The Uncompahgre Plateau and Unaweep Canyon

by John Weisheit

Introduction

The geologic chronology associated with the Uncompahgre Plateau indicates vigorous tectonic activity for over a third of the earths history. The metamorphic rocks viewed within Westwater Canyon have a radiometric date of 1800 to 1400 million years. Besides this obvious record of tectonic activity in the Proterozoic Era, it has also experienced uplift in the Paleozoic, Mesozoic, and Cenozoic Eras. No other uplift on the Colorado Plateau seems to record such periodic sub-surface displacement.

Bisecting the Uncompahgre Plateau is an abandoned river gorge called Unaweep Canyon. It is has been speculated that this canyon was cut by either the ancestral Colorado River or the Gunnison River. The abandonment of this ancestral canyon is suspect to renewed uplift of the Uncompahgre that occurred as little as 1 to 2 million years ago (mya).

Background

Presently, the Uncompahgre Plateau is a northwest-trending anticlinal uplift 25 to 30 miles wide and 95 miles long and is located in east central Utah and west central Colorado. The Colorado River traverses through it seeming to defy its structure. The metamorphic complexes of the Uncompahgre basement formed in the Proterozoic during a history of continental addition by colliding volcanic island arcs, stress-related folding, and subsequent mountain building. These Alp-like mountains eventually eroded to sea level well before the start of the Paleozoic Era. A period of intermittent deposition occurred on these rocks until the early Pennsylvanian Period, and the platform was again uplifted into a set of mountains referred to as the Ancestral Rocky Mountains. These mountains were the source materials for the Colorado Plateau's red-colored shales and sandstones such as: the Supai, Halgaito, Hermit, Organ Rock, and the undifferentiated Cutler. These mountains were eroded to sea level by the early Triassic Period of the Mesozoic Era. With sea level equilibrium established, deposition started with the formation of the Chinle, which caps the metamorphic complexes, and is best observed today on the Colorado River at the head of Westwater Canyon. The Chinle formation is 220 million years old and the division between these two rock units chronicles at least 1200 million years of missing strata. This missing volume in the geologic library is called a "*great unconformity*".

Navajo sandstone, which is one of the most extensive formations on the Colorado Plateau, is also missing from the geologic stratigraphy of the Uncompahgre Plateau, and represents a missing chapter that is called an "*unconformity*". This would indicate a period of renewed uplift for the platform during the Jurassic Period; the Navajo was either not deposited, or was eroded off the feature by consequent drainage. However, Entrada sandstone is present and indicates renewed deposition, and burial of the Uncompahgre Uplift probably until the Laramide orogeny. This famous tectonic event started about 80 million years ago and formed the present-day Rocky Mountains and the surface bulges of the Colorado Plateau -- sisters to the Uncompahgre with names like Monument, Zuni, and Defiance. About 65 mya, the Colorado Plateau area was uplifted from its sea level basin, by what is called an *epeirogenic* (crustal deformation) event, with an amazing vertical displacement of many thousands of feet.

Things changed in-and-around the Oligocene Epoch (38 to 26 mya) of the Cenozoic Era with extensional rifting breaking the highlands to the west and south of the Colorado Plateau area, and forming the Basin and Range Province. However, periods of uplift can even occur today on the Colorado Plateau. In the Pliocene Epoch (12 to 2 mya), the Kaibab Plateau, the Uncompahgre Plateau, and the Uinta Mountains indicate renewed uplift. If uplifting continued today, river systems on the Colorado Plateau would deepen their gorges.

Antecedence - Superposition - Anteposition

The term *antecedence* was described by John Wesley Powell in his report of 1875. This theory relates to the activity of rivers that cut perpendicularly through major uplifts such as: the Colorado River through the Uncompahgre, the San Rafael River traversing the Swell, and the San Juan River crossing the Monument Upwarp. Logic would dictate that a river would simply flow around an elevated land platform. Powell may have scratched his head and concluded these drainages were emplaced before uplifting, that the erosive forces of these rivers kept pace with the uplift, and resulted in their subsequent river gorges. This has been described as a saw (the river) working on a log (the uplift). In this scenario the saw remains in place and the force for cutting is applied by moving the log. What if this process were reversed? That is the log remains stationary and the saw moves. This theory was also describe by Powell and is called *superposition*.

With superposition, the uplift occurred first and then the structure was buried by sediments. This could happen in a desert of wind blowing sand, in an oceanic delta, or in a continental lake. The river, suspended on the sediments that buried the uplift, will eventually erode into the structure from above. A good example of this scenario occurred recently on Lake Powell on the San Juan River Arm forming Paiute Falls. [*See article by Gene Stevenson and Donald Baars in Issue I of The Confluence.*]

Laramide structures were in place and receiving sedimentation in a Cretaceous Sea even before epeirogenic forces uplifted the entire area from its below sea level basin. This activity was progressive, working from the southwest towards the northeast. The subsequent tilt created a natural dam to contain run-off, forming a continental lake that prevailed for at least 45

Geologic History of the Colorado River

According to Hunt, 1969

[Tabular summary of the interpretation, much of it conjectural, presented in USGS Professional Paper 669C. Sequence within time intervals arranged with earliest event at bottom.]

Time interval and approximate age of boundaries (in millions of years)	Geographic regions			
	Basin and Range province	Colorado Plateau		Rocky Mountains Colorado and Gunnison Rivers above Grand Junction
		Southern section Below mouth of Green River	Northern section Green and upper Colorado Rivers	
0				
Quaternary	Colorado River canyon in Black Mountains deepened by renewed uplift (antecedence).	Grand Canyon of Colorado River deepened very little since mid-Pleistocene time. River in Grand Canyon within about 50 feet of present depth about 1.2 million years ago. Uplift and (or) northeast tilting of plateau probably continued intermittently throughout the Quaternary and probably is still continuing.	Canyons of Green and Yampa Rivers deepened about 500 feet.	Main river valleys and canyons depened about 500 feet in glacial Pleistocene time; headwater stretches deepened 1,000–1,500 feet. Unaweep Canyon abandoned in late Pliocene or earliest Pleistocene time.
2				
Pliocene	Colorado River discharges to Hualapai Lake and it overflows westward across Black Mountains. Limestone (Hualapai) deposited in fresh-water spring-fed lake centering at mouth of Colorado River canyon in Grand Wash Cliffs. Alluvial and playa beds (Muddy Creek Formation) deposited in Lake Mead area. Colorado River not there. Estuary along lower Colorado River (below The Needles) throughout much of Pliocene time.	Colorado River discharges at mouth of Grand Canyon. Ancestral Colorado River joins the Little Colorado and San Juan Rivers; overflows through arched ancestral Grand Canyon. Uplift and northeast tilting of plateau probably continued intermittently throughout the Pliocene. Renewed uplift at Kaibab Plateau ponds ancestral Colorado and Little Colorado Rivers; begin deposition of Bidahochi Formation (earliest Pliocene). Ancestral drainage, ponded at Peach Springs, discharged at Grand Wash Cliffs as big springs fed by pipes enlarged in the now cavernous limestone formations dipping down axis of present lower Granite Gorge.	Renewed uplift at Uinta Mountains (or downfaulting of adjoining basins) deepens the canyons by perhaps 1,000 feet (antecedence). Green and Yampa Rivers superimposed in southward courses across the Uinta Mountains, probably when the mountains were structurally lower relative to adjacent basins than now and were buried by Browns Park Formation. This superposition probably took place in early Pliocene time, perhaps in the late Miocene.	Canyons of the Colorado River through uplifted blocks such as the Gore Range or White River Plateau deepened 2,000–3,000 feet during Pliocene time (antecedence); Black Canyon of the Gunnison River. Colorado and Gunnison Rivers cross Uncompahgre Plateau and cut Unaweep Canyon.
12				
Miocene	Estuary along lower Colorado River (below The Needles); Colorado River apparently flowed into it by way of canyon at Peach Springs, Ariz. Accumulation of lavas, dated radiometrically at 16–17 million years old, in gap at Kingman, Ariz., between Hualapai and Cerbat Mountains; the gap may be segment of canyon at Peach Springs, Ariz., faulted off plateau. Deposition of alluvial and playa beds, lower part of Muddy Creek Formation(?), in Lake Mead area; most movement along faults near Grand Wash Cliffs by middle Miocene time.	Canyon at Peach Springs partly filled with deposits dated radiometrically at about 18.3 million years old; renewed uplift at Kaibab Plateau. Gravel deposits on Kaibito Plateau, derived in part from San Juan Mountains, indicate that by late Miocene time, San Juan River flowed across Monument upwarp to within 80 miles of Grand Canyon; probably crossed ancestral Kaibab uplift in canyon and joined ancestral Little Colorado River west of there. By middle Miocene time the Little Colorado River had course south of Kaibab upwarp and left plateau by way of canyon near Peach Springs, Ariz. Plateau uplifted and tilted northeastward intermittently throughout the Miocene.	Doming of laccolithic mountains by intrusions about 25 million years ago caused drainage to be diverted around mountains (La Sal, Ute, Henry, Abajo, Navajo Mountains). White River follows a westward, essentially consequent course down axis of Uinta basin. Ancestral Green and Yampa Rivers discharge into Wyoming basin north of Uinta Mountains. Northern part of main Colorado River drainage is assumed to have ended in playas in Henry Mountains and (or) Kaiparowits basins.	Present course of main stem of Colorado River largely established by overflowing structural barriers by end of Miocene time; Gunnison River superimposed across Precambrian rocks at Black Canyon. Headward part of Colorado River disrupted by formation of structural basins at head of Yampa River, near State Bridge, and in Middle Park; and by uplift of White River Plateau and Gore Range. Ancestral Colorado River continues consequent westward course to Uinta basin; continued outpouring of lava in Gunnison River valley.
26				
Oligocene	Breakup of highlands into basins and ranges, block faulting; probably faulting began at Grand Wash and at the basins downstream along the Colorado River.	Plateau continues to be uplifted and tilted northeast; San Juan River basin probably overflowed west; drainage history obscure because datable deposits are scarce; probably playas in Henry Mountains and Kaiparowits basins.	Plateau tilted northeast. Filling of playa exceeds rate of tilting, and Uinta basin overflows southward; ancestral Green and Yampa Rivers ponded in Wyoming basin. Lakes filled and converted to playas.	Gunnison River valley tilted eastward and begins to fill with volcanic rocks. Ancestral Colorado River had consequent course at about the position of present White River to Uinta basin; ancestral Gunnison River valley eroded into Precambrian rocks.
38				
Eocene and Paleocene	Highlands draining eastward and northeastward; folding, faulting.	Plateau uplifted and tilted northeast; drainage probably northward to lakes because of northward tilting.	Area low lying, close to sea level; large lakes (Flagstaff and Green-river Lakes).	Consequent streams flowing west supplied sediment to lakes.
65				
Cretaceous	Highlands draining eastward and northeastward.	Flooded by seas.	Flooded by seas.	Flooded by seas.

million years; more than enough time to continue the burial of Laramide structures. Due to the breakup of the highlands from extensional rifting, the lake began to drain, forming rivers which started to incise themselves into lake sediments, often forming the river meanders that are with us to this day. These rivers, entrenched as they were, eventually cut down into the buried Laramide structures and created our scenic canyons.

Powell favored antecedence, but many geologists have favored superposition; some a combination of the two, which is called *anteposition* and described by Charles B. Hunt in 1956. Anteposition is explained as an already existing river that has superimposed itself into a structure; the structure later renews its uplift, and the river cuts a deeper gorge by antecedence. This has occurred on structures such as the Kaibab Plateau and resulted in the deepening of Marble and Grand Canyons by many thousands of feet. However, in Unaweep Canyon, anteposition occurred for awhile until another geologic force known as *stream capture* developed. Powell's USGS associate, Grove K. Gilbert, defined stream capture well:

"A stream which for any reason is able to corrode its bottom more rapidly than do its neighbors, expands its valley at their expense, and eventually 'abstracts' them. And conversely, a stream which for any reason is able to corrode its bottom less rapidly than its neighbor, has its valley contracted by their encroachments and is eventually 'abstracted' by one or the other."

Unaweep Canyon

Evidence indicates an ancestral river superimposed itself into the Uncompahgre Uplift and formed the canyon we call Unaweep. However, at some point in time, this canyon was abandoned by stream capture. As on the Kaibab Plateau, anteposition should have occurred, but didn't due to differences in the hardness of the rock. An appropriate metaphor is that "water takes the course of least resistance." Well before the time of the renewed uplift for the Uncompahgre Uplift, the ancestral river in Unaweep Canyon had cut into the very hard metamorphic complexes of the Uncompahgre. The rate of renewed uplift that occurred 1 to 2 mya, was greater than what the river could cut by anteposition, and so the river began to pool before the structure.

It has been proposed that both the Colorado and the Gunnison rivers met at a confluence upstream of the Uncompahgre Uplift and that the combined flow traveled through Unaweep Canyon. This theory has recently lost support. It is now believed that the Colorado River has basically maintained its present course; that the Gunnison River flowed through Unaweep Canyon; and the confluence was downstream of Unaweep Canyon. So, the Colorado River maintained its valley while the Gunnison became stagnant, pooling before the raising Uncompahgre. Eventually, that lake over-spilled into the Colorado River; finding an easier channel to corrode in rocks that were softer than those of Unaweep Canyon. With the Colorado River maintaining its channel as the master stream, the Gunnison was captured above the Uncompahgre. With this piracy, the Colorado River increased its flow and either superimposed itself into the Uncompahgre or was able to keep up with the rate of uplift and maintained its course through antecedence, or both, which again is defined as anteposition.

The Colorado River of the Future

Westwater Canyon begins at Mile 124.3 with metamorphic bedrock riffles. Just before these riffles, the river is abraided into four channels over gravels that are held in repose. Also, one mile upstream, there is an extensive flood plain the river has eroded into -- leaving a steep cut-bank. Could these features indicate renewed uplift of the Uncompahgre in very recent geological times? Did the Colorado River momentarily pool before the uplift to deposit this fluvial plain? Did anteposition pace itself with the uplift, so that the Colorado River maintained its course through Westwater Canyon? Will uplifting someday exceed anteposition, so that the Colorado River will abandon Westwater Canyon, flood the Cisco Desert and over-spill into Cottonwood Wash? Such questions help us to realize that our planet's clockwork is ever ticking.

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