the canyons which are below the Paunsaugunt Plateau. Subsequent cliff sapping along the plateau and continued sediment transport could have deposited alluvium along the upper reaches of Kanab Creek.

e. Recent Erosion Along Kanab Creek

Recent erosion (1880's to the present) has caused steep-sided gullies to form in the alluvium along Upper Kanab Creek. Thus Kanab Canyon extended headward in this time frame from below Kanab to above Alton, Utah. Precipitation resulting from thunderstorms initiated this erosion. These storms likely are a product of climate fluctuations within the last 100-120 years. The steep-sided gullies noted in the upper Kanab Creek region are similar to the ones observed at Providence Canyon State Park, Georgia (Williams, 1995). Possibly cliff sapping processes have played a more important role in the development of Kanab Canyon than is presently recognized?

f. Obviously more field study is necessary to verify, refine or reject these postulates. The scientific work of creationists on the Colorado Plateau has just begun. Many scientific observations of the region need to be interpreted within a young-earth Flood framework. The authors urge our readers to comment on any of the speculations in this paper.

**Acknowledgments**

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**Glossary**

Alluvium - deposits of sand, silt or clay laid down by running water.

Bathymetry -the measurement of the depths of large bodies of water.

Braided Stream - a stream that divides into an interlacing network of branching and reuniting shallow channels due to its inability to transport its sediment load.

Claron Formation - see Wasatch Formation.

Cuesta - an asymmetrical ridge with a long, gentle slope on one side and a steep or cliff-like face on the other side.

Fluvial - pertaining to rivers, streams or creeks.

Incised Meander - a sinuous valley or canyon cut by a river during its course to the sea.

Lacustrine - pertaining to lakes.

Pediment - a broad, gently sloping erosional surface, developed by running water in an arid or semiarid region at the base of an abrupt and receding mountain front.

Sapping - erosion along the base of a cliff by wearing away the softer layers causing the collapse of large masses of material from overlying sediments.

Tropic Shale - thinly laminated to thin-bedded mudstone and shale unit with lesser amounts of sandstone, bentonitic claystone, siltstone and limestone.

Underfit Stream - a stream that appears too small to have eroded the valley or canyon through which it presently flows.

Wasatch Formation (Southwestern Utah) - known informally as the "Pink Cliffs" or "Bryce Canyon" Formation. It contains units of pink, white and gray limestone, calcareous sandstone and mudstone.

**Appendix I**

**Estimated Erosion of Kanab Plateau**

Referring to Figure 9, Gregory's estimate of 6,000 to 8,000 ft. of sediment removed from Kanab Plateau (1950, p. 169) can be calculated as follows. Kaibab Limestone caps Kanab Plateau. As one moves north into Utah, one will find ever increasing thicknesses of strata over the Kaibab Limestone up to and including the Pink Cliffs.

Wasatch Formation
Kaiparowits Formation
Straight Cliffs - Wahweap Sandstone
Tropic Formation
Dakota Sandstone
Carmel Formation
Temple Cap Formation
Navajo Sandstone
Kayenta Formation
Moenave Formation
Chinle Formation
Moenkopi Formation
Kaibab Limestone

The Moenkopi-Wasatch thickness over the Kaibab Limestone in Utah is 8000 ft. If you assume that this thickness of strata once covered the Grand Canyon region but has been subsequently eroded leaving only the Grand Staircase in Utah, then 8,000 ft. of sediment has been eroded from Kanab Plateau. If the Wasatch and Kaiparowits did not extend into Arizona, only about 6,000 ft. of sediment would have been eroded from Kanab Plateau.

**Appendix II**

**Representation of Mouth of Kanab Canyon**

Figure 13 is a three-dimensional drawing of the mouth of Kanab Canyon where it joins the Grand Canyon. Hack and Jumpup Canyons as well as Snake Gulch are side canyons of Kanab.

**Appendix III**

**Lake Sediments - Speculations**

We assume a lake existed from which the "Pink Cliffs" Formation was deposited. Was the lake actually remaining Flood water that had been trapped by tectonic activity before it escaped from the Colorado Plateau? If this supposed trapped water were saline, would it have left the "Pink Cliffs" sediments? A quote on ancient lake environments is helpful in this context.

> Lakes are frequently referred to as "freshwater" but they are, in fact, commonly saline. From analysis of physical, chemical and biological data, evidence indicates that most ancient lake environments were dynamic, and their depositional facies reflect constant changes in tectonic setting, water chemistry and bathymetry. As a result, characteristics used to recognize a depositional setting existing during one period of a lake's history may differ significantly from lacustrine characteristics of a different time. Thus the distribution of sedimentary structures in lacustrine depositional facies can be expected to vary significantly from one phase of a lake's evolution to another as physical and chemical characteristics of the hydrologic basin

> change. For example, beds formed in quiet, relatively fresh, oxygenated water may be fossiliferous and bioturbated. Beds found in the same depositional setting but during an extreme alkaline or saline water phase of the lake's history may reflect little or no influence of indigenous biologic activity except possibly that of algae. Therefore to propose a set of physical and biological criteria that uniquely identify specific lacustrine depositional environments is difficult and potentially misleading (Fouch and Dean, 1982, p. 87).

Possibly some of the almost unfossiliferous Pink Cliff sediments were deposited under saline conditions. As sediments were forming along with a high level of post-Flood precipitation, the salinity could have decreased and the lake evolved into freshwater conditions (Froede, 1996b, p. 226). Then freshwater sediments were deposited.

Another more radical consideration is that possibly the Flood water was heterogenous. This possibility was investigated by Norbert Smith from a biological standpoint. Since freshwater and saltwater organisms were needed to repopulate the seas, lakes and rivers after the Flood, experiments were conducted to determine how certain water-dwelling creatures could survive a heterogeneous Flood (Smith and Hagberg, 1984, pp. 33-37). If there were layers of freshwater and ocean water that did not mix thoroughly during the Deluge, both saltwater and freshwater organisms could survive. If so, some "freshwater" lacustrine deposition was from this type of Floodwater.

Recently Woodmorappe (1996, pp. 143-152) showed how both saltwater and freshwater organisms could have survived the Flood even if it had a small range of salinities in the brackish range. This proposal deserves serious study.

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# LETTERS TO THE EDITOR

## Validity of the Isochron Age Procedure - Response to Brown

I still maintain that isochron age procedure for age dating of rocks is mathematically invalid for several reasons.

The first is that it uses a simple linear regression equation, which is valid only for ONE independent variable acting on ONE dependent variable. The isochron procedure has two independent variables, the $^{87}$Rb radioactive parent and the common isotope $^{87}$Sr of the atomic strontium. The dependent variable is the $^{87}$Sr, but the end products of the two independent variables cannot be separated therein. Three variables are involved, so the Simple Linear Regression Equation (SLRE) output is invalid.

Also, the common isotope is about 7% by weight of the atomic strontium, whereas the daughter $^{87}$Sr of the of radioactive $^{87}$Rb is only in the order of $10^{-9}$ units of weight for each unit of parent weight; an unmeasurable quantity for a historical age of about 4000 years.

The multivariable linear division by a variable does not apply because the $^{87}$Sr and $^{86}$Sr are nearly colinear variables; the division of the $^{87}$Rb and the division of the $^{86}$Sr are quite different procedures as witness the totally different regression values before and after the division shown by Austin's data sets. The near colinearity also modifies the correlation coefficient too.

The meaning of the near zero slope of the regression is that there is essentially no correlation between the input X and Y values resulting from the division by $^{86}$Sr.

As to Dr. Brown's use of the mixing line to bridge the gap between isochron an Biblical ages, it is not necessary if the isochron ages are invalid. The mixing line has no time significance at all.

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## The Process of the Creation of the Universe

I am a layman as far as the sciences are concerned, but D. Russell Humphrey's book: *Starlight and Time* is in line with a question I have always considered to be fundamental in regards to the "apparent" age of the universe, which unless I have missed something, I have not seen addressed before. Specifically, the question is this: If the universe was created as a space-time-matter continuum in which neither aspect exists without the other two, then what was the effect on time (and therefore on atomic constants; the speed of light; decay rates, etc.), during the actual process of creation? In other words, was the universe created with the appearance of age, or rather, does the universe have the appearance of age *because* it was created? There is a big difference in the two when you consider that the universe was not created and completed in an instant of time, but required a number of 24-hour periods during which it was "stretched out" (Isaiah 40:22; 51:13; etc.). And those 24-hour time periods were the same as the time periods we live in today. They were the time periods in the mind of God which He adhered to, in anticipation of man and the completed creation, while "stretching out" the space-time-matter continuum to its, ordained limits.