# The Confluence

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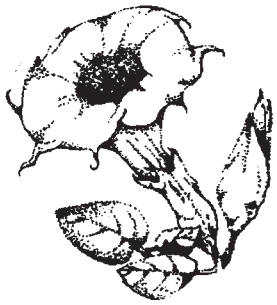



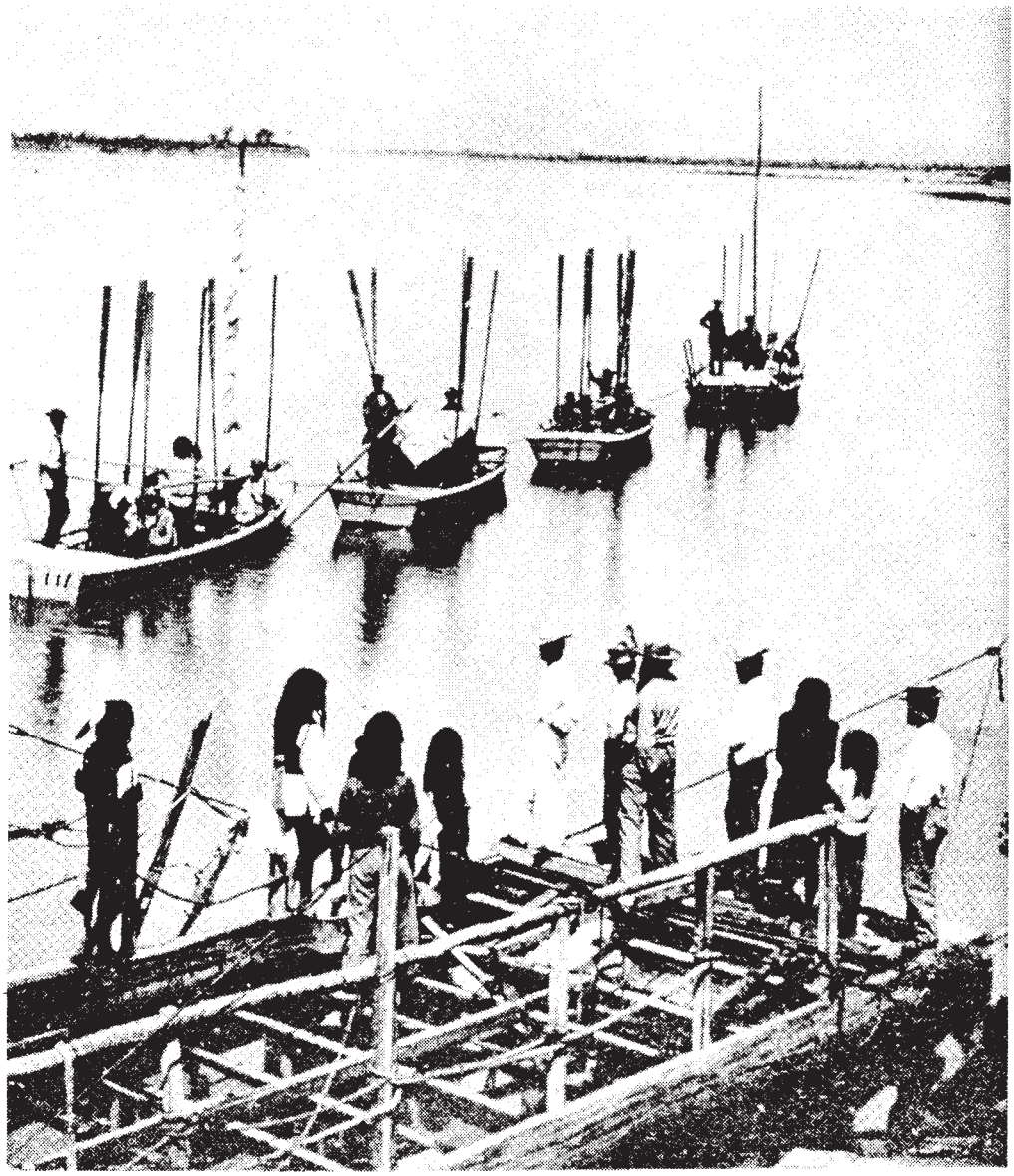

George Wheeler's Grand Canyon Expedition starting from Camp Mojave to Diamond Creek, Colorado River. Timothy O'Sullivan photo, 1871. Courtesy of National Archives

# The Confluence

...wants to be the quarterly journal of Colorado Plateau River Guides, Inc. (CPRG), which is a member of a 501 (c) (3) non-profit organization called Canyon Country Volunteers. CPRG is dedicated to:

- **Protecting the rivers of the Colorado Plateau**
- **Setting the highest standards for the river profession**
- **Providing the best possible river experience**
- **Celebrating the unique spirit of the river community**

**Guide Membership** is open to anyone who works or has worked in the river industry of the Colorado Plateau

**General Membership** is open to those who love the rivers of the Colorado Plateau

**Membership dues**
$ 20 per year
$100 for 6 years
$195 for life
$295 Benefactor

**General Meetings and Board Meetings will be announced**




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We need articles, oral histories, poetry, stories, and opinions. This journal is composed using Microsoft Publisher. If you use a word processor, we can translate most programs. Otherwise, please send your text typed. Please include useful photos, charts, diagrams and artwork. There really is no deadline, but the beginning of each quarter works best.


**Managing editor:** John Weisheit (jweisheit@hotmail.com)
**Editor of this issue:** John Weisheit

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## Disclaimer

The opinions and statements made within the pages of The Confluence are those of the author and do not necessarily represent the position of the guide membership, the board of Colorado Plateau River Guides, nor Canyon Country Volunteers. This forum is open with no restrictions at the present time. If you have an opposing or supporting viewpoint please send your comments to CPRG.

## New Officers for CPRG

The CPRG board met at the America Outdoor convention in Salt Lake City this last December. It has been a struggle to get nominations for the officers of CPRG. T-Berry's term was over last year and he carried an additional year as president because no one stepped forward—until now. That guide is Dusty Simmons and she would like to fill the role as our president; Dusty currently works at Tag-A-Long Expeditions. For vice-president Dave Focardi has stepped forward to replace Michele Hill; Dave is a guide at Sheri Griffith Expedition. For Vernal director, Herme Hoopes will replace Clark Hatch. For the Moab director, Eric Thompson will replace Dusty Simmons. Our sincerest thanks to all for serving past and present.

If guide members object to this ad hoc leadership please act by March 1, 2000, provide nominations and we will do an election. If you are interested in serving on the CPRG board in the future, or known someone who would, please let us know. We have many goals and objectives waiting for leadership.

## River Education Seminars and River Trips

**River Trips (guides only)**

| | |
|---|---|
| San Juan | April 17 – 21 |
| Westwater | April 24 – 27 |
| Cataract | May 1 – 4 |
| Dinosaur | May 1 – 5 |

**(RES) River Education Seminar (for everybody)**

May 5 – 6, "Boats and Boaters." A land-based river history seminar at the J. W. Powell River History Museum, Green River, Utah.

**Remembering Glen Canyon in Word, Song and Film**

May 7, a special public event to restore Glen Canyon
Moab, Utah; Grand County High School Auditorium

## Wilderness Medicine and First Aid Courses

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**Wilderness Medical Institute**; PO Box 9; Pitkin, CO 81241; 970.641.3572; www.wildernessmed.com

**Canyonlands Field Institute**; PO Box 68; Moab, UT 84532; 435.259.7750; www.canyonlandsfieldinst.org

# From the Members

Dear John,

As always, I enjoyed reading the most current issue of The Confluence, Volume 6, Number 2, Fall 1999. I found the article by Jim Strong, regarding the names of our regional rivers, particularly interesting.

As you know John, Canyonlands Natural History Association (CNHA) has been involved in the development of Plateau Journal, a regional publication dedicated to the interpretation of the Colorado Plateau. While I was serving on the editorial board of that publication, a question arose that has haunted me ever after. The question is that of the Rio Colorado—Red River place name.

Mr. Strong mentioned several times in his article that the source of this place name was from the Spanish term for red river. While I could never debate the "Big Red" nature of the river we now call Colorado, especially in the spring runoff, the Spanish translation for red river would be 'rio rojo' not 'rio colorado.' Colorado is in fact an adjective that means colored, it does not translate to red.

Upon consultation with linguist Louis Robledo of Brigham Young University, an even more interesting twist emerged when he said 'Rio Colorado' could be translated to mean either 'colored river' or 'river of changing colors.' While language, and specifically place names, are not an exact science, I felt that these translations more correctly describe the character of the river I have enjoyed so much while living here in Moab. Day to day, hour to hour the color and mood of the river seems to change. To me, this is so much more than 'red river.'

Thinking not only about the uniqueness of the changing colors of the Colorado River, but also of the vast array of colors to we see from the red rocks of Moab to the summits of the Rockies, I really value the rich linguistic depth of the term 'Colorado.' In some ways, I find comfort that a culture which some may define as simplistic, seems to be more adept in describing the natural world around them than we are today.

Sincerely,
Brad Wallis
Executive Director, CNHA

# Trespassing on the Indian Nation

*From a renewal notice by Darren Smith, the CPRG Grand Junction director.*

> In the name of professionalism stop supporting trespassing into the Indian Nation. It does not support our mission.

*Darren brought this topic up at our board meeting in Salt Lake City and we all agreed that the guides need to set a good example of professionalism by honoring tribal lands according to the wishes of the tribal council (s). To not would indeed be a compromise of our mission statement (see preceding page, first column). We ask all guides to please not camp or lead hikes on the Indian Nations without the permission of the tribal government.*

*There is also the issue of trespassing on private land while conducting a river trip, for example: Rock Creek in Desolation Canyon, in the vicinity of Moab, Green River, and from Grand Junction to Westwater, to name but a few.*

*Be a professional and know the boundaries of our public lands where camping and hiking is allowed by law.*

---

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Ellen Tibbetts '99

# Neverland

*Sometimes it's hard*
*To be a boatman....*

by Earl Perry
drawing by Ellen Tibbetts

It was a microkid river trip, and the toddlers were mobbing me. Swarms of toddlers. I felt like a male lowland gorilla with offspring draped all over him. Up in the camp, away from the beach area, were the single mommies: judges and attorneys, doctors, executives, engineers. Power women. In my delusion I thought they had sent their young down to the beach to get them out of the way while they broke camp. But the single mommies knew their business. The flood of the toddlers was to soften me up.

It worked. Draped with leis and lianas and garlands of kids, orchids and bromeliads of kids, feeling the way a tree does when the painted buntings hold a conventicle in it, I had a surge of sentiment. It was as if a Rakshasa had suddenly mastered me; I was dumbfounded to find my mouth open, and hear the fatal words slip out:

> You know, sometimes I feel like having a long-term committed relationship.

It didn't seem very loud, but then it didn't need to *be* very loud.

The toddlers continued:

> Westle Ian. Big westle now!
>
> Shoulder-wide. Kaila-wild-couch-bouncer wide on shoulders, Ur-rul!
>
> Url. Horsey-ride. Horsey.
>
> Earth Creature! Earth Creature. Roar! Get the Earth Creature!

The toddlers continued, but the single mommies did not. In an instant, their ears had pricked up. They milled about for only a moment. Soon they headed my way.

> *Hell,* I thought, hoisting a squealing toddler upside down by her ankle, *I can Einstein them easily enough.* I braced myself for the recoil, and called, *I'm sorry. I just don't feel the way I used to. I need more time. I need more space. I need more space-and-time.*

One of the younger single mommies flared off. But imagine my horror when the older, more experienced single mommies kept coming. Eyes wide, ears flapped forward, they were screaming,

> Long-term committed relationship!

For the first time, I felt a spasm of ... unease. Almost, of fright. Einsteining had never failed to stop them before. I parted the screen of toddlers and called,

> Actually, my feelings have changed. Friendship. I'm really only interested in Friendship.
>
> *That ought to stop them,* I told myself, *Right in their tracks.* But I was wrong, very wrong. On they came. Part of our sandcastle was collapsing from the vibrations set up by the thunder of their feet. *Friendship,* I shouted desperately. *Platonic Friendship.*

On they came, trumpeting,

> Long-term committed relationship!

It was appalling, but beautiful; so must it be when the waters of the bay recede, and the tsunami gathers itself out in the open ocean, and rolls in toward the unravaged shore.

I knew terror.

> *My god! Friendship didn't work. O my god!*

I fell back a few steps, wading through the clinging mass of toddlers adhering to my shins and thighs. Too late I realized it was a La Brea Tar Pit of toddlers. Flight was impossible.

I reloaded and screamed,

> Sex. Meaningless, impersonal sex. That's all I want. That's all I care about. I'm too shallow for you. Back furies, back harridans, back viragos, back succubae, back potential committed life-partners willing to hold space for one another's soul quests. Nothing but meaningless sex.

Most of them dropped. But incredibly, two came on, screaming their battle cry:

He'll change, I know he'll change, once he realizes how much he loves me.

The blood froze in my veins, and where my hair isn't tried to stand on end. They were almost on top of me. They were so close I could see their breasts heaving. One last chance: panic-stricken, I loaded and locked on my last round.

I screamed,

Meaningless, impersonal sex, and I won't use condoms. Never have!

+++++++++

The last two were down. The one within arm's reach was my favorite. I had talked with her a lot; she was humorous and direct. She did yoga and rode a mountain bike. I saw the breasts welling tautly from the sleek bathing suit. I saw the long singing curves of her thighs, leading upward....

I sat down, shaking from adrenaline and the backwash of terror. There was sadness.

*I could touch her,* I thought. *She's that close. Just sort of reach out. I mean, it's a trap, an obvious trap, any fool can see that. It Looks like a trap. It Smells like a trap. It smells ... good. It's just that I wonder, how does this kind of trap Feel?*

I steeled myself. I turned to the toddlers and said,

Tiger hunting. Hana, you're the mahout.

I set her on my neck and shoulders, explained that a well-trained elephant was guided by the pressure of the knees only, and emplaced a whole row of heavily-armed toddlers in the howdah on my back. I lumbered off on all fours into the tamarisk jungles of the Colorado River, trying to keep the toddlers balanced, hunting the shadowy and elusive chasm tiger, *Felis tigris abyssus.*

*Boy,* I told myself as I left the single mommies behind, *You're gettin' half a step slow for this kind of work. Don't never try that move again.* I looked back. I saw my favorite of the single mommies, again. She looked ... good. She looked ... very good. I caught myself wondering, *How does this kind of trap ... Taste?* but then the jungle of the river swallowed me.



# Announcing!

## International Day of Action!

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**Tuesday, March 14, 2000, at high noon**
**Carl Hayden Visitor Center parking lot**

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**Richard Hass**
**Katie Lee**
**Martin Litton**
**Ken Sleight**
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**email: info@drainit.org**

**For info on the international scene contact:**
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**Berkeley, CA 94703 USA**
**(510) 848-1155**
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**email: irn@irn.org**
**web page: www.irn.org**

# The Diary of Grove Karl Gilbert

## The George M. Wheeler River Expedition of 1871

### by George Simmons

*When George Simmons presented this manuscript to CPRG we almost fell dead. This is a very significant piece of literature that has, to our knowledge, never been published. The trip occurred in the fall of 1871, before John Wesley Powell's second expedition through the Grand Canyon. This is one of three factors which led to the decision by Powell to abandon the rest of his expedition at Kanab Creek in 1872.*

*Lt. George M. Wheeler was in charge of the expedition in which Grove K. Gilbert was the geologist. This is the third expedition to reach Diamond Creek; Wheeler rowed, towed and portaged boats upstream from Camp Mojave. The first expedition was by saddle in 1858 with Lt. Joseph C. Ives in charge; John Strong Newberry was the geologist. The second was by boat in 1869 with John Wesley Powell in charge.*

*This is the document which has the type locality for Redwall Limestone. Grove K. Gilbert is considered by many geologists to be amongst the finest. See The Confluence Volume 3, Issue 2, Spring 1996. The document also has many other significant entries which we will allow the reader to discover for himself. Enjoy!*

**Thursday September 14, 1871 Camp Mohave**

Started on horseback to find a quartz mill eight miles below camp and had a delightful ride over the bottom land, the best of which is cultivated by the Indians and made to produce corn, melons, squash, and beans. Cottonwood, true willow, screw bean, muskeet [mesquite] and a similar acacia with constricted pods abound, and a climbing milkweed. The Indians came trooping on their way to sit for their picture. On the west shore the range seems granitic with one or two volcanoes. On the east, hills of granite and metasedimentary rocks are covered by lava (collected) east of Boundary Cone.

The gravel at the edge of the mesa near the Boundary Cone is composed of this lava in large part but shows much quartzite and some gneiss and granite. Near the Post there is very little lava, much quartzite and some altered limestone.

The mesas are terraced in three steps below the Post, the terraces not differing greatly in height and sloping riverward thusly [sketch omitted]

Failed to find the mill.

Friday, September 15, 1871

Camp Mohave all day, making preparations for river trip. Solar observations.

We are to depart tomorrow for the upper Colorado. [tables of river depth and solar observations not included]

Saturday, September 16, 1871

Section [sketch omitted] of the Cañon of the Colorado on the high mesa west of the Little Colorado, from p. 42 [Geology report from the Lt. Joseph C. Ives Expedition of 1857 and 1858].

Turned over to be forwarded from Camp Mohave [presumably to Peach Springs].

saddle and circingle
water bridle
1 picket pin and rope
1 pair spurs
1 pair saddle bags
1 halter and strap
1 blanket and cheval

Saturday, September 16, 1871

We started our boats from Mohave today at 11:35 A.M. after having posed for a stereograph. "The Commodore," Mason has been discharged, and one James hired in place. As I write we approach Hardyville and I doubt not our camp will be made there. Our party consists of

Barge
- 1 boatmen
- 2 soldiers
- 5 Indians including Askut [or Asquit]
- 8

Boat No. 1
- Lt. Wheeler
- Loring
- Roberts
- 1 soldier
- McGeary
- 3 Indians
- 8

Boat No. 3
- Hamel
- Richardson
- Hecox
- Gilbert
- 2 soldiers
- 3 Indians
- 9

Boat No. 2
- Dr. Hoffmann
- O'Sullivan
- Pfifer
- 1 soldier
- Salmon
- 3 Indians
- 8

[This list totals 33 and omits one of the boatmen either James, who is mentioned above as replacing Mason, or Thomas Hoagland. One of these two men is the boatman listed as being on the "barge"]

Where we touch the south spur of Dead Mountain—Spirit Mountain—it shows a volcanic conglomerate roughly homogenous and showing no lamination. Erodes in grotesque but not bold forms. O'Sullivan photographed these from Mohave. The front line of hills in the picture is laminated coarse sand like that near Desert Springs.

Camped at Hardyville mill. Salmon's boat behind.

Sunday, September 17, 1871

Before breakfast examined a wash from the Black Mountains. The 24 first boulders gave

1 white quartzite
1 vein quartz (volcanic?)
1 (volcanic) tufa
1 basalt
1 lava like that (collected) below Mohave
3 lava (or quartzite) dark gray and homogenous
7 other lavas

This showing corroborates my impression of yesterday that the Black Mountain with Rhine [?] Valley Needles and castles is volcanic or rather lava over an axis of metamorphic rock as at Boundary Cone.

Today we pass in Pyramid Cañon through a cut gap in granite—gneisssoid and feldspathic.

I think on reconsideration that the spur of Dead Mountain we passed yesterday is granite. Mount Newberry may be set down as granitic. All the rocks adjacent to the river are granite, but the washes from the east bring lavas in some part basalt but mainly the typical Black Mountain lava. Also some quartzite as last night. Pyramid Cañon seems to be named from an obelisk of granite traversed by some whitish veins, said to be auriferous. Seen from the water it has somewhat this phiz [sketch omitted].

Above the cañon we camp. Found a large fragment of olla [Spanish for round earthen pot] or other earthen vessel of the Mukhoves [Mohaves].

Monday, September 18, 1871

From Camp 2 near Mount Newberry [Named after Dr. John Strong Newberry, naturalist of the Ives Expedition; Gilbert had previously worked for Newberry during the Ohio Geological Survey] to Camp 3 above Cottonwood Wash. Camps 1, 2, and 3 are in Arizona all. Mount Newberry and less confidently Dead or Spirit Mountain are of granite. The Black Mountains as every wash on the west side today has demonstrated is volcanic in its chief characters or rather in the chief part of its surface. The pinto surface and battlements are concordant features.

Looking forward toward Painted Cañon I see a number of black volcanic buttes, overlying everything except perhaps the mesas. Mount Davis is one of them.

The mesas rise in terraces as in Mojave Valley. The steps having the greatest height near the foot of the valley. This may be due to the more level character of a deposit from more sluggish water or a mere appearance referable to unequal erosion. The slope riverward would give the appearance if the erosion was regularly arranged in diminuendo.

Yesterday and today favorable winds and a deal of sailing. Gulls of small size. Ducks or geese in air.

Camped at dusk with the barge, the others being ahead. After supper and during a swim received orders to follow on and after a smart pull in the dark, reached Mr. Wheeler, etc., and finished the Stars at 11:40.

Tuesday, September 19, 1871

Remained half a day in Camp 3 which is just below Painted Cañon and then moved on. Painted Cañon is not a very startling affair in point or size but well deserves its name. Its variegated lavas are umber, ocher, black, and reddish. Not brilliant colors but in good contrast. Mount Davis just above has a covering and probably a mass of basalt (collected), and several buttes on the opposite side of the river have a similar appearance. They form isolated foot-hills to the mountain range.

Mount Davis has for a background the Black Mountains. Not near so black as it and plainly of volcanic surface.

Fine exhibitions of cemented gravel mesa in the vicinity of round island. Bold bluffs facing the stream 50 feet high.

The rocks through which Painted Cañon runs rise little or none above the gravel mesa.

The consolidated gravel was upheaved probably in common with the volcanic activity forming the Painted Cañon range. The shore profile is somewhat thus [sketch omitted].

Wednesday September 20, 1871

At dusk last night we had on our left a bold Basalt hill--one of the Mount Davis suite and from camp we could see another. The Opal Mountains look like granite, but I have not seen the wash yet to ascertain. Much of our way we have on one or other shore a bold, even overhanging bluff of gravel or river deposit standing often 100 feet high.

12 to 2 o'clock we passed a beautiful volcanic mountain in Arizona, a mountain banded with umber or vandyke brown, and orange lavas and piled up in turrets and of symmetrical verticality.

We camp at Eldorado Cañon. A five-stamp mill with 4 pans and 2 settlers and all accessories stands essentially in ruins, that is it is keeping itself and everybody (inclusive) that comes along packs what he fancies.

Rations for 14 Indians

½ cup flour morning and night each
⅓ cup coffee morning and evening all
⅓ cup sugar morning and evening all
6 lbs. Bacon morning all

## Grove Karl Gilbert, 1843 – 1918

Geologist of the U.S. Geological Survey, 1879-1918. Gilbert, who had been a member of both the Wheeler and Powell surveys, was a close friend and advisor to John Wesley Powell. Gilbert served as Chief Geologist from 1889 to 1892. Gilbert was described as "An authority in many fields and yet one who never assumed authority; a leader in science and yet one who never assumed leadership; neither power or glory did he seek, but the satisfaction of contributing his share to the sum of human knowledge."

2 crackers morning all
Dried beef q. s. m. [q. s. m is Latin for *quantum sufficito* or whatever suffices]

Thursday, September 21, 1871

This morning the main party goes ahead and leaves me with a side party consisting of

T. H. O'Sullivan
Frank Hecox
[George] Salmon
[Johnathan] W. Grinnel
Arthur Keegan
3 Indians

Rations for 7 days; to connect above Callville.

The mail carrier from Mohave to Salt Lake via Callville weekly passes Eldorado Cañon and we left letters conspicuous on his trail.

Table Mountain the flattest of the flat volcanic mountains. Everything looks volcanic ahead---red and brown and black over a purplish gray.

We make camp several miles up the cañon but don't know whether we have passed Roaring Rapid. Cool water and clear in a pool separated from the river. But the river is of the color of red clay and thicker than the Missouri itself.

Our photos today are Cabinet—

Gibraltar from below. The gate of the Black Cañon.
Gibraltar from above, looking toward Cottonwood Valley

Stereo—
Gibraltar from below gate of the Black Cañon.

The wind was of great service today carrying us along gaily except at three or four rapids. Contra. it interfered with photography and kept O'Sullivan in a perpetual state of profanity.

I am a little disappointed in the Black Cañon as I had based my ideas on Ives' view of the entrance [drawing by F. W. Egloffstein from sketch by Lt. Ives, Part I General Report, Plate V facing p. 80] of which I cannot find the original. Gibraltar affords data for half of that picture but the other side is wanting. The points are comparatively few where it is impossible to land a boat on one side or the other of the river. As a rule one side is accessible and the other not. There is no mile in which the cliff cannot be scaled on both sides.

Geologically the cañon is an eroded channel through lava umbrous red and brown or burnt umber and burnt Sienna in surface color, but gray on fracture. In a few places near the foot of the cañon there is interstratified ochre-yellow volcanic conglomerate (conspicuous at the left view of the gate). The lavas too are conglomerate in structure.

Friday, September 22, 1871

Had a glimpse of 2 [desert] sheep while at breakfast. We all rushed for our guns, though they were far beyond range, and they disappeared . Two Indians started out and obtained a shot that did the sheep no harm [four pages of sketches omitted].

| | |
|---|---|
| Dead Mountain | S 13° E |
| Davis Mountain | S *33° E* |
| Table Mountain | S *65°* E |
| distance *5* miles to | N *55°* E |
| Gibraltar | S 22° E |
| Camp Big Horn | N 20° W |
| ½ mile distant | |
| A Table Mountain highest | N 10° W |
| point 15 miles | |
| Acute point | N 16° W |
| in range 25 miles | |
| Acute point in range | |
| 12 miles | N 60° E |

These are magnetic bearings from a peak near Camp Big Horn.

Everything appears volcanic except distant mountains at the north and perhaps the Opal Mountains. The lava I start on bears many boulders of granite and gneiss.

| | |
|---|---|
| Cistern (barometer) at Camp | 29.330 in. |
| Aneroid at Camp | 29.120 in. |
| Aneroid on hill | 27.900 in. |
| | 1.220 in. |

Corresponding to 1,325 feet the height of the hill above camp.

This gives Gibraltar about 700 feet. Table Mountain must rise above camp 2250 feet and a few other points 1750 feet, but the buttes will not average higher than the one climbed and the general height of the visible walls of the cañon is but little over 1000 feet. The butte opposite camp is about 900 feet. Above camp the walls are low for a space.

Below high water mark the surface of the rock is blackened.

Above Camp Bighorn and thence to Camp 2 the immediate walls are low and the view from the river is more extended. Looking ahead from Camp 2 we see walls closing in again and the portal is so impressive that we camp so as to photograph it in the morning.

Approaching this camp and for two miles below, the walls are of a peculiar old lava or young plutonic rock, highly feldspathic and with the feldspar in large crystals. It is divided by parallel curved joints into sub-vertical strata a few inches thick and decomposed on the surface. Fragments of this imbedded in later lava I have alluded to above as granite and gneiss but the identification now seems doubtful and the case requires examination.

Rapids are caused on this river chiefly by washes; not entirely however. A notable example is afforded by Roaring Rapid. A wash here comes from the Nevada shore and carries a great amount of large boulders

athwart the current. At some time these have been so far removed as to carve a deep channel above so that slack water prevails above the present dam. Other rapids are at narrow points in the gorge where the walls are falling in and so obstructing its water.

Saturday, September 23, 1871

From Camp 2 to Camp Keg (3) of the Black Cañon Series.

Most of the day was spent in photographing but we managed to get a few miles ahead toward night. The cañon in this part is in better accord with the idea I had conceived. The walls are not so steep as fancy (and Ives) had pictured them nor are they so high but they are for considerable distances unclimbable and we found camping ground so scarce that our search for it was prolonged into the darkness. While supper was cooking a mysterious object appeared floating down the stream. Opinion was divided as to whether it was an Indian or a box and it was hailed and shot at in the division of sentiment. Finally after a brisk excitement of ten minutes it was overhauled and found to be an empty barrel of bacon discarded by the Main Party above us. Thus ends the second Battle of the Kegs.

The general section along here is [sketch omitted].

1. Gneissoid lava (?) described above
2. Red lava
3. Brown lava

Sunday, September 24, 1871

In the deepest and blackest part of the Black Cañon from Camp Keg (3) to Camp Snug (4) a distance of not over 3 or 4 miles. O'Sullivan took photos at Camp Keg and again further up at a point where a side cañon gives the impression that the main cañon is narrower than it is. Here we found a large pool that we made use of for reflections. Took a ghost picture.

Rock all volcanic in the walls but the washes from Arizona bring pale granite and the bars show limestone.

Overtook the larger party and let—them go ahead again today.

Monday, September 25, 1871

From Camp Snug (4) to Camp 5 at the head of Black Cañon, passing two camp fires of the other boat parties at different places. On the way we took some views including one looking up. At the head of the cañon [we took] photos of the entrance, of a table mountain and of camp.

The cañon holds its features to the end, but is higher than below. For today's march it is all lava of the beds 2 and 3 [red and brown lava]. The Table Mountain has several hundred feet of basalt above, the talus of which lies against yellow and red soft beds, probably of volcanic ashes.

Hecox climbed the mountain back of camp today and observed with large Aneroid

| | |
|---|---|
| Hill | 27.320 |
| Camp | 28.920 |
| | 950/ 1.600 |

This gives 1725 feet as the height of the wall at the entrance of Black Cañon. The Table Mountain is 200 feet higher and the mountain climbed is overlooked by higher [Mountain?] at the south. The highest wall in the cañon is not over 2000 feet and probably not so much.

Sand worn rocks. This afternoon I examined the best exhibition I have seen of rock worn by blown sand—on the talus of the cañon wall near camp. The rock is sub-homogenous lava and lava breccia, and is worn in such manner as to give an appearance of solution influenced by grain in the stone. The surfaces all bear relation however to the position in which the boulders lie, being deepest on the windward side and diverging where the air currents divide.

The foreground of the Table Mountain view has red and yellow soft crumbling lavas.

Names of Indians in the Boat Picture

Eul - l - táw
Tah - wáh - gah
It´z - l - quáh - rah
Eelitá
Taw´aga
Itsiqúara

older than No. 3 and probably synchronous with No. 2 [the red and brown lavas].

Tuesday, September 26, .1871

| | Magnetic [bearing] |
|---|---|
| Acute peak in range, 10 miles | S 75° E |
| Acute peak in range, 15 miles | N 8° W |
| Spring Mountain Peak | N 60° W |
| Table Mountain | E N E |

The gravel that underlies Fortification Rock and Table Mountain, is newer than Black Cañon lavas and older than the basalt of those peaks. The river bluffs above are of more recent gravels. Think the lower (red) bed of Table Mountain is lava—the yellow above gravel. The same beds north of the river bear the same relation to the basalt that forms the Table Mountain there.

At Fortification Rock were pictured the Butte itself the sculptured gravel opposite and some sand-worn rocks. We left the spot at about 1 P.M. and to Vegas Wash—2 or 3 miles—had to tow up a steep hill made by the debris from the wash. The slack water above this dam gave us easy work nearly to Callville, a distance of ten miles(?). All the way the banks show gravel bluffs of coarse and fine material, half consolidated so as to give rough semi-castellated forms.

Wednesday, September 27, 1871

Our camp last night was at Callville, a deserted city of a dozen houses, all roofless. Two are squarely built with mortar, the rest of loose stone. Lots are fenced in with

stone.

Left letters for mail riders who meet here.

O'Sullivan's hand so sore that we make no pictures here.

Just above Callville is the head of the valley we spent yesterday in. Here is the greatest exhibition of gravel we have seen not less than 700 feet high and. lying north of the river principally. A mile above Callville carries us up a very steep rift and. brings us in still water to Camp Layover at another mile.

Layover Camp (11) is in Boulder Cañon a mile from its mouth where the sides are steep but not high. Hamel rehearses his woes and exhibits his sores and I help him make a section of the river at a point where it can be little broader in high water [section measurements omitted].

Thursday, September, 28, 1871

From Layover Camp (11) to the head of Boulder Cañon. Boulder Cañon is identical in style with Black Cañon but much shorter. Gneiss and other metamorphic rocks are distinctly developed in it. Rock salt and incrusting salt occur in its banks. The section next page expresses my present view of the sequence of rocks:

1. is granite or at least ancient plutonic rock upheaving.
2. a series of metamorphic rocks chiefly gneiss [sketch omitted].
3. and 4 are unconformable with 2 and are red and brown lavas gray to purple in fracture.
5. is a later volcanic (3) product showing at the head of the cañon and in the valley above soft and pale yellow and capped near the Cañon Range by
6. a red basalt

All the rocks within the cañon are pale ocher in sheltered places and black to umber on projecting surfaces. This remark refers to the appearance at a distance and cannot be applied to the details of the surface.

Friday, September 29, 1871

From Camp Dust at head of Boulder Cañon to Camp one mile below mouth of Virgin River. At Camp Dust we were overwelmed with fine and coarse sand all evening until late at night. In the morning I found some sand worn rocks as at the head of Black Cañon.

On further examination it looks as though 6 [above] might be identical with 4. A still more recent sediment is a red water laid conglomerate seen only near the mountain where it dips west toward it. This bed may be equivalent to other beds in the open valley and separated by convulsion from them. Leaving the mountain slope we strike on the north bank an amygdaloidal basalt not rising to any height near the river and probably coeval with the low butte that rises a mile and a half northwest from our evening camp. In the evening I visit with Lt. Wheeler a salt well near the butte and a [sketch map omitted] mile from camp. The sand worn pebbles on the mesa are very interesting and serve to account for markings that have puzzled me heretofore because I could only suppose them due to peculiar atmospheric conditions. The effect could hardly be produced when meteoric decomposition wasrapid or rain frequent.

Notes on well [sketch and part of description omitted].

The upper surface of this gravel is covered by pebbles curiously wrought by blown sand. Carnelians too are common.

The strata at the sides were evidently formed continuously with water at a high level and have been undermined by a subterranean current induced by the subsequent drainage. The walls are of undisturbed. gravel and as steep as it will lie.

Water salt almost as the ocean. Felt but did not taste alkali. It is possibly derived from the Virgin River but not, probably. Water with a free outlet does not force its way through sand beds. Some water we saw trickling through gravel on the river bank probably comes from this stream, and it is probably merely a course along bedrock of water accumulated in the gravel mesa. The salt is derived from all of the sand of the region.

Saturday, September 30, 1871

This morning paid another visit (from Camp Virgin River) to the Salt Well with Richardson to sketch and Hecox to read barometer (stupidly). Whatever may be his result I record it as evident from inspection that the water of the well is not lower nor much higher than that of the river and that the depth of the open hole is not far from 45 feet at the low (river) side.

Mojaves and Piutes last night talked, laughed and gambled with each other in our camp. Today after we were well under way Eelitaw announced that he had overheard the Piutes planning the shooting of the Mojaves from. ambush up the river. So we had a mild panic (chiefly our invalid) and concluded to make camp with the other boats tonight though it cost us two hours of fair wind to wait for them to overtake us.

At intervals all day we have been in sight of the Virgin Range, not near enough to see more than that the rocks are obscurely stratified and contorted, whence metamorphic is inferred. Tomorrow we shall see some rocks that have the same distant aspect as these, q. v.

At night we approach the Cathedral of the Colorado and it is resolved to wait and photograph it tomorrow.

Sunday, October 19, 1871

A mile of travel early and than a delay until 1 P.M., photographing the Cathedral. We waited for a favorable light.

The Cathedral I guess to be 600 – 700 feet high, a mass of half-cemented gravel and sand with one belt of basalt at the base of the principal tower. The whole is a remnant of a gravel formation that has filled the valley formerly. The absence of marine deposits on the west flanks of the Black Mountains leads me to suppose that the retaining wall for this gravel-spreading was of rock, the cañons, Black and Boulder not having been cut through. This gravel era was interrupted or interspersed

**George Montague Wheeler, 1842 – 1905**

In 1869, Wheeler, 27 years old and three years out of West Point, began a reconnaissance south and east of White Pine, Nevada, to obtain data for a military map and revived the interest of the Army Engineers in mapping. From an article by William Rideing in *Harper's New Monthly Magazine*, May 1876, p. 807.

by basalt. The eruptions forming hard beds that form frequently the crests, tables and combs of residuary gravel buttes and mesas near the head of this valley.

Three or four miles above the Cathedral we start into a cañon through a metamorphic range (the Virgin Range) the general dip of the rock is anticlinal and its character gneiss and gneissic quartzite. Navigation occupied so much attention that I had little for the rock. Through the first half we sailed and through the second rowed. Finally at the head we overtook the other boats at a long stiff rapid that we did not attempt on account of darkness. The superiority of management of the barge as compared with No. 1 was conspicuous as they went up this rapid where everyone put his best foot foremost. Richardson steered No. 3 up by moonlight.

Monday, October 2, 1971

This morning we put on a heavy line and towed up our boat.

Palisade Rocks

Day before yesterday at the point where we stopped to wait for the other boats we passed under a low palisade on the south bank composed of massive breccia of gneissoid (?) rock (collected). From the massive character of the face of the bluff I infer doubtfully a volcanic origin of this formation. The stone itself will bear study.

Coming up the long rapid (the first long and swift rapid of our trip) we emerged from the metamorphic cañon and entered. a small valley bounded west, north, and south by metamorphic or at least highly inclined sedimentary rocks, and east (visibly) by a high gravel mesa. Adjacent to the river are gravel mesas of two distinct epochs, the lower being red. These are in one sense unconformable. The red was eroded deeply before the deposition of the other [sketch omitted].

General Ideal Section

1. Red gravel
2. Gray gravel and sand
3. Red rock

[sketch omitted]

In places the gray overlies the red after erosion and in general we may say that the red was succeeded by a low water system, succeeded in turn by a higher.

At several points the upper gravels are seen to be interstratified with basalt flows, or rather, at several points I saw the same intercalated flow 10 – 20 feet thick.

We camp (tin advance of the others where we command a view for morning photography) I set a goose to stewing, a goose that was shot by Hecox 99% and O'Sullivan 1%.

Tuesday, October 3, 1871

Yesterday Halitauwa had a talk with some Piutes on the shore, and obtained from them a melon and doubtless information that he did not divulge.

Photographs this morning: 1st Cabinet and stereo of highly inclined sedimentary rocks through which the Colorado flows in a monoclinal valley of erosion.

2d. A dry wash seen across the river [sketch omitted].

General section of photo

a, a series (200 feet) of various rocks but chiefly sandstone, consolidated red sandstone.

b, a series (500 feet) of various rocks thick-bedded. Includes chiefly limestone secondly quartzite.

c, a bed of soft gray shale.

The strike of these beds is very straight and N 20° E, their dip 45° to 6O° E.

Two niles north the river channel turns obliquely to the right, cutting across the b beds while the monoclinal valley continues to the north as the channel of a wash that pours down detritus to dam the river very seriously.

Turning into this oblique channel I get a continuation of my section of rocks drawn on page 37 [omitted].

a thin-bedded sandstone, etc. = a of page 34 [previous column], 200+ feet.

b = b of page 34. Heavy limestone beds, blue gray within and gray, snuff, vandyke brown, etc. within 600 feet.

c thin-bedded sandstone, etc. of many colors, at top chiefly yellow sandstone 600 feet.

d Red sandstone, friable equal in quality that of Cottonwood, massive and changing to 800 feet.

e yellow sandstone like the Cottonwood 800 feet.

f must be described tomorrow.

We encamped at a rapid and photograph it trying unsuccessfully to catch a boat in its passage.

Our lunch—rather late—was under a bluff [sketches omitted, including Beaver Rapid and Grand Wash] of yellow and red sandstone and our supper not a mile away and in plain sight of it [sketch omitted] [spelling of two Indian names omitted].

Back of our camp was a low bluff or basalt—detached masses of columns falling down from the undermining of the supposed sand beds. Above them on the same side is a large wash (see map) the largest we have yet seen. Its grade is low and its bed broad. From it comes percolating water that rises in a series of springs along the Grand Wash [sketch omitted] river bank. A great mass of gravel from it blocks the river and makes three rapids. On the upper the barge stuck at night and had to be relieved of her cargo. Ryan and an Indian were hurt in the melee. From our camp 40 rods below we went up to their assistance.

Beavers tracks plentiful and Hecox saw one by twilight. I watched for them in vain.

At our morning camp the limestone (framing this foreground of vertical strata view) is finely sculptured by blown sand as well as bored by potholes. The stone takes a beautiful polish and I secured a number of splendid specimens.

Wednesday, October 4, 1871

Sent help again this morning to the barge who reciprocated. While this was transpiring O'Sullivan made two views of basalt columns, one of fish-hook cactus, and one of muskeet [mesquite] and Nitchiquava whom I persuaded to sit for his portrait.

At the head of the difficult rapid we enter a cañon at first across and soon with the strike of the strata. I am disposed to believe a fault exists at this point so that the limestone and sandstone of the bluff we cross are the repetition of b, c, and d

(Section Page 37)

b′ ! massive limestone, gray blue within; variegated without, but umbrous in the distance, 500+ feet, +

c′ yellow sandstone, crossbedded, 150 – 200 feet.

d′ red sandstone, crossbedded, 500 + feet.

e′ yellow sand, 100 feet.

On the upturned d′ beds rest gravel beds that continue all the way to the Crossing and to the Great Mesa front.

Reached camp about 1 P.M. and found letters from Emma, Grace, Howell, and Bill.

A trip to the mesa back of camp:

Ist. I see no distinctive great wash here in this north/south valley, but think the wash of last night must be the one known as great wash.

2nd. The edge of the Great Carboniferous Mesa is not due to erosion, but to a dislocation with a north/south trend [sketch omitted].

This is the section of rock for yesterday's, today's, and the next day's travel.

The wall has the right to all the adjectives (except numerical) that have been given to it.

The gravel that forms the valley mesas has been formed and reformed in a manner indicating something besides agradial drainage. It is not however highly inclined and perhaps not at. all disturbed. The lower gravels are redder, perhaps because more of the sandstone then contributed to the formation (poor guess).

The barge reached camp at 3 P.M. and so the entire water party got in to the crossing rendezvous in time.

Flour
Yeast Powder
Hard bread
Bacon
Beans
Rice
Sugar
Coffee
Cans
Vinegar
Pickles
Pepper
Salt
Soap
Matches

| | Pilots | Keegan | Pfifer | |
|---|---|---|---|---|
| Plates | 5 | 1 | 2 | 8 |
| Knives | 7 | | 1 | 8 |
| Forks | 5 | 1 | 1 | 7 |
| Spoons, large | 3 | | 1 | 4 |
| Saucepan | (overboard) | | | |
| cups | 5 | 1 | | 6 |
| Kettle | 1 | | | |
| Pail, small | 1 | | | |
| Frypan | 1 | | | |

Oven for Sgt. Eisenbise
[two Indian names omitted]
Flour 1 cup a day each
Sugar Coffee Salt
Bacon [?] each
Cracker each per day

Thursday, October 5, 1871

In camp at the crossing of the Colorado. In the course of the afternoon the land parties arrived and were ferried over.

Had a long talk with Marvin and Ogden. [A. R. Marvine, a geologist with the Wheeler Survey in 1871, but not on the Colorado River trip.]

Packed a box for Truxton Springs's

Hence the River party takes but three boats, each with 15 days' rations for its 9 men; Lieutenant Wheeler, Mr. O'Sullivan and I command the boats. My party to start in the a.m. consists of

G. K. Gilbert , Geologist
E. M. Richarson, Artist
Frank Hecox, Meteorologist
Richard W. James, Cockswain
Thomas Hoagland, Cook
Private Arthur Keegan
Mojave
Mojave
Mojave

[omitted: barometer reading for section at mouth of Grand Canyon, small sketch and description page mostly blank, description of section at mouth of Grand Canyon. Section published in Wheeler report, Vol. 3, Geology p. 162-163, Section VII]

The general dip of the rocks is northeast. The mesa rises a little toward the south and drops off to the north. The hard lime that caps it is smooth and bare of soil though as well covered by vegetation as the most of the country.

"Rat-tail" Cactus [Ocotillo] is a bush branching at the base and sending upward a dozen shoots [sketch omitted] all armed with strong spines as frequent as those of the osage orange. The leaves are obovate lanceolate and shorter than the spines. The branches rarely divide.

Friday, October 6, 1871

I propose to call our boat (No. 3) the *Trilobite*. We managed to get off from Camp Crossing at about 10 a.m., just in time to miss the swimming of the mules. Mr. Marvine accompanies us so far as to get a glimpse of the mouth of the Cañon and then returns. We camp outside the Cañon and Hecox and I start to climb the wall. Hecox sickens (morally) at the first third of the climb, and returns. I do not reach the top until after sunset though I started at about 1 P.M. It is the hardest climb I ever undertook.

Saturday, October 7, 1871

Last night I spent alone on the mountain at the foot of the Big Cañon. Having no blankets I built a little fire in a sheltered spot among the rocks and hugged it all night, getting little sleep.

The first thing that day light shows me is that I am on only the first terrace and the second rises 5 miles to the east and trends a little south of east. I cannot yet tell whether the Colorado cuts it. There can be no doubt that it consists of yellow and red sandstone thus: [sketch showing yellow overlying red omitted] and the best guess I can make at its feet is

| | |
|---|---|
| Yellow | 600 |
| Red | 1200 |
| Total | 1800 |

There is a dip of this mesa toward its base so that it does not tower more than 1500 feet above this point which seems to be 4000 feet above the water. The magnetic bearing of a profile of it that may be 20 miles distant is S 71° E of a very distant profile, S 67° E.

The wash opposite the camp of the land parties last night comes from this mesa a few miles from here. It is not easy to be sure from this point, but it looks as though the great wash made into the Colorado at beaver Rapid.

The Wash Valley lies between the Virgin Range and. this mesa front, and is very broad. There are many basalt flows on its western side none to be seen on its eastern. Here is the limit of disturbance. I will redraw my section p. 41 with trifling amendment thus:

The ridge b terminates a little north of the river and runs not very far south. The ridge is not conspicuous [sketch omitted].

The gravel accumulations in the Wash Valley are immense and prove that a high barrier has once contained the waters of the valley. The rise in going south in the valley is rapid and a point cannot be distant whence the drainage is southward. [continuation of geologic section at Grand Wash Cliffs omitted].

Reached Camp at about 1 P.M. with a big tired on. Whiskey coffee and rest brought me around however. The south shore is festooned and covered by calcareous tufa, in places still moist. A great deal of water is now flowing from springs along the shore.

Broke camp about 2 P.M. and worked up the river a few miles, passing springs.

The granite that we had at the mouth and which I neglected to collect disappeared on today's march and. the strata descended so as to bury No. 2 [Tapeats Sandstone] below water. I feathered out my collection to represent the great section but still left the representation meagre.

Sunday, October 8, 1871

This morning we got ready early and I walked back to meet Lt.. Wheeler who with O'Sullivan had camped a mile below. With him I revisited the springs on the north shore and we named them.

A large one of the crater style with flowers we called Tufa Spring and Tufa Springs would be a good name for the group. Another larger one with a fantastic canopy of tufa is Grotto Spring.

A third is Baptismal Fountain.

A fourth (now dry) and hanging against a larger one is the Holy Water Fountain.

A dripping spring where tufa a foot from the water projects far over it. Starting our boat along we find yet other springs on both shores. Many of them voluminous. At one are some scrubby trees a foot or two in diameter but with the habit of the water willow. The leaf is small and unequally cordate [sketch omitted] the leaves on sprouts being rounder than those on old stems.

Verdure is to be seen at many points on the bank and referable to springs. It is confined however to the sandstone doubtless because the limestone is not so pervious [barometric readings omitted].

In the afternoon Lt. Wheeler and I came to a rapid where we deemed it advisable to wait for the *Picture*.

I climbed the bluff to Old Snuffy [one of the brown dolomite tongues in the Bright Angel Shale]. Near the water line are rocks with scolithus, loosely aggregated sandstone, Potsdam sandstone? It must be 75 feet thick on the granite [sketch and description of geologic section omitted].

Copy of Order, Camp No. 20, October 8

Plan from crossing of Colorado to mouth of Diamond River, 65 miles. Have reached a point 60 miles from Diamond River on the eve of the 8th. Diamond River should be reached eve of the l6th. Number of days (9, 10, 11, 12, 13, 14, 15) = 7 – average per day = 8 ½ miles.

The boats should be within short communication from this point until a distance of 15 miles when it will be expected if nothing remarkable happens that there will be no physical obstacle to the reaching of Diamond River.

This point must be reached on the evening of the 10th inst [in nomine Sanctae Trinitatus, in the name of the Holy Trinity].

The boats may each run independent—

Mr. Gilbert should camp with Lt. Wheeler at two points between this and Diamond River—1—evening of 10th; 2 about midway.

If it is considered advisable one boat—light will be sent ahead to be some 48 or 72 hours from mouth of Diamond River and this will complete the time alotted for river

exploration.

It therefore becomes necessary to lose no time that can be devoted to the collection of details.

finis

Monday, October 9, 1871

Last night all three boats camped together and this morning started in inverse order of numbers. The *Trilobite* did not however keep her lead, but was passed by the *Picture*.

Last night observed the stars and this morning found a quantity of sand on bed clothes and in eyes, ears, and mouth. Plenty more tufa springs this morning, all on the north side. Afternoon we see more of the subadjacent granite, now a flesh colored variety. For a mile it shows in both banks and it rises in places 30 feet above water. It is beautifully wrought in potholes and resists the erosive forces better than the sandstone though not much better than the superposed sandstone that up to the scolithes beds is 100 feet thick (guess) and coarse, purple red; cross-laminated, and black below high water line.

Tuesday, October 10, 1871

Our Camp (21) last night was on the debris from a large wash from the north—the largest wash we have seen in the cañon. The gravel is piled up 40 – 50 feet above the water though it is covered by high water. Along the whole length of it is a rapid with a fierce one (that we dubbed the Cascade) at the head. In attempting these rapids last night by No. 1 boat a failure and Roberts hurt—it is feared seriously. This morning Panambona was hurt near the same place, striking his chest against a rock. When we finally got up the cascade it was about 11 A.M. solar time.

A low arch of granite was visible near Cascade Rapid and not far above it began to be continuously visible. Through the day it has risen higher and higher until now (5 P.M) I think it is 200 - 300 feet above the water. Rapids today have been fewer and higher than yesterday when 15 were counted. The granite stands up at 45°, the sandstone (Potsdam?) above it is nearly as steep, in fact steeper at base and the shales make a base for the limestone wall that averages about 45° [sketch omitted].

This is the profile or something like a true scale so far as the angles of slope are concerned.

The tufa has not formed a wall anywhere today but I see a small line of it ahead. Neither have I seen any springs along shore. The washes I have entered so far all have running water in them though not very much. At the middle of the day's march is a basaltic lava flow occupying an old channel cut in the sandstone.

The section on next page is almost a sketch of the view given by a side canon of the arrangement of [sketch omitted] the different beds. The base of the lava is about 200 feet above river and 50 - 75 feet thick, and flows (according to O'Sullivan) from the north shore though the sketch is made on the south. I could see (certainly) no remnant of basalt indicating that it flowed from the south. The arrangement of the columns is noteworthy. It seems as though they had been [sketch omitted] formed normal to the cooling surface.

Encamped on the granite (Camp 22) because night left no time to pass a rapid and reach sand as usual.

Wednesday, October 11, 1871

Direction of great joints of the red wall limestone (approximately) N. 30° W. and N 75° E. There are no well marked systems of joints in the stratified rocks. These bearings are along pretty continuous walls of the "red wall limestone" as I may as well designate the heavy mass that it troubled me so to climb.

A mile from the sandstone cliff opposite our camp where Messers. Wheeler and Hamel and I have climbed for a view, etc., my principal point of interest is a black vein in the granite that proves to be basaltic lava. It is about 6 feet thick where visible and apparently tapers upward, though this could not be definitely ascerted as it is lost in the debris.

The granite adjoining the lava is unaltered. The lava seems homogeneous throughout and neither close nor distant inspection revealed any prismatic structure.

We find as we proceed two long stretches of rowing water when granite walls hold the river narrow with very little debris at the foot.

A sharp rapid intervenes and at the head. of the upper a rousing rapid that gave us one too many.

The leading boat, McGeary at the helm, Hoagland at the pole, wrecked or rather swamped and upset scattering its freight along the bottom and top of the river. I started at once with Hecox, Salmon, and Keegan and Drew as oarsmen to save the floating debris. We managed to pick up the oars and some blankets, baggage and others were saved along shore, but 3 or 4 beds, 3 pairs of saddlebags, and a considerable amount--nearly all the rations were lost. The most serious losses were those (continues after tables below)

P.M.
- 1 ½ cups flour
- 1 ½ cups coffee
- 1 ½ cups sugar
- beans

A.M.
- 1 ½ cups flour
- 1 ½ cups coffee
- 1/12 cups sugar
- 1 3/4 lbs. bacon
- 2 crackers each
- dried beef

of the Record of Astronomical Observations of Party 1 and of Lt. Wheeler's basket of papers and notebooks. My only loss is of the Macomb Expedition Map that Dr. Newberry gave me.

Some of the men are demoralized a little by the rapid and tomorrow I have volunteered to steer a boat up.

The granite continues to grow higher and is beautifully

sculptured by potholes and sand action on. Much of the surface is smooth and glazed.

Thursday, 0ctober 12, 1871

This book opens under a cloud at Camp 23 in the Big Cañon, for last night occurred the accident that lost valuable books and papers and this morning all hands are at work repairing and searching. As the sextant books are lost I have given observations a place here [observations omitted].

Did I forget to record that on the 9th inst [in nomine Santae Trinitatus] we passed a monument of stone built by white hands, .5 feet high by 2 feet square. Lifting the top stone I found under it a box and a piece of paper. On the paper is written:

Sevintz Cañon
Sevinta Mountains
May 5 186(4)

This point was reached by party of men with ( P ) [?]. We believe that we are the first and only party who have explored the cañon this high.

( ) following ( ) [?]

and on reverse side:

| | |
|---|---|
| James Ferry | La Paz |
| Chas. Fisher | Mohave |
| C (W) Stoddard | Eldorado Cañon |
| ( ) D Gass | Eldorado Cañon |

[Lt. Wheeler had met 0. D. Gass in 1869, Grand Canyon].

In the afternoon after astronomical observations and caulking we take all things up again to the rapids and with Mr. Wheeler for bowsman I take boat *Picture* up the rapid. We ship water where McGeary did but the large force on the rope pulled us through safely. Our camp at the head of the rapids.

Friday, October 13, 1871

From this point of time the boat party is divided. One boat goes down stream with dispatches and exhausted and demoralized men. The *Picture* and *Trilobite* go on up with 10 men (7 white and black; 3 red) each. Salmon being sick and James demoralized I take the tiller in strong rapids and Hecox is my efficient assistant. During the day we make some lively transits. One involved a run out with the line on the thole-pin and then a jerk ahead after throwing it off. The boat was often so highly inclined on a fall that to go forward one must climb as though up stairs.

The rock character continues unchanged. A little basalt at two points of old river bed high (200 - 300 feet) above the river. The carving (pothole wise) of the granite is most beautiful and very many potholes are shown in section I and 2 are type forms, 3 and 4 are [sketch omitted] oddities. Very commonly the bottom is worn out (5) probably after the falling off that left the section a knob or ridge in the bottom. (2) is exceedingly common and suggests a cutting on the principle of the annular drill.

Saturday, October 14, 1871

This morning visited a creek opposite Camp (25) and saw Indian gardens. Left a paper. Gneissoid rocks are commonly mingled with the granite (collected specimen). Here too a little basalt on the cliff on the south side.

At noon we encounter again the worst rapid we have met and this time are compelled to make a portage of boats as well as freight. Above the rapid the current for a few rods being too swift to row and the cliff perpendicular so that towing is out of the question, we have "crept" in the old Genesee style and laid a rope to warp up by with loaded boats.

Picked up a dead duck today and saw a flock of live ones, the first in the cañon I believe.

At the last mentioned rapid more gneiss and more basalt.

The principal birds in the cañon are bats! and they can be seen at all hours of the day and night. The steep walls do really shorten the day in such manner as to delay us somewhat. Not only the granite, but even he limestone is steeper. The lower sandstone has increased in thickness.

The shales are invisible owing to the greater comparative steepness of the granite. Some granite here has a very peculiar aspect too large in pattern to be represented by a specimen we can afford to carry: [sketch omitted]

Some whitish (concretionary?) spots are suffused by mica with approximately all in the same plane, but in their general distribution presents a stellate-dendritic appearance is represented. These occur at intervals through a great mass of granite.

Camp after dark on some sand. Astronomical Observations. Camp 25.

Sunday, October 15, 1871

Inventory of provisions on hand

| | White | Red | Total |
|---|---|---|---|
| Flour lbs | 20-5 | 25 | 45-60 |
| Bacon lbs. | 0 | 1½ | 1½ |
| Hard Bread lbs. | 1½ | 6½ | 8 |
| Coffee lbs | 2¼ | 2 | 4¼ |
| Sugar lbs. | 3 | ½ | 3½ |
| Rice lbs. | 2½ | | 2½ |
| Pears cans | 1 | | 1 |
| Beans lbs. | 0 | 1½ | 1½ |
| undivided coffee | 8 | | |

This is for the *Trilobite* only. The *Picture* is much better provisioned, but it is doubtful whether we can fully ration both for five days. The ration matter may yet turn us back.

No geological points of novelty. I collected some rounded pebbles from potholes today.

Our progress is but four miles over a series of rapids. Toward night we reach a double rapid, two rapids with a short interval of water that can be crossed.

On the lower half the rope broke and let Hecox and me drift own stream. We did not discover that we had our line dragging until it anchored us in comparatively slack water below. Then we pulled in the rope and made for the nearest accessible shore. We had shipped some water and put the cargo ashore to save wetting. Made coffee and beds.

Monday, October 16, 1871

Hecox and I were out of camp [27] last night on account of boat accident, and the camp missed us for we had food and beds, and our boat crew went without either. They had however some bread in the morning when we came up and some of them made up all deficiencies by a good hearty grumble lasting through the day. Tonight Lt. Wheeler puts us on short allowance of flour—four pounds a day for seven men (the full ration is 7 lbs. 12 oz.). Our bacon is gone, and beans and rice are scant, but coffee is in plenty and will outlast every other item. Our flour will hold out at this rate six days and those must bring us to the Diamond River or back to the crossing, the former if possible. I make out from Ives map and Newberry's section that we are not to expect any great change in the character of the cañon at Diamond River, but merely a retirement of the Red Wall from the immediate cliff. It is now far enough back to be out of sight except through canon vistas.

The granite cliff continues to show much schistose rock gneiss, chlorite slate, etc.

Basalt veins (as I can only suppose them to he for I have no time to examine them) have appeared along the cliff at many (3 or 4) points today though we have come but 1½ miles.

Our work of today was the completion of the passage of Double Rapid. On the upper half Salmon and Hecox broke loose in a boat and brought up in an eddy between the two falls and on the wrong side. Indians had to swim the river and climb around to them (a work of 2 hours) to row them over when they succeeded in getting them up. Once above the rapid we found deep slow running water (with slight interruption) for 1½ miles when we encamped and drew our daily ration or half ration. Drew the *Picture* up for repairs.

The force of the current in high water is here so great that no small gravel remains on the surface of the bottom—only large boulders. These give the rapids quite different character as regards navigation. Standing ground is generally convenient for men on the tow line. Sunken rocks are likewise abundant and the water is much tossed. The towing force does not have to wade, but pulls hand-over-hand. The steersman and bowman have to be on the alert.

Astronomical Obseravations tonight: Camp 28.

Tuesday, October 17, 1871

My half ration for breakfast proved quite satisfactory and I recognize the fact that I have been eating less than the full ration in time past.

Today the same routine of rapids and rowing, and 3¼ miles progress. No change in the features of landscape or geological formations.

Wednesday, October 18, 1871

Another day of the same sort. At night a dull green schist (chlorite?) forms the whole face.

Two accidents and I in each of them.

1st. As my boat the *Trilobite* was taking in her cargo her fastenings gave way and she fell backwards over the rapid, bumping her stern severely over the rocks and starting a rapid leakage. Richardson, Hoagland and I had the ride down and I did not enjoy It.

2d. At a very lively rapid an attempt was made to drag up an otherwise empty boat with Salmon and me aboard and we were swamped and upset. Shore was near at hand and we swam to it and hung our clothes on the rocks to dry. Here I found the inconvenience of having no change of raiment (McGeary responsible).

In the first accident three carbines were lost and one of them mine. I do not feel very sorry unless I am called on to pay for it, which would be highly unjust. The care of it was onerous and not compensated by any present nor probable use.

This forenoon we saw a star (probably Venus) [Seymour Dubendorff wrote a similar diary entry for the Julius Stone trip in 1909] by day, probably at 10 or 11 A.M. It appeared just above a 1000 foot cliff that occulted the sun and was plain to be seen. This will go well with the bat matter in describing the gloom of the cañon.

Tomorrow morning Roberts and Hecox are to start ahead for Diamond River following the first bench above the river. They carry a demand for grub.

This afternoon we saw after an interval of many miles some tufa cascades. They are at several points and quite picturesque. The great drawback to their beauty is in the slimy appearance of many of their faces. They seem to head at the shale line.

The roar of the rapids is echoed by the cliffs and in the still of the night has the seeming of a mingling of many voices. As I write it is somewhat musical and reminds of church-bells in the distance (where alone they are musical).

Astronomical Observations tonight. Camp 30.

Thursday, October 19, 1871

Roberts and Hecox started this morning on foot for Diamond River and Lt. Wheeler accompanied them to the lower (Potsdam) mesa which they are to use. We hauled up the boats on the rocks last night and overhauled their bottoms (sadly in need of it) this morning.

Writing at 10 A.M. I can see but one bit of the red wall, the view on all other sides being limited by the Potsdam (?) Sandstone or the underlying granite and metamorphic rocks. Here for the first time I see an Indian (Mitawava) dress his hair. The hair is cut square across in front so as to just shade the eyes. Behind it hangs to the middle

of the back and is loosely trussed in a dozen ringlets. To dress it, he covers it all with soft mud—parts it behind so that the long part hangs forward over his bowed head in two ropes. These he [sketches omitted] twists slightly and wraps turbanwise around his head. The front lock is then brushed up and adheres to the turban, giving a Ciceronian appearance, if I remember rightly the bust of Cicero. It is said (I know not how truly) that this is done to kill lice. Our boatmen practiced it every two or three days. When the mud had dried it was rubbed out [sketch omitted].

The ordinary wearing of the hair is in a loose queue behind with a band near the end while the front hair hangs straight to the eyebrows.

We did not start today until 10 A.M. our delay being for O'Sullivan to dry things. At noon we found a salmon attached to a line and pole and hooks and two pieces of bacon—all of which gave us assurance that we had not far to go. A little later we found a float from Hecox announcing Diamond River 6 miles from our last night's camp.

By pushing we made Diamond River by night fall.

The character of the cañon immediately on the river has changed in great measure. The plutonic and metamorphic cliff has become less steep and softer. The shore of the river can be traveled on foot if one is willing to climb 50 or 75 feet occasionally. Potholes are seen no more for the rock is not firm enough to retain them. The water surface is broader and the rapids shallower. Just below Diamond River is a long rapid of course. The slack water above is not of great extent. The current has been so swift today that we have had to tow the boats most of the way.

Arriving at Diamond River we found notes from Dr. H [W. J. Huffman] announcing his departure at 10 A.M. the same day, and from Hecox and Roberts announcement. that they had arrived at 1 P.M. and started on after the train hoping to catch them at Peach Springs.

It afterward transpired that the two pedestrians traveled till 10 P.M. and stopped exhausted. At dawn tomorrow morning they started on and found the train at Peach Spring, but not before they had been met by a party that Loring's message had started back from Truxton Spring.

Friday, October 20, 1871

Lay in camp at Diamond River all day resting or trying to. The river trip has proved very exhausting and after 24 hours of nothing to do (heavier than solar observations) I still feel as though just out of a threshing machine. The mule train came in at about 3 or 2 P.M. Our supper was a full-ration one, but we were not very ravenous as last night we had ⅔ ration of flour and a can of pears and a salmon extra.

Four home letters and 1 each from Lucius Williams and Howell [probably E. E. Howell, a geologist with the Wheeler Survey] all via Camp Hualapais.

Saturday, October 21, 1871

I was photographed this morning as a member of the *Trilobite* crew. Started mountain climbing with Hamel and lost him in the first 100 feet.

Sitting on the Potsdam step opposite Diamond River I note--

There is a fault near here of a trend N. 25° or thereabouts [sketch omitted]. It passes a mile or two east of where I stand and I think determines the wash we are to follow tomorrow. East of it this horizon is lifted 500-1000 feet above its height at this point and the other beds to match. It evidently occurred after the deposition of all these beds. Near it they are inclined somewhat. Along the Colorado the inclination is thus: [sketch omitted]

along the Diamond River thus: [sketch omitted]

My travel today is an aggravation because a sore toe prevents me from going to the top or the Hill. Mr. Hamel has made the trip however and his report of the high mesa confirms my idea so far as it goes. He estimates the height of the high mesa above the low at 1000 feet.

[omitted: barometric readings for geologic section at the mouth of Diamond River].

Mr. Hamel says we have come 222 miles from Mojave in 30 days traveling time and have passed 208 rapids [names of Indians omitted].

Sunday, October 22,1871

Some doubt was thrown yesterday on my discovery of basalt veins by an examination of a black or green-black vein a foot wide that looked plutonic.

This morning I wrote some letters and packed my box.

I gave Panambona and Mitiwara some tobacco to pose for their picture. Bought of the latter for $.20 an ear ring that proves to be pottery. Panambona has a scar under his left nipple given in the late battle by a Pahute arrow.

Said good bye to the boat party at about 1 P.M. and they shot the rapid.

I have saddled *Ruth* and am waiting to start away from the Colorado. Someone has just discovered that we have not enough transportation for our stuff and so we are feeding the grain to our mules.

Starting up Diamond River we quickly turn to ther right with a wash for which I propose the name Straight Wash. This wash as I surmised yesterday is due to a fault [description of geologic section omitted].

Monday, October 23, 1871

Peach Springs for breakfast.

**End of Transcript**

Probably the only known photo of George M. Wheeler, the man in black hat. This photo was taken by Timothy O'Sullivan at the mouth of Diamond Creek in 1871. The man standing behind Wheeler is probably Gilbert. The names of the other men are uncertain.

# THE F. G. FAATZ INSCRIPTIONS

**by Jim Knipmeyer**

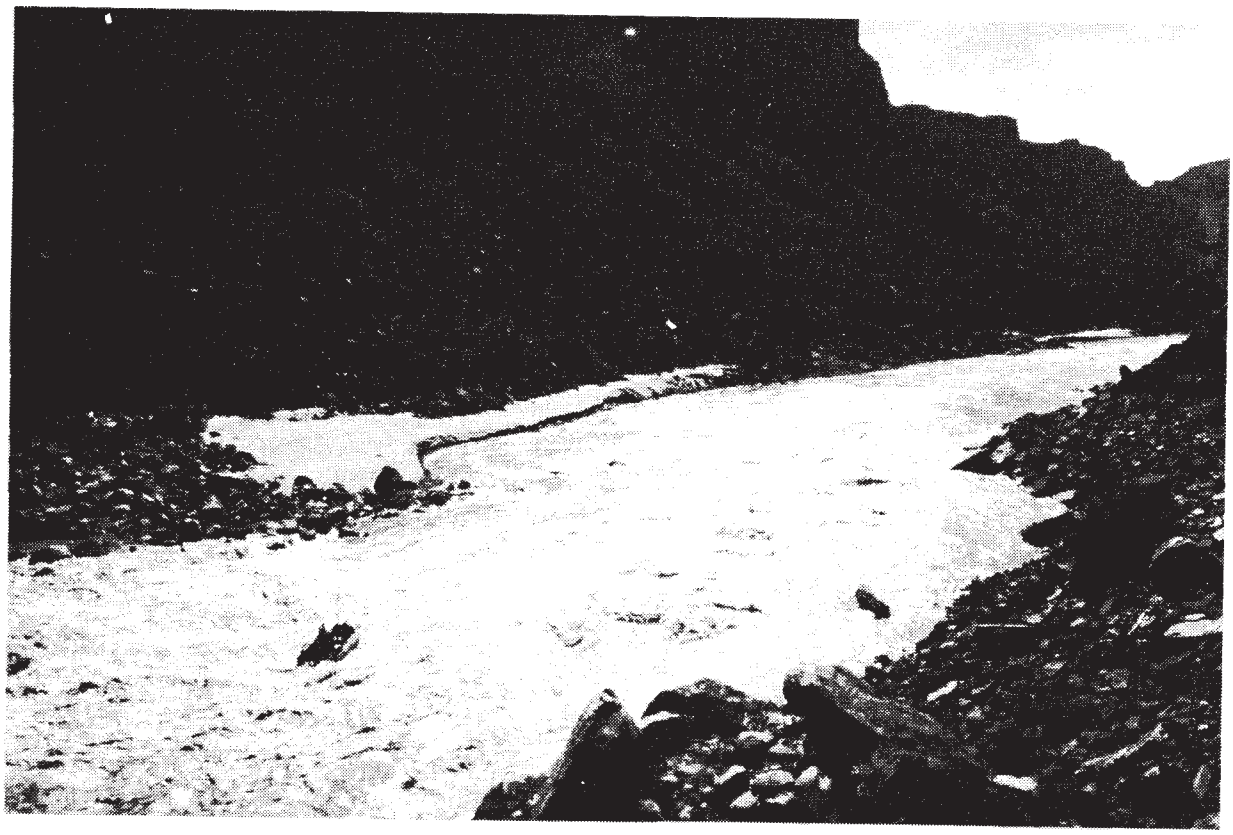
Not many people recognize the name Friend Grant Faatz, even river-runners of the Colorado in southern Utah and northern Arizona. But F. G., as he always signed his name, was one of the first persons on record to have successfully boated the treacherous rapids of notorious Cataract Canyon. This he accomplished in 1892. However, for decades little was known about either the man or his voyage.

Faatz left two inscriptions of his trip incised in the canyons of the Colorado River. The first is located in mid-Cataract Canyon at what is sometimes referred to as Capsize Rapid, part of Mile-Long Rapid between river-miles 205 and 204. On a large talus boulder on the right bank, evidently using a metal punch or drill and hammer, his name, "F.G. FAATZ" and the date, "AUG. 27. 1892" are pecked into the rock. While the name remains easily readable, the date is now much fainter.

Other river-runners before and after Faatz also stopped at this point to look over one of the more difficult stretches of whitewater in Cat, as other names and dates on surrounding boulders will attest. It was while doing just this sort of scouting that the Faatz inscription was first recorded for history. Charles Sharp, a member of the 1909 Julius Stone expedition down the canyons of the Green and Colorado rivers, briefly recorded in his journal the following statement in his entry for October 17: "At rapid No. 16 a number of names were cut on the rocks. One was Faate (sic) Aug. 27th 1892."

The second inscription, which proved that he did indeed survive the "Graveyard of the Colorado," while undoubtedly having been seen before, was not noted for posterity until the latter part of 1956. Lois Sanderson wrote to Colorado River historian Otis R. "Dock" Marston on August 29, informing him that her son Bill, a boatman for the U.S. Bureau of Reclamation, while doing survey work for the new Glen Canyon dam had found the following: "F. G. FAATZ NOV. 16. 1892." It was on the vertical canyon wall, a few feet above the sloping talus, at Mile-10.4, right bank. It is done in the same style as the earlier one farther upriver, but was this time literally chiseled into the rock, and remains very plain today.

A short article and photograph of this second inscription was published in the December 31, 1956, issue of *The Salt Lake Tribune*, and elicted a response



Looking downstream from F. G. Faatz inscription, Cataract Canyon. Photo by Jim Knipmeyer. This photo was taken during a USGS trip in October of 1993. The sport boat featured in this run of Rapid #15 was provided generously by Navtec Expeditions. In 1999 the USGS took a photo on the other side to record a new debris flow that altered the boulder fan on the left shore; the rapid did not really change much as a result of this debris flow.

from descendants in the area of Manti, Utah. F. G. Faatz was born in Homesdale, Pennsylvania, on June 3, 1864. He later spent much time "seeing the country," and subsequently established a home in Salina, Sevier County, Utah. Faatz married Sarah Jensen on August 29, 1894, in Manti, and the couple lived in Mayfield, Sanpete County, Utah, until his death March 4, 1948. He is said to have spent much of his later life selling wallpapers and painting house interiors.

But even the indefatigable Dock Marston, until his death in 1979, was unable to learn anything more concerning F.G. Faatz's life or his Colorado voyage of 1892. It remained for river-runner and writer P. T. "Pat" Reilly to fill in the story with the publication of his lengthy book on Lee's Ferry just this past year, 1999. In 1968 Reilly tracked down and communicated with Faatz's daughters and a son. They did not have a diary or journal of his river trip, but remembered quite vividly the stories he told them as children.

Faatz left Pennsylvania when he was "eighteen or twenty" years old. He wanted "to see the world," and traveled to many states before starting out "to conquer the West." For a while he worked for a mining company in Arizona. In 1891 Faatz's only sister died. He went back for her funeral, but then turned around to Arizona. He never returned to his home in Pennsylvania or saw any of his relatives for the remainder of his life.

One of his daughters described Faatz as "a small man, only 5 foot 5 inches tall, and weighing only 140 pounds. How such a small man could do all he did is quite unusual." Either before his river trip of 1892, or sometime in the two years following, he and a companion named Glover went all through southwestern Utah: Bryce, Cedar Breaks, Zion, and Grand Canyon, "any place they could get in and come out alive."

Evidently, during this period of his life Faatz was a prospector and miner, perhaps spurred on by the Glen Canyon gold rush of 1883-91 and the San Juan River "excitement" of 1892-93. His Colorado voyage, detailed in Reilly's book, was the result of being hired by a mining company in Salt Lake City, Utah, to "go down the river in search of gold." After ending the trip on November 17, he stayed in the lower Glen Canyon region around Lee's Ferry, Arizona, for the next year and a half. Reilly's last recorded mention of Faatz was a prospecting tour around that area in the spring of 1894.

His marriage in August of that year seems to have effectively ended Faatz's mining career, but not his memories of those days. He told his sons as they grew older that if he was younger he would go down the Colorado every summer and pan enough gold to live on each winter. One of his sons related his father asking, "Why don't you go down the river and pan gold? You could make more money in a few months than you can around here in a whole year!" I would say, "Dad, let's go," but he would always reply, "No, I'm too old."

End

# Westwater Canyon

## A Geologist's River Guide

### With a Focus on Precambrian Rocks

**by Wil Bussard**

*In the fall of 1998, CPRG conducted a volunteer science trip through Horsethief, Ruby and Westwater canyons. It was an eight day trip attended fully, or in parts, by Wil Bussard, Tamsin McCormick, John Dohrenwend, Paisley, Greg Trainor, Earl Perry, Bob Parker, Michael Milligan, Steve Young, Dusty Simmons, John and Susette Weisheit, and Joe Keys. Outfitting assistance was provided by Adventure Bound, Tag-A-Long, Canyon Voyages and Kyler Carpenter. The following is a geology report from that trip and is gratefully provided to the CPRG membership for their use and enjoyment.*

The Colorado River in Westwater Canyon cuts down through Mesozoic sedimentary rocks, across The Great Unconformity and into Precambrian metamorphic and igneous rocks of the continental basement. Precambrian rocks in Westwater Canyon vary along the run of the river from coarse-grained igneous at Black Rocks and Miners Cabin to high grade metamorphic at Little Hole and Cougar Bar, and lower grade, layered metamorphic at Big Hole. These rocks are part of a "Migmatitie Complex": a deep crustal intrusion of magma, which cooled in an actively deforming environment. Layered schist and gneiss from Cougar Bar to Big Hole reflect the original sedimentary rocks, which were cut by basalt dikes and regionally metamorphosed prior to the intrusion of granitic magma at Black Rocks and Miners cabin.

The purpose of this writing is to point out that not all the "black rocks" are the same, and to provide some general geologic information.

Mesozoic sedimentary rocks are briefly described from Loma, CO to Cisco, UT and have been written up extensively by Don Baars and other authors. These sedimentary strata are laterally continuous across large portions of the western U.S. They vary in thickness and taper out in response to the changing paleotopographic shape of the continent and intracontinental basins through geologic time. They hold a long variety of fascinating history, much like the pages in a book.

This text is prepared in conjunction with Belknap's *Canyonlands River Guide*, with the intent that the reader will use this guidebook and refer to the mileage, landmarks, geologic time scale and stratigraphic column within for a more direct complete and effective understanding of the matters at hand.

Loma boat ramp

**R**ecent river gravel in the upper parking lot are

deposited unconformably on the Cretaceous Lower Mancos shale (85 m.y.) [million years ago]. The Mancos is dark gray to black, high in organic carbon and in many places a source rock for economic hydrocarbon deposits in sandstones above it (like the Roan Cliffs and San Juan Basin). It was deposited in an oceanic environment and in places contains marine fossils (oysters and ammonites, for example). The Mancos Shale is named for Mancos, Colorado. Formations are usually named for the first place, the type locality, where they were identified as a unique set of rocks.

The Cretaceous Dakota sandstone (90-98 m.y.) outcrops on river right about 1/2 mile down river [151.5]. This off-white sandstone was deposited in a coastal plain/ beach environment and stretches from New Mexico to the Dakotas. It is a porous, permeable rock and often a good reservoir for oil and gas. In various places in the Four Corners it has a basal coal layer or a coarse conglomerate named the Burro Canyon (Cedar Mountain) Formation (Fm.). Coals are formed in swamps and the Burro Canyon Fm. is a continental (non marine) river deposit.

The Jurassic Morrison Fm. (138-160 m.y.), in the slopes to river right, is not well exposed at river level. This extensive set of varicolored shales, sandstones and conglomerates tells the story of infilling a large continental basin, which stretched from Nevada to eastern Colorado and Arizona to Canada. Dinosaur fossils are found in the Morrison Fm. near Moab, Utah.

The Jurassic Entrada sandstone (180 m.y.) is off-white and meets the river at about mile 151, followed in quick succession by the rose pink to red Kayenta Fm. (200 m. y.) and the orange Triassic Wingate sandstone (210 m. y.). The Entrada and Wingate sandstones are both remnants of sand seas (Sahara desert type environments). Note the high-angle cross-bedding typical of windblown (eolian) sandstones. The intervening Kayenta Fm. consists of these eolian sand grains reworked into stream and river deposits, and suggests a period of climate change. The Kayenta is not as laterally extensive as the Wingate or Entrada formations and is restricted to a sub-circular area around Four Comers.

These Early Mesozoic sandstones are among the most dramatic rocks in the western U. S. Much of the good rock climbing in Canyonlands (Supercrack, Castleton, Six Shooter Peak) is in the hard, orange Wingate sandstone. The Entrada is present throughout the area as well. At first glance many people do not see much difference between one sandstone and another. Differences become clear when one views the details of these rocks, both in (1.) large scale; outcrop appearance (is it massive, blocky, cliff forming?, how big are the cracks in it?, things like this), and (2.) small scale; grain size and shape, is it clay, sand, clear quartz?, are there fossils?

The Entrada is very fine to fine-grained, very well rounded, has a sugary texture and calcareous cement, it often has a red orange lower member and an off-white to tan upper member. These characteristics are consistent in the Entrada from Wyoming to Mexico and Nevada to Colorado. It commonly erodes as massive slickrock domes, with high angle cross bedding, typical of sand dune deposits, it is very well-sorted (consistent grain size).

The Kayenta is rose pink to red, throughout the deposit, on the Dolores River, in the town Kayenta, in Glen Canyon and here. Color is not always a consistent characteristic, but in some cases it is. The Kayenta is horizontally bedded and ledgy, typical of stream deposits, has blocky splitting and occasional freshwater limestone lenses of sabkha lakes (like the small ones in the White Sand Dunes in southern New Mexico). The grains are well-rounded and well-sorted, some are frosted; they are eolain (windblown) grains reworked in stream deposits.

The Wingate is orange-orange-orange all through the West! It is medium-grained, very well-rounded, well-sorted, non calcareous, and has beautiful cuspate, interlocking grain boundaries surrounded by secondary quartz overgrowths which look like ice crystals with a good magnifier. It is massive and cliff forming, with high-angle cross-bedding, blocky splitting and forms excellent dihedral cracks.

The missing Navajo sandstone is worth noting. It's absence is due to (1.) it was never deposited here, or (2.) it was eroded off between 200 and 180 m.y. It stretches from Wyoming to Mexico and forms Checkerboard Mesa at Zion National Park. It erodes into slickrock domes (Slickrock Bike trail) and with a magnifier has a conspicuously bimodal grain distribution of fine and coarse, round, clear grains. This unique bimodality exists in the Navajo sandstone in Wyoming, Utah, Arizona, and on the Mexican border. The Navajo is an important oil and gas reservoir in places where hydrocarbon source rocks exist beneath it.

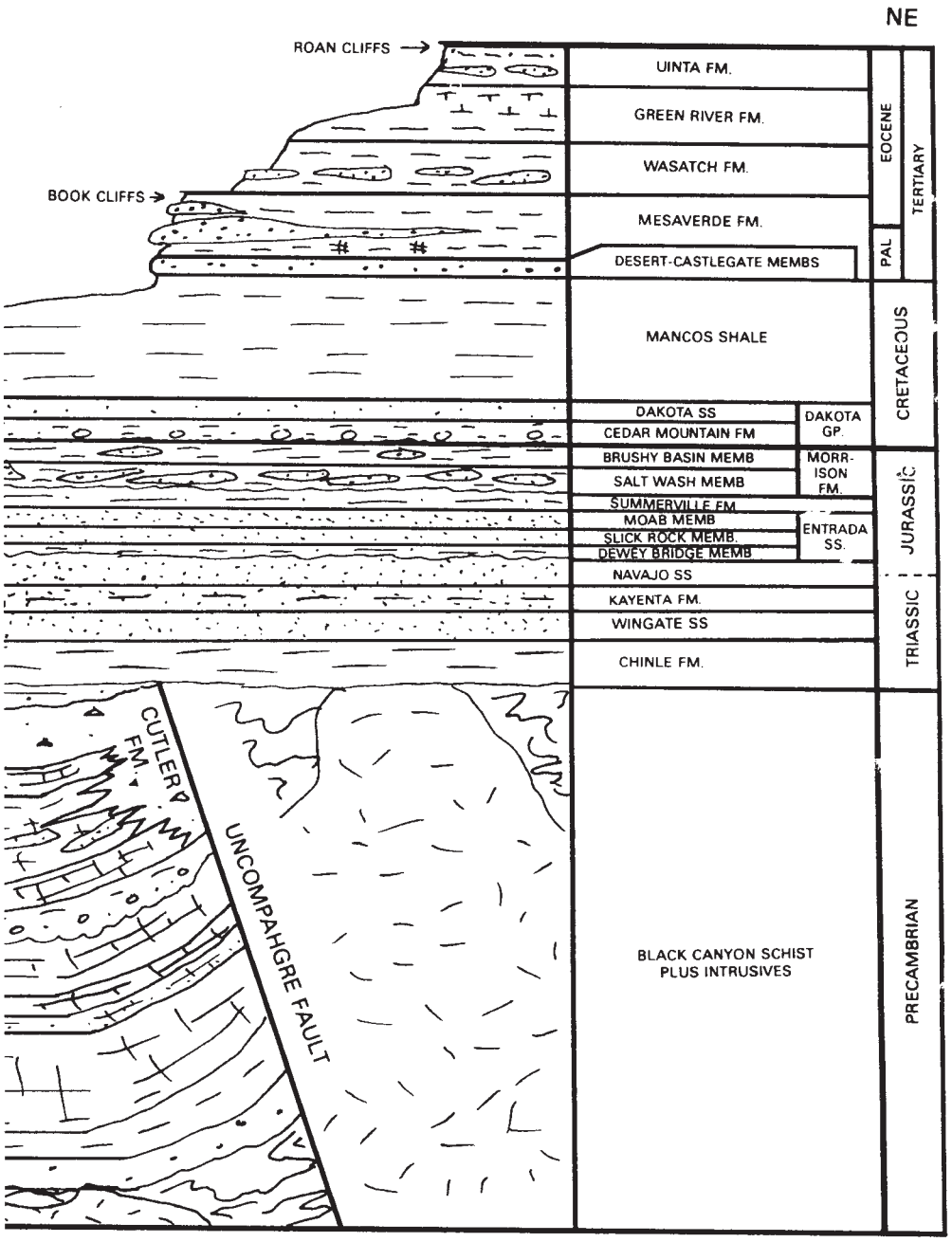
Continuing downsection are red beds of shale, siltstone and sandstone in the Triassic Chinle Fm. (210-215 m.y.). The Triassic is the first period of the Mesozoic Era and also records the first appearance of biped dinosaurs. The Chinle was deposited in continental swamps, streams and rivers. It extends from Wyoming to Mexico and Nevada to Colorado. The source of the Chinle continues to be debated; somehow a doming event in the south and in the west, preceding Jurassic subduction, volcanism and mountain building, occurred. Scattered data for this doming exists in the dismembered mountain ranges in Arizona and Nevada. Some workers have discovered paleocurrent data suggesting a source in Oklahoma (the ancient Ouachita Uplift revisited?). The Ancestral Rockies existed in some form right here in the Westwater area and likely provided a source for some of the red beds. We see this at Moore Canyon, where you can actually stand on the surface of the Uncompahgre Uplift and the Ancestral Rockies with the feather edge of the Permian Cutler Fm. coming off the uplifted Precambrian granite and the Chinle Fm. overlying this paleosol.

Sedimentary rocks record geologic history and tell us about paleoenviromnent (beach, swamp, river),

paleolatitude, tectonics of the continent and the development and breakup of Pangea. Bentonite clays in the Mancos Shale attest to Cretaceous volcanism. Granitic clasts in the Cutler are derived directly from the Ancestral Rockies, and volcanic detritus in the Chinle and Morrison formations tell us of distant volcanoes.

Precambrian Rocks

**P**recambrian rocks are generally more complex than younger rocks. They are often highly metamorphosed and have been subjected to a longer and more involved geologic history. Time and history are cumulative, building up layer upon layer, thus every tectonic, magmatic and erosional event that has taken place through time has changed the existing Earth's crust on which it occurred. One of the biggest problems with Precambrian rocks is that the exposure is very limited, in most places they are covered by younger rocks. Outcrops are sporadic and sparse. In the Four Comers region, only a few exist: Westwater, Unaweep, Grand Canyon, and that is about it. Further afield and off the edges of the Colorado Plateau good exposures exist in the Transition Zone of central Arizona, the Rio Grande Rift Valley, the San Juan Mountains and scattered outcrops, north and west of the Plateau in Utah.




Stratagraphic column from Northern Paradox Basin and Uncompahgre Uplift, Grand Junction Geological Society, 1983. Note: In Westwater Canyon, Navajo sandstone is missing.

The Great Unconformity

**T**he Great Uncomformity at the contact of the ancient Precambrian and overlying younger rocks exists throughout the North American continent as a sub-horizontal line of great mystery. It represents an absence of geologic history in our area of 1.1 to 1.8 billion years! In the Grand Canyon there are places where 1.7 billion year old rocks are overlain by 570 million year old Tapeats sandstone. In the San Juan Mountains the unconfonnity is more variable and exists between rocks of 1.8 to 1.4 b.y. and overlying rocks ranging in age from 520 to 23 m.y. Continental tectonics have been more active in the San Juan Mountain area throughout post-Precarnbrian time than in the Grand Canyon region. Observations at the contact guide us to understanding various aspects of regional tectonics (mountain building, basin development, faulting) that have occurred since the Precambrian, but there simply is not information available for geologic history during most of the time from 1.4 b.y. to 570 m.y.

Here in Ruby and Westwater canyons, the Great Unconformity spans from the 1.7 b.y. "black rock sequence" to the overlying 220 m.y. old Triassic Chinle Fm., a gap of 1. 5 billion years! In Moore Canyon at mile 135.5, there is incipient

soil formation into the Black Rocks, overlain by the Chinle Fm. This red paleosol may be the very feather edge of the Permian Cutler Fm. (270 m.y.) and is a very interesting field stop for geologists; one can see the breakdown of granitic rocks, weathering of feldspar and mica and the development of paleosol all "frozen in time" by the overlying Chinle Fm. and Wingate sandstone.

Nearby exposures

The longest and most continuous exposure of Precambrian rocks in the southwest USA is across the transition zone of central Arizona. Seven distinct "blocks" of Precambrian rock have been identified as separate entities that were accreted and sutured together during the growth of the earliest continents, specifically proto-Pangea (Anderson, 1989). The geologic history of the Precambrian underpinnings of present-day North America is described as an accretion of volcanic island arcs, undersea volcanoes, beaches, micro-continents, and terrestrial sedimentary deposits. Apparently the convergence was from the southeast towards the northwest as seen in present-day North America. The Wyoming Suture Zone has this same southwest to northeast trend, orthogonal to convergence, present in the central Arizona blocks. A write up of these details is found in *Arizona Geological Society Digest* #17, "Geological Evolution of Arizona."

Precambrian in Westwater

Precambrian rocks in Westwater Canyon consist of coarse, crystalline, granitic rocks (Black Rocks, Mile 136 and Miners Cabin, Mile 124) intruded into a pre-existing crust of high to low grade schist and gneiss, amphibolite, augen gneiss, garnet-bearing schist, granulite and garnet granulite (Mile 124 - 114), and intermittent zones of well developed migmatites (Mile 122-12 1). Similar rocks outcrop in lower Grand Canyon, the Upper Animas Gorge, Black Canyon of the Gunnison and Unaweep Canyon.

In efforts to understand this complex geology we look towards the literature; studies from other areas and the interpretive models. Precambrian rocks exposed in Westwater Canyon appear to fit genetic models for migmatite complexes defined by Haller, 1971: a deep crustal intrusion cooling slowly under pressure in an actively deforming environment. The migmatites are generated as "mixed rocks" in Hallers' "Zone of Detachment" between the infrastructure (intrusion) and the superstructure (wallrock) (see diagrams 19-28, 19-30). Continued upwelling of the hotter, more bouyant magma creates more interaction, in this zone, as the overlying superstructure is partially melted, metamorphosed and deformed. The following text briefly describes the Precambrian rocks along the Colorado river from Loma, CO to Cisco, UT and a concordance of these rocks with Haller's models.

Infrastructure

Coarse crystalline granite with a pronounced alignment of crystals is the intrusive rock in Rattlesnake Canyon (Mile 149), at Black Rocks and Moore Canyon (Mile 136-135), and at Miners Cabin (Mile 124). Orthoclase crystals are euhedral (well-developed crystal faces) and often elongate and quite large. The bigger ones are 1.7 cm. x 6.5 cm., with an elongation factor of four. They exhibit pervasive alignment along azimuth 340 $\pm$ 20 degrees. Elongation beyond typical feldspar crystal shape and preferred alignment strongly suggest emplacement of the intrusion into a tectonically stressed environment or cooling of the intrusion in an environment of non-uniform stress. The long axis of crystals grows preferentially in the direction of least pressure. Crystals align with long axes perpendicular to principal stress as the magma cools.

Other possibilities exist, that might explain alignment of crystals in igneous rocks, but these concepts do not fit the outcrop and petrologic relationships as well as cooling within an actively stressed environment. (1.) Alignment of crystals can result from flow within a convecting magma body or in an actively intruding body: This does not fit the outcrop because (a.) the crystals are very large, requiring a long cooling time and as convection and movement occur in an igneous body, the directions of flow change through time, (b.) The alignment is pervasive (consistent throughout). Crystal alignment due to flow is not homogenous across large areas, convection is spherical; hot zones, dikes and sills, flow in accordance with their [irregular] boundaries. There is no good evidence for flow. (2.) Alignment may result from later metamorphism: If this were the case we would see alignment of other minerals in the granite, especially mica (at the lowest temperatures) and this is not here. [Plagioclase feldspar, quartz, muscovite (silver) and biotite (black) mica, and hornblende are also present in this granite]. (3.) Filter pressing of crystals against the wall of an intrusion can produce alignment: If this were the case we would see variations in abundance of crystals across the outcrop(s), and we would see at some place in the outcrop a change in orientation of crystals.

Thus, the most likely scenario is cooling within a tectonic environment with principal stress oriented perpendicular to the long axes of crystals. This also fits outcrop data at adjacent stops and the big picture concepts which may be invoked to explain the entire package of Precambrian rocks and other outcrops regionally (Unaweep, Grand Canyon, San Juan Mountains).

Zone of Detachment

Migmatites are very unusual rocks and contain contrasting mineral assemblages, which appear to have been mixed in a semi-molten state. These are the highly contorted, pink, white and black rocks at Little Hole and up Little Dolores Canyon (see river guide section). Migmatites were not understood for a long time and still present a lot of physical-chemical type problems for those who study them. They are really weird rocks. The only viable explanations put forth involve mixing under multi directional and shear stress at relatively high pressures

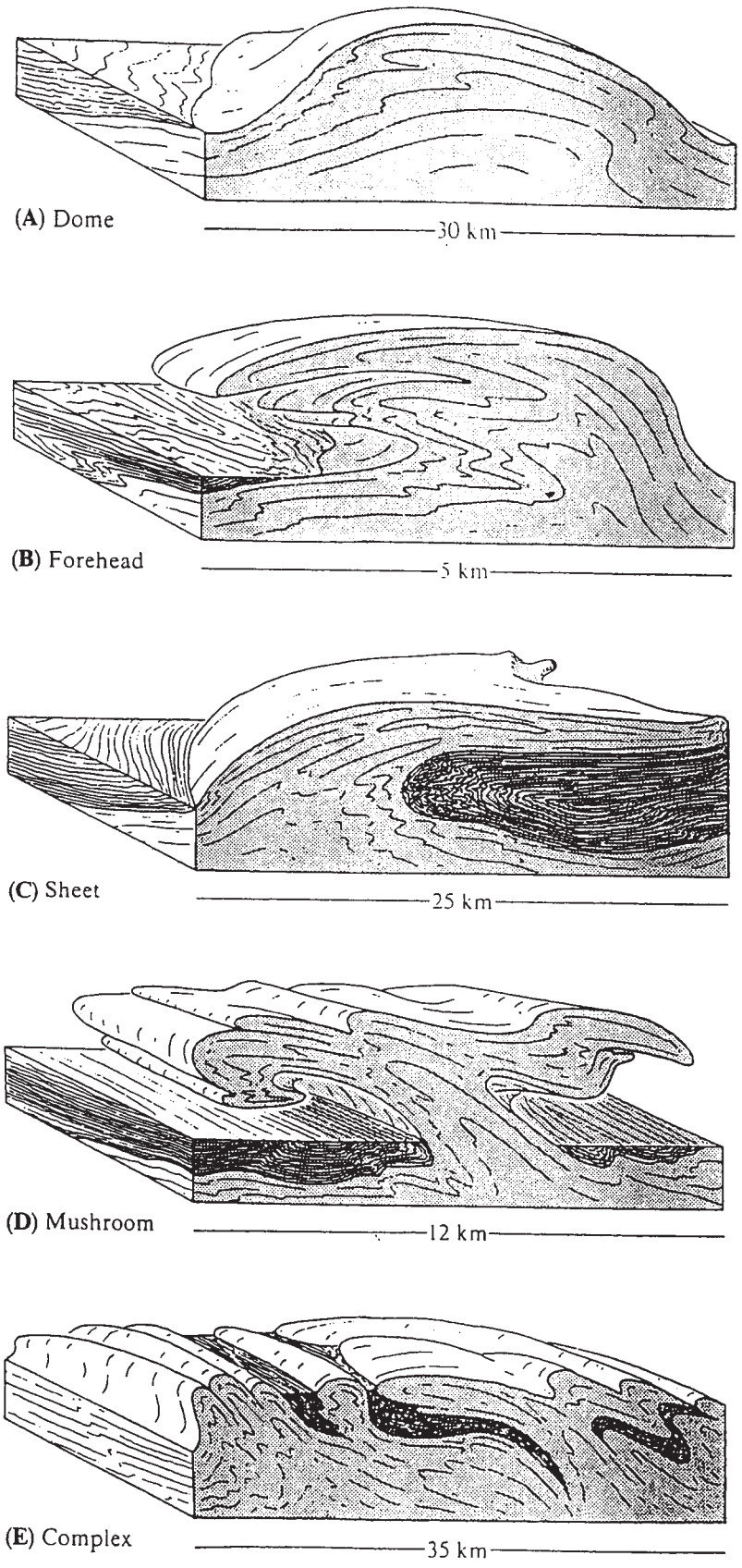
and temperatures, with perhaps long time intervals. Mechanisms of partial melting are invoked to explain the presence of conflicting mineral assemblages. Textural observations in the rocks support all this, Haller's models (figs. 19-28, 19-30) were based upon field observations in Greenland (and other locales) at outcrops on enormous cliff faces which cut across all three zones in one place. The Colorado River in Westwater Canyon cuts through a similar situation and migmatites also exist in other 1.7 billion year old rocks elsewhere in the western U.S. Perhaps it is not all that uncommon in the deep crust. Geologists in the Grand Canyon describe migmatites and those rock are similar to these at Westwater.

The migmatites are intermittent, oddly-shaped zones of complexly mixed quartz-rich granitic rocks (low temperature) and ultramafic amphibolite rocks (high temperature). The migmatites here are somewhat abundant, and they are really beautiful. These zones pinch and swell, presumably in response to higher and lower pressure areas within the deforming, strained crust. They appear to mix on a fractal scale, from exceedingly fine (centimeters or less) to coarse (meters). Zones are from one half a meter to 5 or 10 meters wide and perhaps as long as ½ mile.

These are the exact zones of detachment and they vary in shape in response to folding and buckling in the infrastructure below and the superstructure above, mixing and deforming, partly granite and partly re-baked metamorphic rocks. Ductile deformation and rock type constrain the depths of occurrence, this is a deep crustal phenomenon.

Superstructure

The pre-existing superstructure was apparently a sequence of sedimentary rocks; shales, sandstones and sandy limestones, intruded with basalt dikes and sills (Mile 122-114). Sedimentary rocks were regionally metamorphosed into garnet-bearing schist, and high and low grade schist and gneiss of the granulite facies. Basaltic intrusions cut the sedimentary rock parallel to layering and across layering and were metamorphosed into amphibolites. Coexistence of these two facies narrows temperatures to between 600 and 700 degrees Celsius and pressures to between 3 and 8 kilobars (10




Types of infrastructure upswellings. From J. Haller, copyright 1971, *Geology of the East Greenland Caledonides* (New York: Wiley Interscience), Fig. 64. Reprinted by permission of John Wiley and Sons, Ltd.] Ehlers and Blatt, 1985.

to 20 kilometer depth) (Ehlers and Blatt 18-1).

This early metamorphism occurred before the intrusion of the granite, as evidenced by the presence of xenoliths (inclusions) of amphibolite gneiss in the granite at Moore Canyon. Layered metamorphic rocks occur at a scale of one to ten meters, and this layering is more pronounced and better exposed and preserved, partly due to a lesser metamorphic grade further down river away from the intrusion and detachment zone, from Big Hole to Big Horn (Mile 116-114).

Near and adjacent to the granite the rocks are high grade banded gneiss, granulite, greenschist and amphibolite and commonly contain large red garnets to 1.5 cm, bladed hornblende to 5 cm, and abundant sheet biotite. In a few places, hydrothermal deposits occur in these rocks. Rocks in Little Dolores Canyon contain a fibrous, soft white mineral sillimanite (?). This unique occurrence of "spot rock" may have been due to ex-solution of water from the intrusion into wallrock. Hydrothermal alteration and epithermal quartz are present in hot springs deposits in the area of a small prospecting and surface operation at mile 123, just down river from Miners Cabin. One of the drill sites appears to have targeted a hot springs deposit within the metamorphic rocks. This box-like network of veinlets is where hydrothermal fluids cooled into microcrystalline quartz. This type of environment is occassionally a site of metal deposition. This operation also appears to have targeted a chloritized fault zone and a rose quartz pegmatite with exploratorv drilling.

Rocks outcropping farther away from the intrusion are somewhat lower grade and less disturbed by the deformation at the interface of the intrusion and zone of detachment. Pelitic schist are interbedded with metagraywacke and biotite and garnet schist on a scale of one to six meters at Big Horn. Foliation parallels larger scale layering, suggesting foliation development parallel to original bedding. Textures in the metagraywacke (impure quartzite) suggest relict bedding and this also parallels layering and foliation. Rotational structure in garnets is rarely found and depicts shear stress during crystal growth. Foliation parallel with bedding is neither required nor uncommon. Bedding planes between different rock units can act as free surfaces and partition or re-orient strain. The more numerous the bedding plane contacts are, the more strain is re-oriented perpendicular with bedding. Often foliation in metamorphic rocks cuts across original sedimentary bedding planes, but here foliation is parallel with layering and perhaps bedding.

## Protoliths

*Protoliths* (rock prior to metamorphism) for the present metamorphic rock are proposed in accordance with chemical, physical and textural constituents in the rocks as follows:

*Metagraywacke (impure quartzite); protolith; sandstone, perhaps graywacke.* This rock consists mostly of clear, fine to medium, subangular quartz grains, some of which fall off in your hand (and 10% biotite). It has not been metamorphosed to a high grade (lower granulite). Chemically, it did not change much; it was sandstone it is now quartzite. It is found at mile 114, farthest from the intrusion.

*Pelitic schist; protolith; shale.* These occur throughout "superstructure" rocks, from Mile 123-114. Grade and size of garnets is roughly the same throughout. They contain abundant biotite and chlorite, 0-25% quartz, segregated into lenses and eyes, some layers have 25% actinolite, garnets are present in some layers and not in others. commonly garnet, quartz, biotite and $\pm$ actinolite are intergrown together in layer parallel, irregular masses. Variations in mineralogy from unit to unit in the section, depict variation in original abundance of elements (iron aluminum, calcium) in the shale protolith.

*Garnet granulite; protolith; calcareous sandstone/ shaly sandstone/graywacke/arkose.* Abundant clear and opaque, coarse angular quartz, big and small garnets, chlorite, biotite, and overall large grain size suggest an impure clastic rock; a dirty sandstone, perhaps like the sandstones in the Cutler Fm., or a marine graywacke.

*Amphibolite; protolith; basalt.* Chemically, basalt goes directly to amphibole with metamorphism. Outcrop relationships show amphibolites crosscutting and paralleling layers. These were dikes and sills of basalt prior to metamorphism. Crystal size ranges from 1 x 20 millimeters to a whopping 30 x 60 millimeters at Cougar Bar. Some of these are pure hornblende, others have some red garnets and up to 30 % biotite.

## Conclusion

The occurrence of Precambrian rocks found here fits into existing genetic models of migmatite complexes, developed at depth. The mineral assemblages and structural observations at the igneous contact and migmatite zones also support this. The infrastructure of coarse granite is seen at Black Rocks and Miners Cabin. The contact of the intrusion is irregular and visible at Cougar Bar, right at Mile 122. It is an intrusive contact with pegmatites sweating out of the granite, xenolithic inclusions of amphibolite gneiss in the granite, structural deformation; boudinage and augen gneiss. Within a mile of the contact, at Little Hole (river right, Mile 121.2), well-developed migmatites of Haller's "detachment zone" occur. Further down river, at Big Hole and Big Horn (Mile 116–114 on river right), higher levels of the superstructure are found, consisting of lower grade garnet-granulites and intervening pelitic schists, all cut by amphibolite dikes and sills.

The intrusion at Black Rocks was emplaced into a "typical" sedimentary section of shale and sandstone that was crosscut by basalt dikes. Deformation with cooling occurred and distinctive zones of migmatites formed at the interface of the intrusion and the pre existing crust.

## Acknowledgments

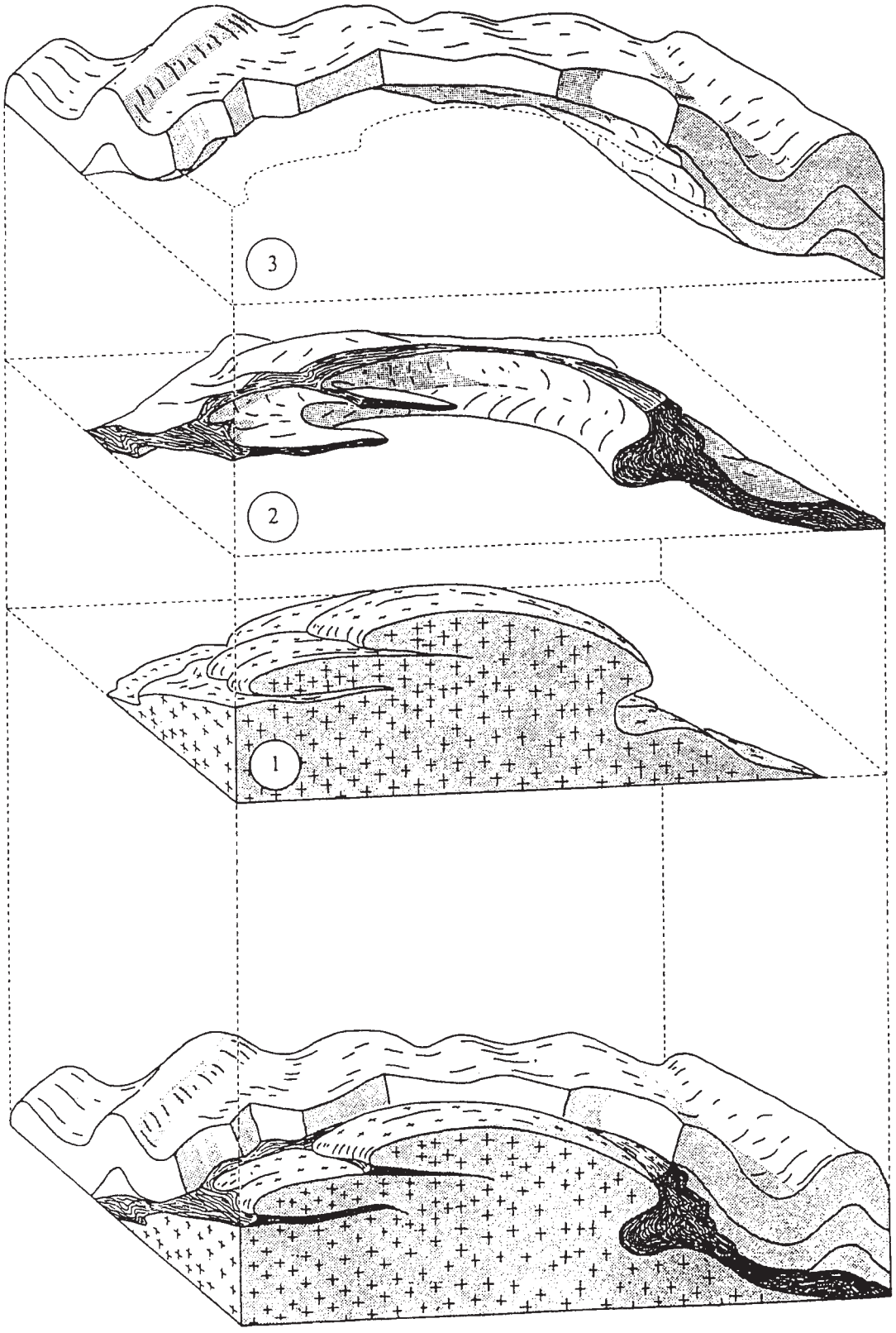
All of the diagrams here are from *Petrology: Igneous, Sedimentary and Metamorphic* by Ehlers, E.G. and H.

Blatt, published by W. H. Freeman and Company, 1982, San Francisco, CA. References appearing on these diagrams refer to the original literature. Belknap's *Canyonlands River Guide* was used for mileage and is suggested as a supplement to this writing.

The knowledge presented herein came from (a.) *Petrology* by Ehlers and Blatt, and (b.) Anderson, 1989, in Penney and Reynolds; *AGS* #17, "Geologic Evolution of Arizona," (c.) verbal communication with river geologists Brad Ilg, Andre Potochnik and Tamsin McCormick.

Field work was made possible through an 8-day river trip sponsored by the Colorado Plateau River Guides in October, 1998. Special thanks to John and Susette Weisheit, Tamsin McCormick, Dusty Simmons and T. Berry, and the other trip participants, for the excellent guiding and great good fun.

End




Three-dimensional representation of a migmatite complex in exploded view. Zone 1 is the granitoid basement portion of the infrastructure. Zone 2 is the zone of detachment, a portion of the infrastructure attached to the granitoid basement. Zone 3 is the weakly deformed and detached overlying superstructure. [From J. Haller, copyright 1971, *Geology of the East Greenland Caledonides* (New York: Wiley Interscience), Fig. 51. Reprinted by permission of John Wiley and Sons, Ltd.] Ehlers and Blatt, 1985.

# RIVER GUIDE

## Precambrian rocks along the Colorado River from Loma, CO to Cisco, UT Westwater, Ruby and Horsethief Canyons Using Belknap's *Canyonlands River Guide*

by Wil Bussard

INTRODUCTION

I left out the sedimentary rock from this section, you can find the descriptions and initial mileage in the first 2 pages of the accompanying text. This guide is really about Precambrian rocks.

Mile 149

Rattlesnake Canyon, small landing on river left. Up the canyon the Bull Canyon Fault brings Precambrian rocks up against Mesozoic sandstone, some small fault structures; poorly developed tectonites, conjugate shears with fault growth calcite steps. Precambrian rock here is granite with big and small crystals, similar to Black Rocks and at Miners Cabin.

Mile136-135

Moore Canyon/Black Rocks, river left, this is a great stop. The Black Rocks exhibit excellent fluting in the river. The rocks are granite with large crystals to 7 cm long and pervasive alignment. Up the canyon, an excellent hike, (a.) xenoliths of amphibolite gneiss in the granite, (b.) zones of larger, strongly aligned and discordant crystals (perhaps incipient pegmatite or the result of flowage after cooling and fracturing of the magma? who knows, they look like a bunch of cars all trying to get on the L.A. freeway at once.). (c.) The big happening here, along with the best outcrop of granite is that you can stand on the surface of the Ancestral Rocky Mountains, and there is a paleosol developed into this surface and on it. This paleosol. is (d.) the feather edge of the Permian Cutler Formation. It is centimeters thick here and hundreds of feet thick at Hittle Bottom, not far down river in Professor Valley. The Ancestral Rockies are one of the really big things that happened here, 300 million years ago, and the basin created when this mountain range was thrust upon the continent to the southwest is called the Paradox Basin and is a major oil and natural gas reservoir, with thousands of feet of fossil-bearing limestones, shales, evaporite minerals and hydrocarbons. Take a deep breath and imagine yourself, while you stand, on this uplifted surface looking down to the southwest over a vast Paleozoic sea filled with trilobites and bony fishes, eurypterids and sharks. Four-footed reptiles roam through the tropical Ginkgo forest, knocking over trees and making babies (there are no upright dinosaurs yet). There are no birds in the sky, just the warm, sultry tropical Paleozoic sun, shimmering off the surface of the Paradox Sea. There are no Wingate sandstones, no Chinle or Morrison formations above you, just you and the phenocryst-rich ancestral Rocky Mountains standing in the sun.

Mile 125-123

Miners Cabin, river left, another good stop. This is where we begin to see the interaction of the intrusive granite (from Black Rocks) and the existing crustal rocks into which it was intruded as magma. Note and investigate the variety of rocks here, they are described in the preceding text. The granite is no longer the only rock here, also present are schist and gneiss. There is a mining claim on the south part of this bench area. It is not legal to trespass on some mining claims and most miners do not like at legal or not [the claim now defunct]. There are some interesting rocks back up in there, but not largely different from other stops in this guide. Apparently they are placer gold from the river gravel on the surface of the bench here. There is a USGS document out describing placer along this section of river. It is doubtful that anyone is getting rich here and it is not advisable to mess around on the claim area.

Mile 122-121

Cougar Bar, river right, excellent outcrops on river particularly as you round the comer to lower Cougar Bar and Little Hole. (a.) The intrusive contact into the crustal metamorphic rocks is visible in the cliffs at river right, note the stoped-out blocks of wallrock and the irregular nature of the contact. (b.) Layered metamorphic rocks 100 yards down river from this contact are worthy of investigation (for rock heads). Here you will find the biggest and best of the amphibolites; one linear body is composed almost entirely of two inch long, greenish black hornblende crystals, also garnet schist and granulite facies rocks are here, and biotite schist. These layered rocks are quite diverse and the layers may reflect original sedimentary rock units. These would be in Haller's "superstructure" (see text).

Mile 121.5

Little Hole, river right, excellent stop, small landing. Migmatites are here in the gully; a layered sequence of all kinds of cool metamorphic rocks; amphibolites, migmatites, schist, gneiss—wowie! The intricately banded pink, white and black rock that looks like taffy in the canyon bottom near the river really is taffy!, in the sense that it has been mixed and pulled around and swirled while hot. THIS IS THE MIGMATITE! This is Haller's Zone of Detachment.

Mile 121

Little Dolores Canyon; river left, good landing, okay geology stop, much of the same as what we have seen. It is hard to beat the rocks at Little Hole. Up the canyon there are some unusual, although not particularly pretty "spot rocks" with a white fibrous mineral that may be sillimanite, why is this here? Calcareous waters?, hmmmm. Migmatites are here as well.

Mile 121-116

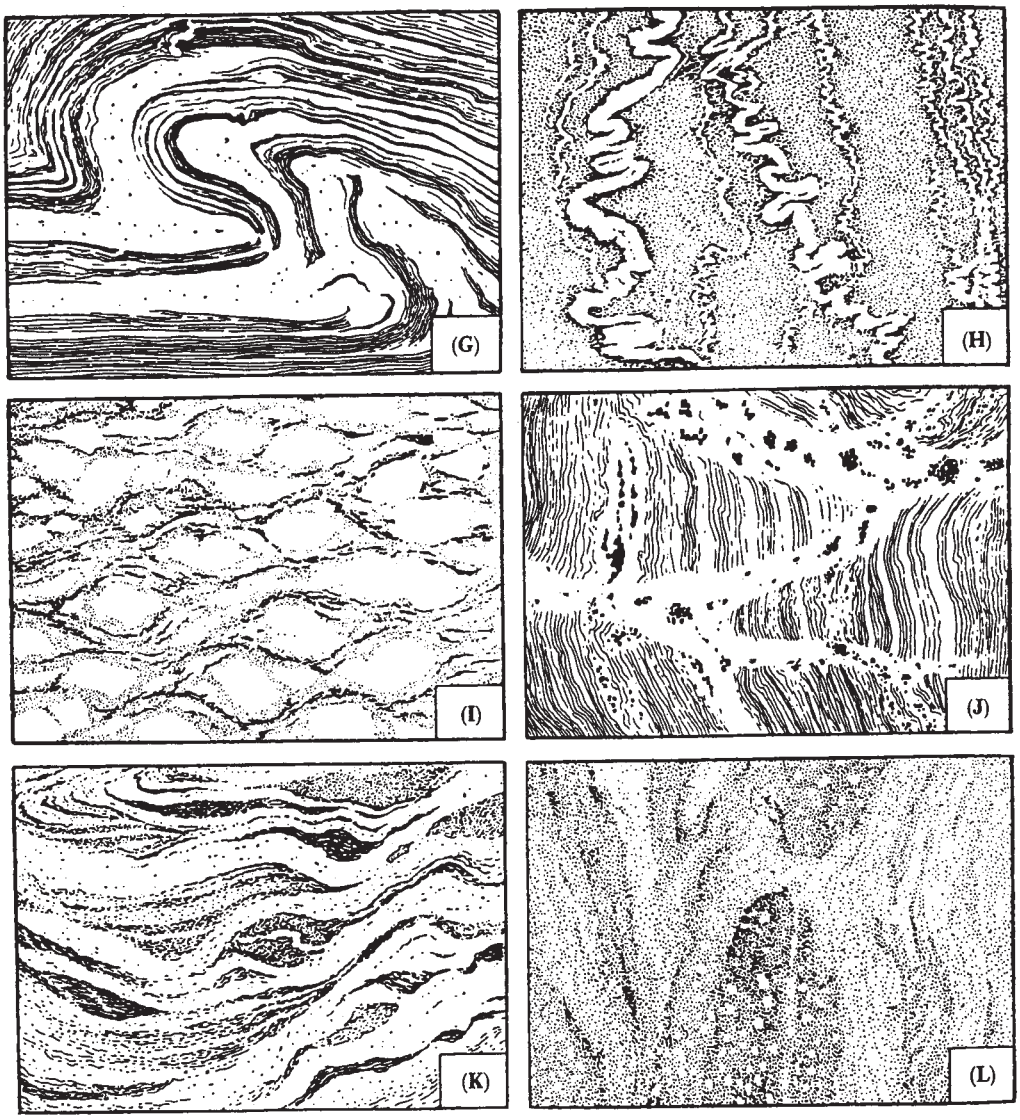
Unknown to this author. Guess I will need to return. It is kind of hard to stop here; narrow gorge, rapids, etc. Some of that at Skull Rapid looks like granite, I think, maybe it is gneiss. I forgot to look at the rocks here.

Mile 116-114

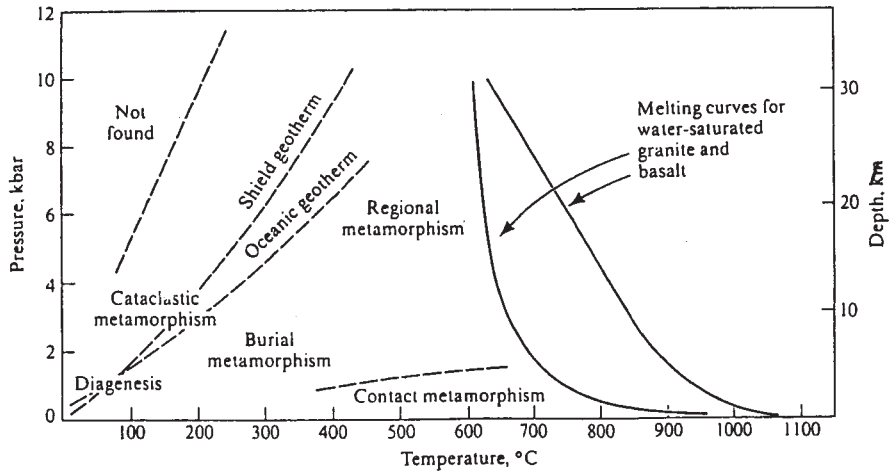
Bighole to Big Horn, river right, excellent stops and you can hike between them. This is the Superstructure of metamorphosed sedimentary rocks and they range from meta-sandstone or low grade quartzite to garnet-granulite and amphibolite. This is a really good place to investigate the layered metamorphic rocks and observe mineralogical changes from layer to layer. These changes probably represent the differences between shales, sandstones and calcareous siltstones in the original sedimentary rocks prior to metamorphism 1.7 billion years ago. That's right, this was an ocean back then, with mountains and volcanoes and back arc basins, all smashing up onto the continent of Proto-Pangea, the original supercontinent.

Hope you like this and I hope to get back out there with you all again sometime! -- Wil Bussard

End




Typical structures in migmatites. The lighter areas are rich in quartz and feldspar; the darker portions are richer in mafic constituents. [From K. R. Mehhnert, 1968, *Migmatites and the Origin of Granitic Rocks* (Amsterdam: Elsevier), Fig. 1a, b.] Ehlers, and Blatt, 1985.



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