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SURVEYING THE GRAND CANYON OF THE COLORADO

An Account of the 1923 Boating Expedition of the United States Geological Survey

BY LEWIS R. FREEMAN

SEVEN of our United States are vitally interested in the great Colorado River which, with its major tributaries, has a length of more than 1,700 miles and the phenomenal fall of 10,000 feet between its head waters in the Rocky Mountains and its mouth in the Gulf of California.

The control of the flood waters of this mighty river and the utilization of the power which now goes to waste in its drop of nearly two vertical miles, as well as the vast irrigation projects which have been and are yet to be developed along its course, directly concern the citizens of Wyoming, Colorado, Utah, New Mexico, Arizona, Nevada, California, and our neighboring Republic of Mexico.

The most spectacular section of the Colorado River Basin is the Grand Canyon, with its mile-high, multihued walls, which in any list of natural wonders of the world inevitably stands among the first.

More than half a century ago John Wesley Powell made two daring and historic voyages through this Grand Canyon and later published some remarkably interesting narratives of his explorations.

Probably the work of no other explorer of the nineteenth century—not even that of Stanley and Livingstone in Africa—has survived a period of fifty years with so little modification from the observations of those who followed.

But with the vast projects for irrigation, flood control and power development which now engage the thoughts of empire-builders of our West, more specific information than that obtained in 1872 has become essential. Therefore, in the summer of 1923, the United States Geological Survey, a government bureau which in large measure owes its establishment to Powell, the pioneer explorer of the Colorado, organized an expedition to make a new map of the Grand Canyon—the last stretch of the great river which remained to be accurately surveyed.

PERSONNEL OF THE PARTY

Claude H. Birdseye, Chief Topographic Engineer of the Geological Survey, was named to organize and head the expedition. With the surveying of Mount Rainier and of the crater of Kilauea and other notable field work to his credit, he was especially well fitted for the arduous work.

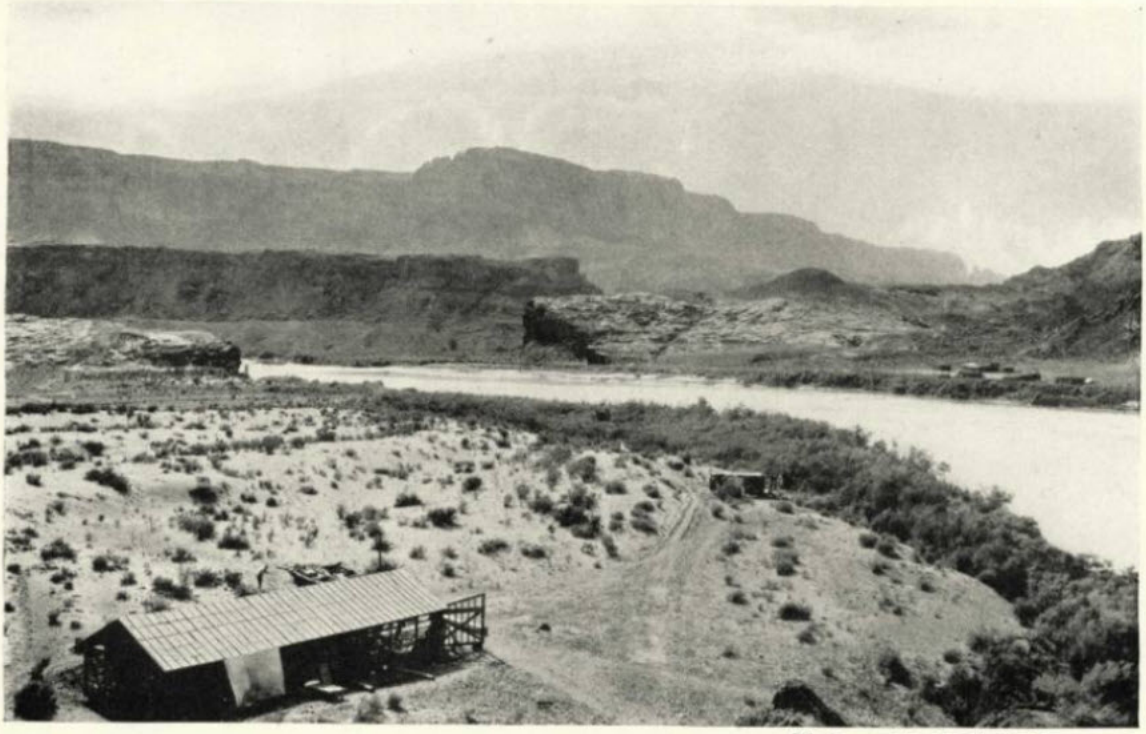
The Geological Survey party assembled in Flagstaff, Arizona, on July 15. The leader, a topographic engineer, a hydraulic engineer, a geologist, a rodman, a cook, and one boatman for each of four boats comprised the party.

R. W. Burchard, the topographic engineer, had surveyed the Boulder Canyon dam site, as well as most of the river between the foot of the Grand Canyon and

Photograph by E. C. La Rue

ONE OF THE CANYON EXPEDITION BOATS BEING TRANSPORTED BY MOTOR TRUCK TO LEES FERRY

At some points on the road from Flagstaff, Arizona, it was necessary to rebuild the road (see text, page 473).



Photograph by Lewis R. Freeman

THE BOATHOUSE AT LEES FERRY, WITH VERMILION CLIFFS IN THE DISTANCE

Three of the boats to be used by the expedition were here when the party arrived (see text, page 473).

THE SURVEY PARTY AT LEES FERRY

Left to right: Leigh Lint, boatman; H. E. Blake, boatman; Frank Word, cook; C. H. Birdseye, leader of the expedition; R. C. Moore, geologist; R. W. Burchard, topographer; E. C. La Rue, hydraulic engineer; Lewis R. Freeman, boatman, and Emery C. Kolb, head boatman.

Needles; also 35 miles at the lower end of the Grand Canyon itself.

R. C. Moore, of the University of Kansas, geologist of the expedition, owed his appointment to the fact that he is an authority on the geology of the middle Colorado Canyon region, a former college athlete, and a veteran of many a hard summer's field work in the desert West.

The hydraulic engineer of the expedition was E. C. La Rue, of the Water Resources Branch of the Geological Survey, who qualified for that appointment through many years of specialization on Colorado River problems.

The boatmen of the expedition were H. E. Blake and Leigh Lint, two trappers and rivermen from the Northwest; Emery Kolb, the Grand Canyon photographer, and myself. Frank Dodge, the rodman, was also a competent boatman and by long odds the best swimmer in the expedition.

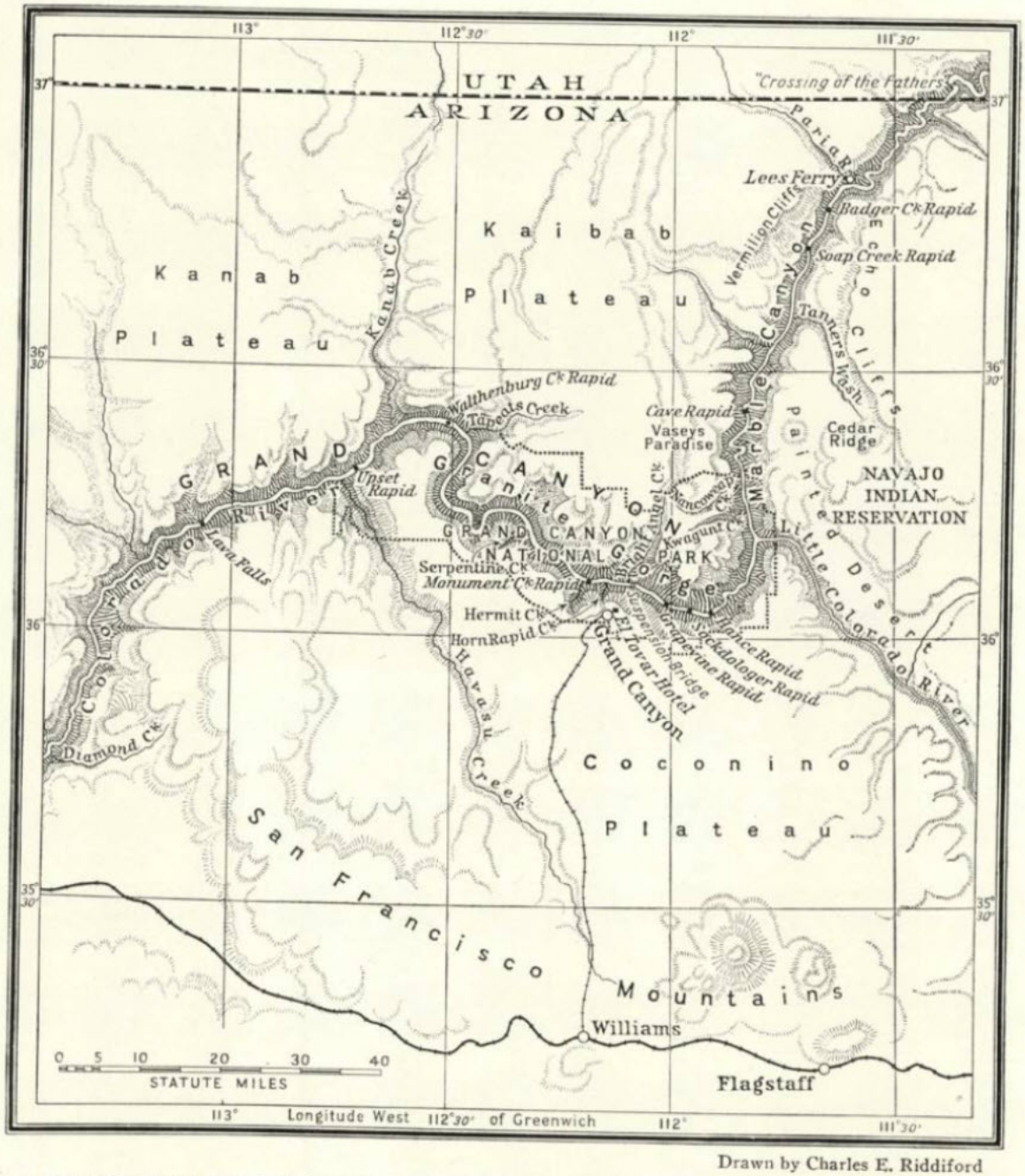
AT THE POINT OF EMBARKATION

Three of the boats to be used by the expedition were already at Lees Ferry; a fourth, built at Los Angeles Harbor, awaited us at Flagstaff. A cradle of heavy timbers was built on the truck to relieve the strain on the latter craft during a 140-mile run over ungraded mountain and desert roads to the river. With 10 feet of overhang behind the truck, men had to ride the radiator on the climbs to keep that vehicle from rearing like a balky horse (see page 472).

A second truck and two autos carried the remainder of the party and outfit.

Leaving Flagstaff at noon of the 18th, we camped that night at the Cedar Ridge trading post of the Navajo Indian Reservation. Pushing on early the following morning, we were delayed by the necessity of repairing washouts from a recent cloud-burst in the road along Tanners Wash. In spite of the tendency of the overhanging tail of the boat to wag the truck, little real trouble was encountered.

The gorge of Marble Canyon was as baffling as ever in its concealment, as we approached it across the plateau. It was impossible to say with certainty, judging



Drawn by Charles E. Riddiford

A SKETCH MAP OF THE GRAND CANYON: THE 1923 EXPEDITION BEGAN ITS VOYAGE AT LEES FERRY

Twenty-one new dam sites were surveyed by the Grand Canyon party and the Diamond Creek dam site was resurveyed. The Geological Survey is now preparing a report which will give details of the possibilities for power development, flood control, and irrigation at each of these sites. The complete course of the Colorado River is shown on the Map of North America which is issued as a supplement with this number of THE GEOGRAPHIC

only from what met the eye, that even so much as an arroyo or gully intervened between the road and the wall of the Vermilion Cliffs towering against the northwestern sky. Yet the ever-deepening chasm of the world's most profound canyon was at times less than a mile distant from our winding desert track.

At the old Mormon dugway we were confronted with the alternative of unloading the boat and taking it down to the river by a long-unused stretch of grade or

Photograph by E. C. La Rue

THE "MARBLE" BEING SOAKED READY FOR THE TRIP THROUGH THE GRAND CANYON

This, one of the three boats loaned to the expedition, had been exposed to sun and dry air for two years. It had to be thoroughly reconditioned (see text, page 479).

trying to run it through on the truck. Fortunately, we decided upon the latter. Notwithstanding the fears of the driver that the boat was too long for the shelving curves, it rode through with plenty to spare.

Camp was made at the boathouse of the Southern California Edison Company, on the right bank of the river, just below the cable ferry. A temperature of 110° Fahrenheit in the shade, with considerable humidity, was trying, after the exhilarating mountain air of Flagstaff. As this was the sort of thing to be expected for the next month and a half, however, nothing was to be gained by waiting for a cooler spell.

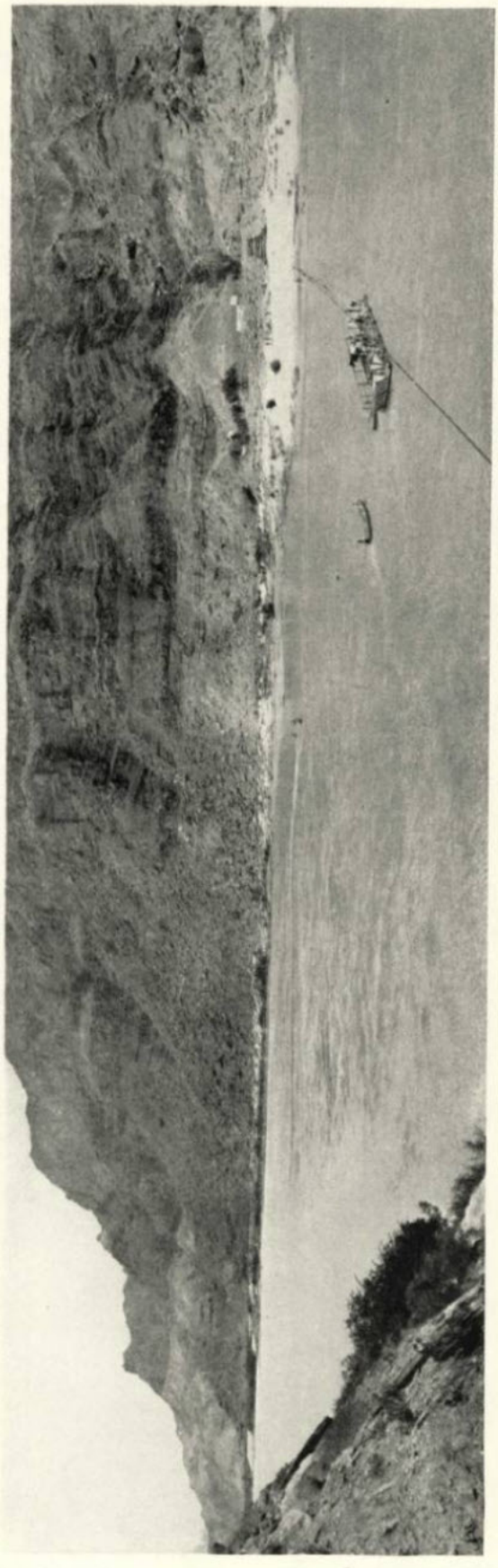
THE MOUTH OF THE PARIA HAS DRAMATIC HISTORY

The end-of-the-day plunge in the river that evening after work was over became an established feature for many weeks. The water was red with mud at its clearest; but it was a clean sort of mud, as mud goes, and came off freely under vigorous toweling. Until we were far enough down-river to be exposed to the liquid filth poured out by the floods of the Little Colorado, our evening, morning, and interim dips were refreshing.

The mouth of the Paria, from where our start was to be made, is one of the most historic points on the Colorado. Fray Escalante, searching for the ford which has since been called "The Crossing of the Fathers," camped there in 1776, seeking a way to reach the left bank of the Colorado. The "great gray cliff" where his party starved on horse meat and toasted cactus fruit is readily recognizable.

James Pattie, the trapper, passing here in the middle twenties, expressed his relief at coming out even temporarily from "the horrid mountains."

Powell, making an overnight camp at the Paria in early August of 1869, pushed off into the depths of Marble Canyon the following morning, on the final stage of his pioneer voyage. He met neither Indians nor whites in the valley at that time, but three years later his second expedition found the Mormon renegade, John



Photograph by E. C. La Rue

LEES FERRY FROM THE LEFT BANK

This point on the Colorado derives its name from a renegade Mormon who, after eluding officers of the law, cultivated a fertile patch of ground here. He was eventually captured, tried, and executed as the instigator of the Mountain Meadows Massacre. The voyage of the 1923 expedition from Lees Ferry to Needles, where the party disbanded, required 80 days.

D. Lee, farming a patch of fertile overflow land above the ford which still bears his name.

Lee was a fugitive from justice, being widely sought by the Federal authorities as the instigator of the Mountain Meadows Massacre of 1857, a crime for which he was finally tried, found guilty, and executed.

Dellenbaugh writes in delightful vein of the way in which he and one or two of the younger members of the second Powell party helped Sister Emma (Mrs. Lee XVIIIth) irrigate her melon patches, and how Jack Hillers got no end of a rise from the nervous fugitive by cocking a gun behind him during Lee's Sunday sermons.

The Brown-Stanton party, surveying for a railroad through the Grand Canyon, halted and refitted at Lees Ferry in July, 1889, after losing much of their inadequate outfit in the rapids of Cataract Canyon. Three of the eight men of the reduced party were lost within a few days of putting into Marble Canyon, forcing the temporary abandonment of the expedition.

Stanton's reorganized party had Christmas dinner at the Ferry six months later, before resuming the uncompleted survey. A few days afterward that indomitable leader was back again, this time to seek help to bring out his photographer, who had broken his leg by a 20-foot fall.

No place on the river has the power to awaken more memories of the past than Lees Ferry, but, strangely, little remains that can be touched save by the imagination. Lee's first log cabin and his four-way lookout on a point above the Paria are still

there, but all we ever found that pointed to one of the early navigators was the name HISLOP, pricked in large capitals on the red sandstone of the house now occupied by the Government hydrographer. That could only have been the stout Scotch engineer, John Hislop, Stanton's right-hand man on both voyages. Hislop, after surviving the passage of the Grand Canyon rapids and several years in pioneering railroad work in Alaska, was finally killed by a street-car while home on a vacation.

EXPEDITION'S BOATS WERE FLAT-BOTTOMED AND DECKED OVER

The four boats used on our expedition, while differing slightly in size and details, were all of the flat-bottomed, decked-over, one-man type that is appropriately called the Galloway-Stone. The somewhat crude original was designed and built by Nathan Galloway, a Mormon hunter, for use on his lone-hand trapping expeditions to stretches of the upper Colorado canyons.

On the sound theory that it is better to avoid a rock in a light boat than to hit it with a heavy one, Galloway sacrificed strength for handiness, but built a boat which he repeatedly ran single-handed through rapids in which the large, heavy boats of Powell and Stanton had encountered much trouble.

When Julius F. Stone, an Ohio manufacturer, scientist, and sportsman, decided to make a voyage to photograph and study the geology of the Colorado River canyons in 1909, he had Galloway come to his home in Columbus, where the two men put their heads together to build an ideal boat along the lines of that already used with such success by the Utah trapper.

The present type of the Grand Canyon boat was the result. It was entirely decked over, except for a cockpit for a single oarsman, and weighed less than 250 pounds. Its length was 16 feet 4 inches, its beam 46 inches, and its depth 16 inches. The material was Michigan white pine five-eighths of an inch thick.

The four boats of this type built to Mr. Stone's order were used with signal success on his voyage through the canyons. The run from Green River, Wyoming, to Needles, California, was made in one week over two months.

Both Stone and Galloway brought their boats through all the way without an upset and with but a single little collision each while under control of the oars—by long odds the best record ever made, both for time and for skillful boatmanship.

THE KOLBS DOUBLED WEIGHT OF BOATS TO INCREASE STRENGTH

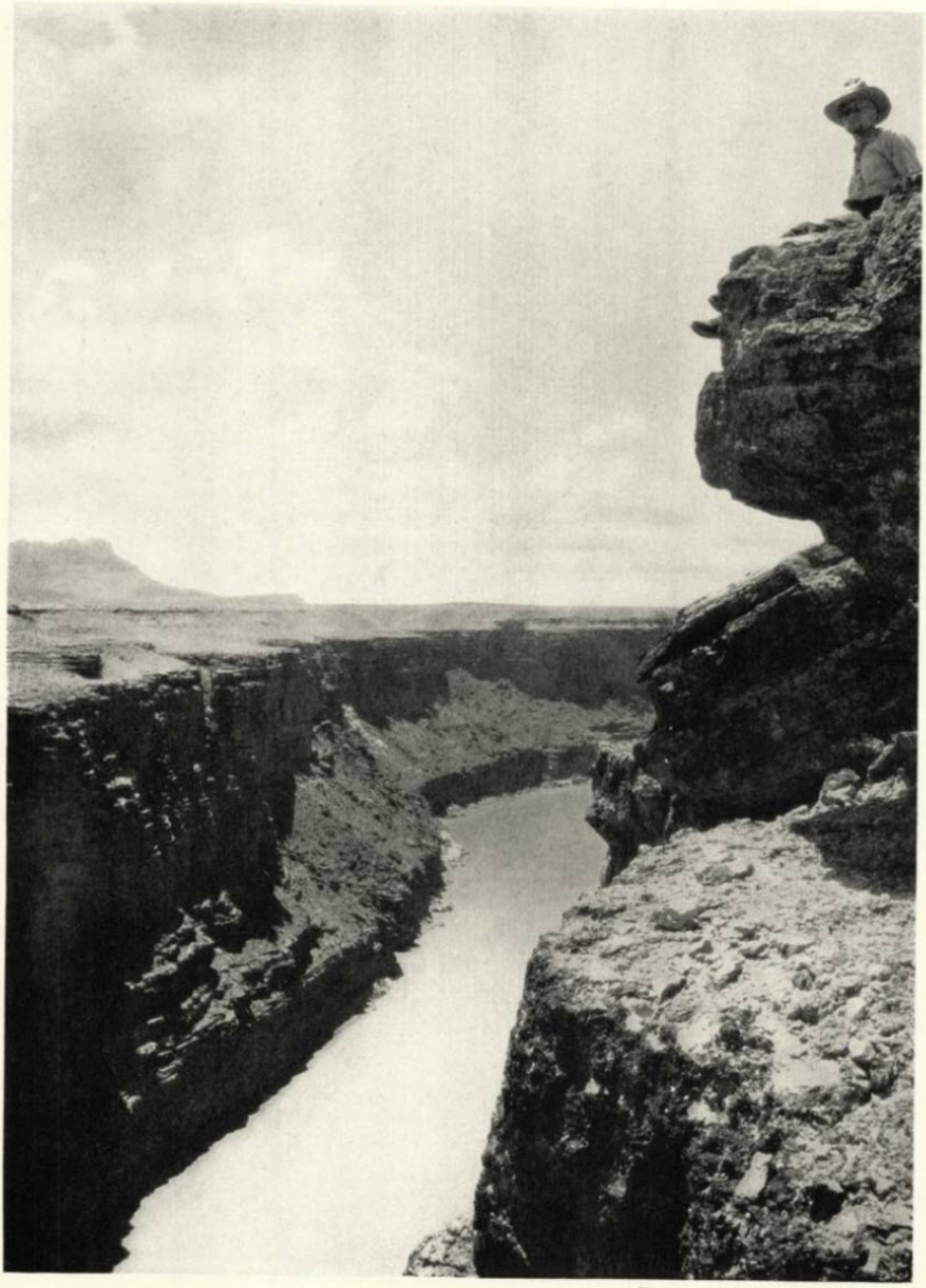
When the Kolb Brothers were planning their photographic expedition through the Colorado canyons in 1911, Mr. Stone furnished them with blue prints of the design of the boat which had served him so well. Desiring a boat of greater strength, the photographers retained the original dimensions, but doubled the weight by using heavier materials. Without greatly decreasing handiness, they materially increased power to withstand punishment. This boat weighed 500 pounds.*

Ten years later, when the Geological Survey and the Southern California Edison Company planned a joint expedition through Cataract Canyon, boats of larger dimensions were needed to carry the heavy outfits. Still retaining the lines of the Galloway-Stone original, 18-foot craft were built, with proportionate increase of depth and beam. These weighed close to 800 pounds and must have had not far from double the cargo capacity of the early prototype.

The fleet assembled for our Grand Canyon expedition consisted of three of these 18-foot boats and a lighter one of slightly different lines having a length of 16 feet.

One of the many interesting things that the coming voyage was expected to reveal was as to whether in the building of this comparatively heavy cargo- and passenger-carrying boat, there had been too great a departure from the original Galloway-Stone craft of extreme lightness and handiness. The latter weighed 243 pounds and was built to carry a comparatively light load and one man—its oarsman. The boats we were about to use were more than three times as heavy as this, carried at least twice the weight of cargo, and were expected to find places for three men; that is to say, there had been an increase of upward of 500 per

* See "Experiences in the Grand Canyon," by Ellsworth and Emery Kolb, in the NATIONAL GEOGRAPHIC MAGAZINE for August, 1914.



Photograph by Lewis R. Freeman

A PLACID STRETCH OF THE COLORADO RIVER NEAR THE HEAD OF MARBLE CANYON

"Ahead the portal of Marble Canyon was the beginning of a black gash cleaving the plateau like the wound from a giant's kriss" (see text, page 485).

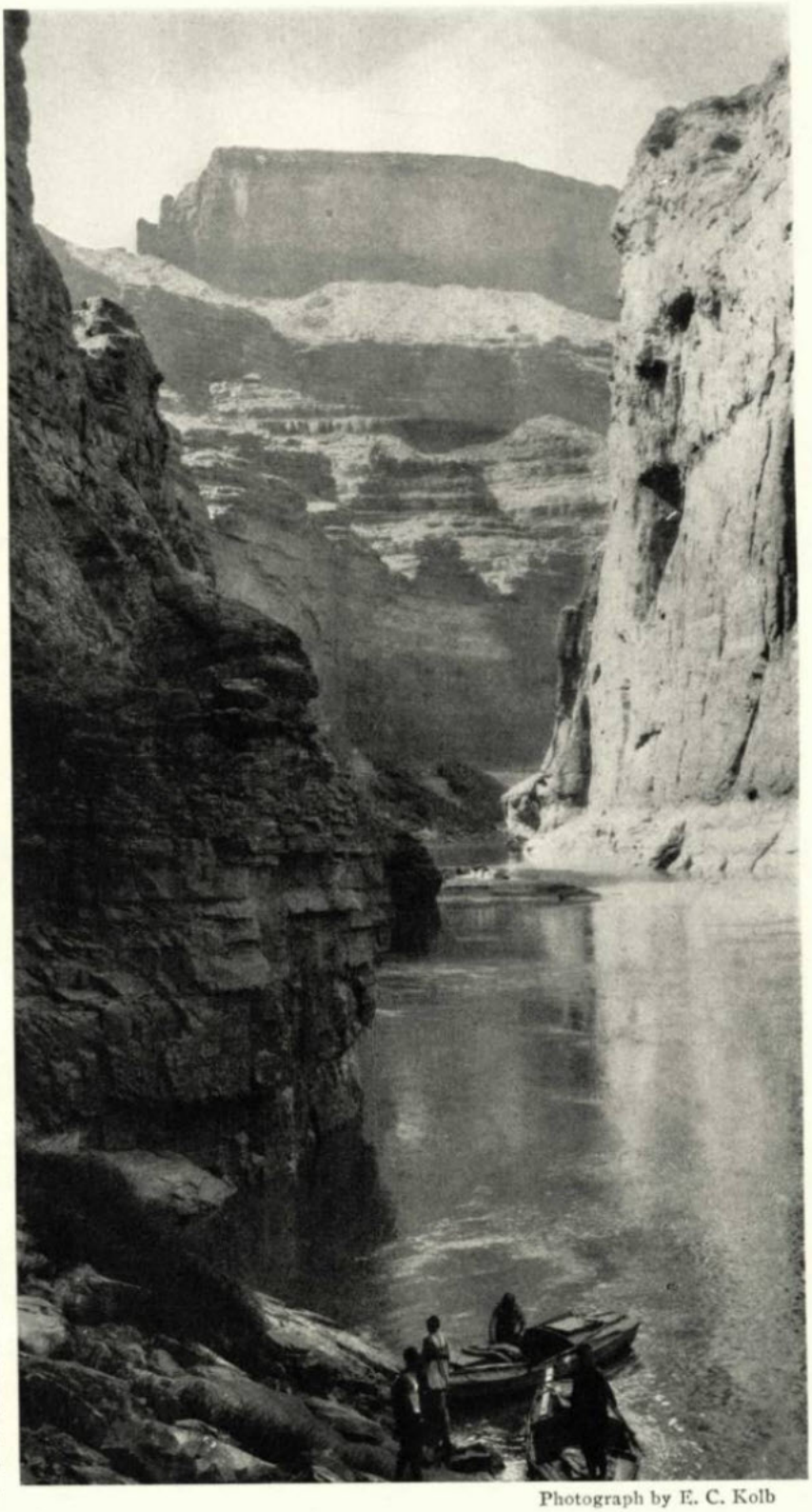
cent in weight without any increase of power.

The latest boat had still to be handled by a single man. Whether the demand was too great—whether too much handiness had been sacrificed for carrying capacity and strength — remained to be seen. The Powell and Stanton boats, it is true, were larger and heavier than these of ours, but they were manned by a minimum of three men each—two rowers and a steersman.

Thirteen days were spent at Lees Ferry getting ready for the voyage. Recoppered, recaulked, and repainted, the used boats appeared tight and thoroughly serviceable. A folding canvas boat, to be used by the rodman and to have below rapids, in the event of trouble, seemed to promise real usefulness—as long as it lasted.

Satisfactory waterproof bags and boxes had been made only after months of trials and experiments, during which all of the tubs and sinks and basins in the Geological Survey wing of the Department of Interior building in Washington had served their turns as testing tanks.

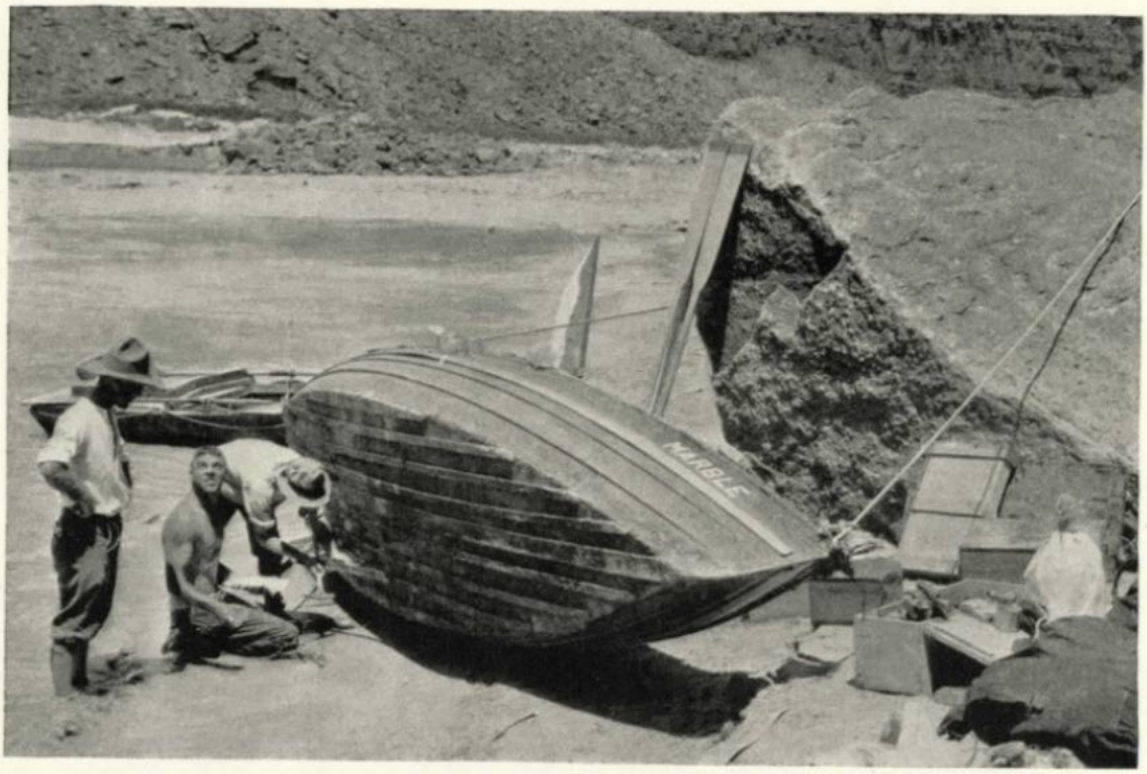
The best protection for bedding, duffel



Photograph by E. C. Kolb

SHEER WALLS IN MARBLE CANYON

The rate at which this canyon burrows its way into the earth never fails to astonish the traveler entering it for the first time. Twenty miles below its head, the walls are 2,000 feet above the river, nine-tenths being due to the rise of the plateau and one-tenth to the descent of the stream (see page 485).



Photograph by E. C. La Rue

THE "MARBLE" BEACHED FOR REPAIRS AFTER RUNNING BADGER CREEK RAPID

The bottom of the path-finding boat was punctured in the first rapid negotiated by the expedition, but the damage was quickly repaired (see text, pages 491 and 493).

and provisions such as flour, sugar and dried fruit, proved to be an inner sack of rubber, covered with an outer one of waterproofed canvas with a double tie.

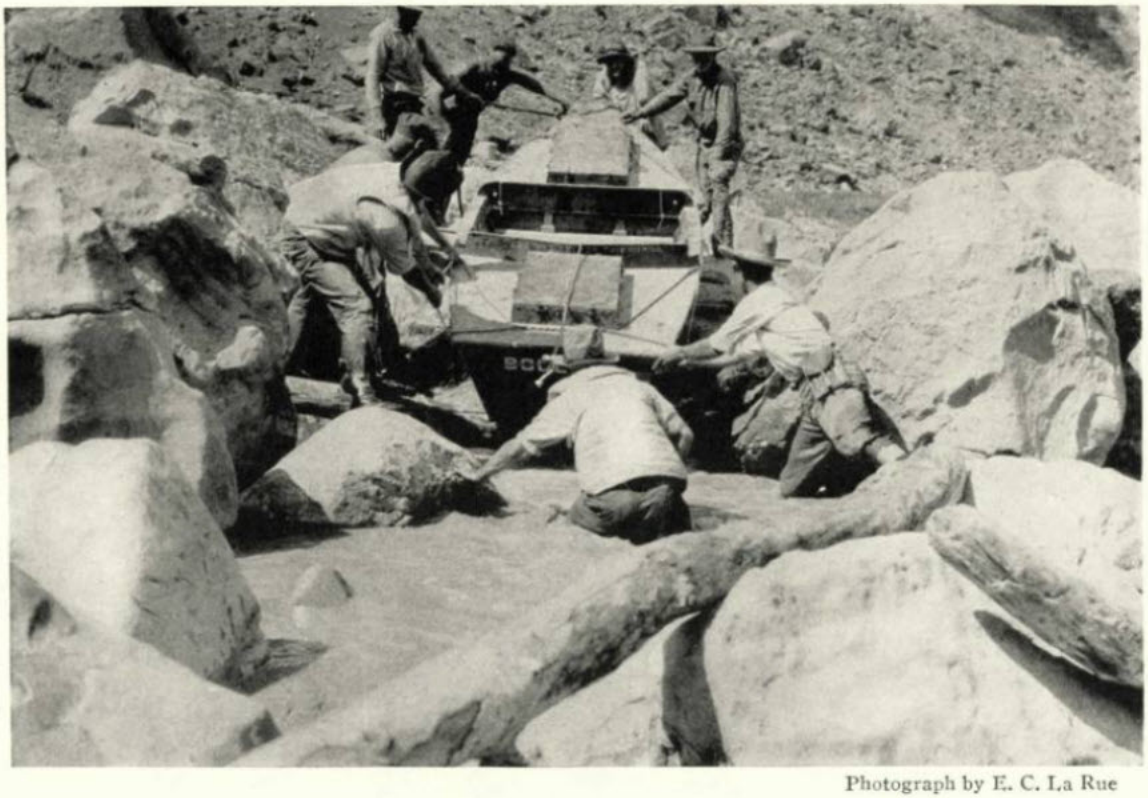
An attempt to make water-tight instrument and camera boxes from galvanized iron was a failure, principally owing to the tendency of the metal to bend under pressure. Further experimentation resulted in a highly serviceable wooden box, the cover of which was held down upon a rubber gasket by brass catches.

WE CARRY A RADIO SET AND SEVERAL TYPES OF LIFE PRESERVERS

Of the several kinds of life preservers provided, the old cork type was the only one giving any great amount of buoyancy. A type of stuffed jacket and an inflatable rubber girdle that just about kept a man up in quiet water were tried and the two worn in combination lifted him higher, but were scarcely less bulky than cork. Real freedom for rowing action in a life preserver was a problem which would have to be worked out by experience. Something of the kind had to be worn in every bad rapid; that was the leader's order and a very sensible one.

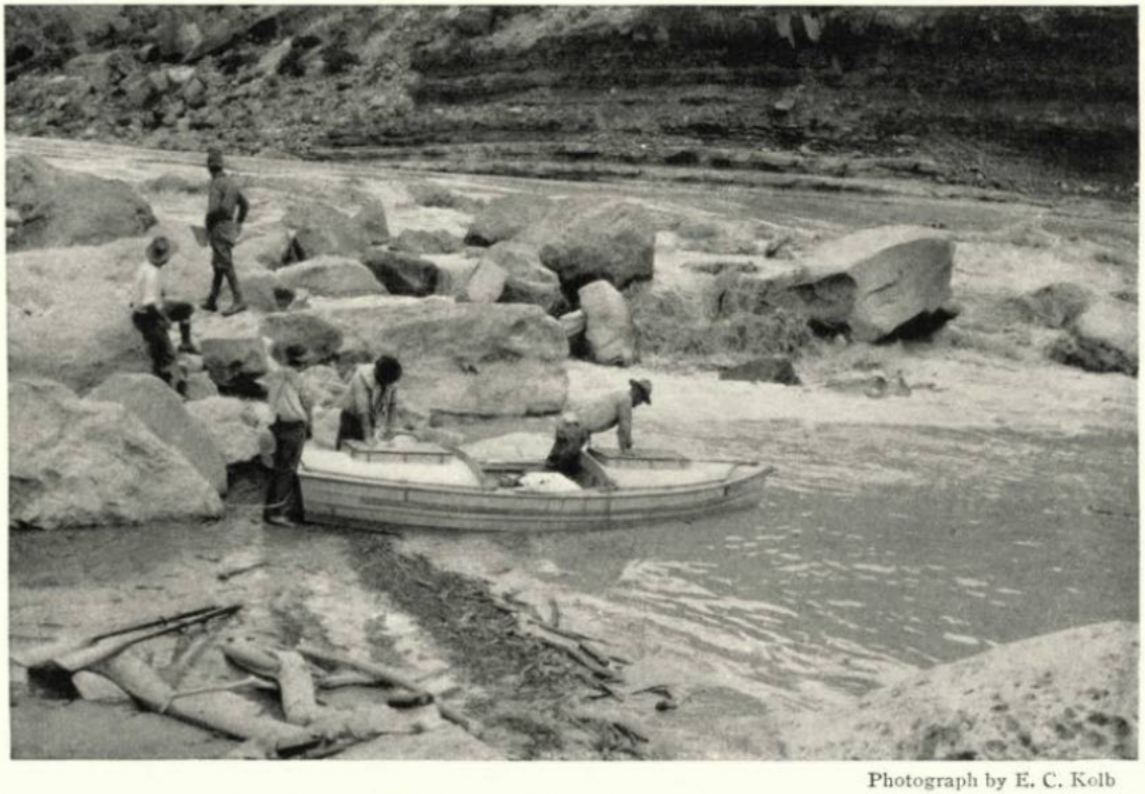
A receiving radio set had been included in the outfit for two reasons: on the chance that it might bring us warning in the event of a flood descending from above and as a possible source of entertainment. The publication of an article in a prominent radio magazine the week we left Flagstaff provided a new line of interest. In this it was stated quite definitely that it was impossible to receive radio messages in any deep, sheer-walled natural depression. As we were about to enter the deepest gorge of this kind in the world, an unparalleled opportunity would be offered to put this theory to the test.

In spite of the interference of daily thunderstorms and terrific heat radiation from the Painted Desert, our set gave good service from the day it was set up at Lees Ferry. The broadcastings of KHJ of a Los Angeles newspaper always came in most clearly, but on several occasions we had stations as far east as Chicago. We had only four earpieces, but an amplifier improvised from a baking



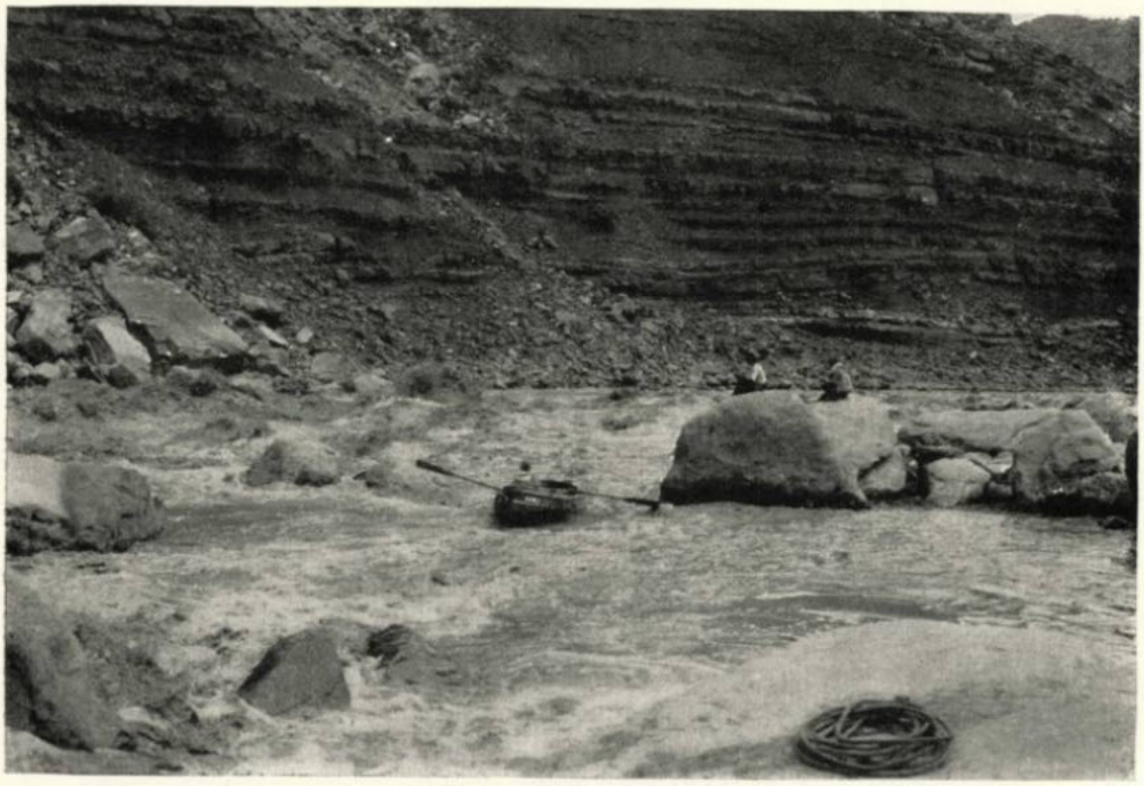
Photograph by E. C. La Rue

THE "BOULDER" BEING SKIDDED OVER THE ROCKS AT THE HEAD OF SOAP CREEK RAPID
(SEE TEXT, PAGE 496)



Photograph by E. C. Kolb

THE "GRAND" AFTER PORTAGE AT SOAP CREEK RAPID
Left to right: Moore, Birdseye, Blake, Lint, and Burchard.



Photograph by E. C. Kolb

THE "BOULDER" RUNNING THE LOWER PART OF SOAP CREEK RAPID

One man of the Stanton surveying party of 1889 lost his life in this turbulent stretch of water (see text, page 496).

powder can and a tin funnel offered entertainment for a wider audience on occasion.

THE BOATS NAMED AND ASSIGNED

Nomenclature of the boats was a serious question, but after much discussion we decided to base it upon Colorado River canyons—gorges which we were to touch or pass through on the voyage. The new boat (see text, page 473, and illustration, page 472) was called *Grand*, the other two 18-footers *Glen* and *Marble*, and the 16-footer *Boulder*. The canvas boat received the name of *Mojave*.

To the *Glen* was allotted the duty of carrying the cooking outfit. Blake was to be its boatman and the cook its passenger. The *Boulder* was designated as survey-boat, to be handled by Lint, with Birdseye and Burchard as passengers.

The *Grand* was given to me to handle, with Moore and La Rue as passengers. Besides geology and hydraulics, we were to specialize on pictures. La Rue had a small moving-picture machine and two or three ordinary cameras. I had two cameras, to be used where they did not interfere with my boating work.

Kolb, with the *Marble*, had no passenger at the outset. Dodge was to carry the rod in the *Mojave*.

Of the four regular boatmen, Lint, Kolb, and Blake had put in several seasons of work in the Galloway-Stone boats; with some little previous rough-water experience, I pulled an oar in this type of boat for the first time. Dodge rowed well and was still more at home in the water.

Of the engineers, Birdseye, Moore, and La Rue had done some rowing. Both the leader and the geologist had good natural water-sense and took to the river like ducks. Before the voyage was over either would have qualified for a boatman's job had the occasion arisen.

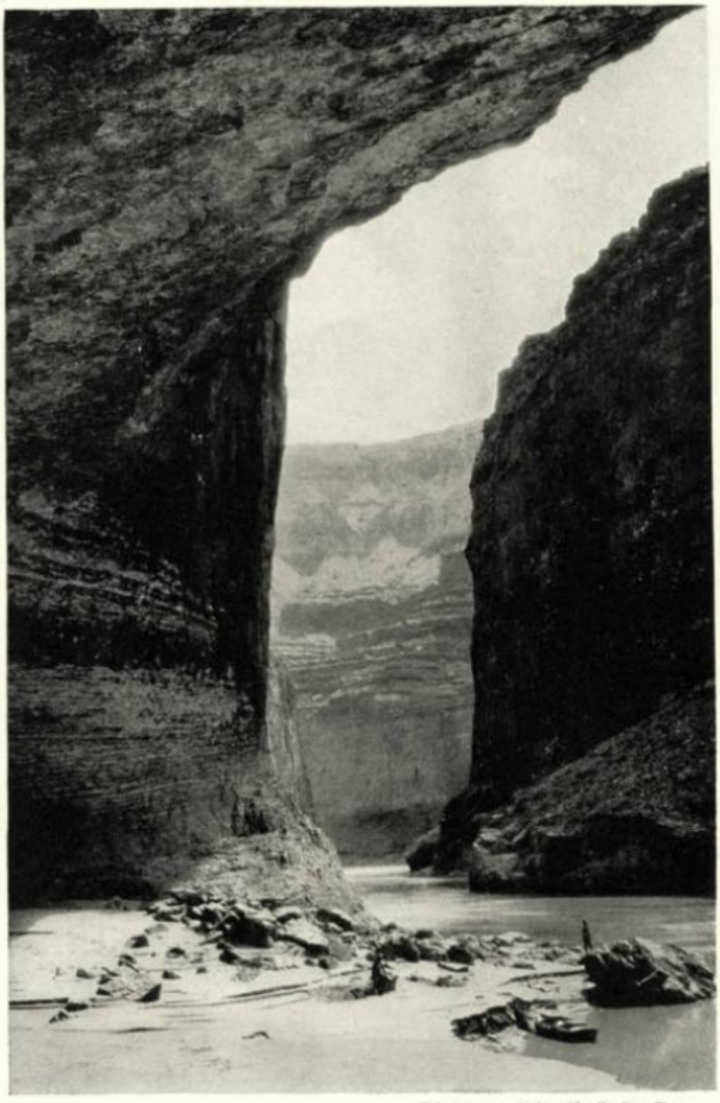
LAST-MINUTE SUPPLIES

A line on the multifarious needs of an expedition such as that upon which we were about to embark may be gained from a list of last-minute purchases which Roger Birdseye, our land manager, drove

out to make in Flagstaff the final week in July. Although six months of study and thought had been put into the outfit, which was supposed to be complete when we came in a fortnight previously, there were about a hundred additional items that seemed desirable. Another formidable list was made up of things to be brought down to meet us at the foot of the Hance Rapid, below the mouth of the Little Colorado (see text, page 498).

The ability to secure necessities of every description in a comparatively short time was the outstanding advantage that this expedition had over those of earlier Colorado Canyon navigators. Powell's first party was able to replenish supplies only once after the start from Green River, Wyoming, and the second party only three or four times.

As the time for starting approached, it became evident that we must expect to cope with unseasonably high water. The river, which Mr. Cockroft, the Government hydrographer, reported as flowing from 30,000 to 35,000 second-feet during our first week at the Ferry, was still holding up around 25,000 second-feet at the end of the month—well above the normal for that time of year.



Photograph by E. C. La Rue

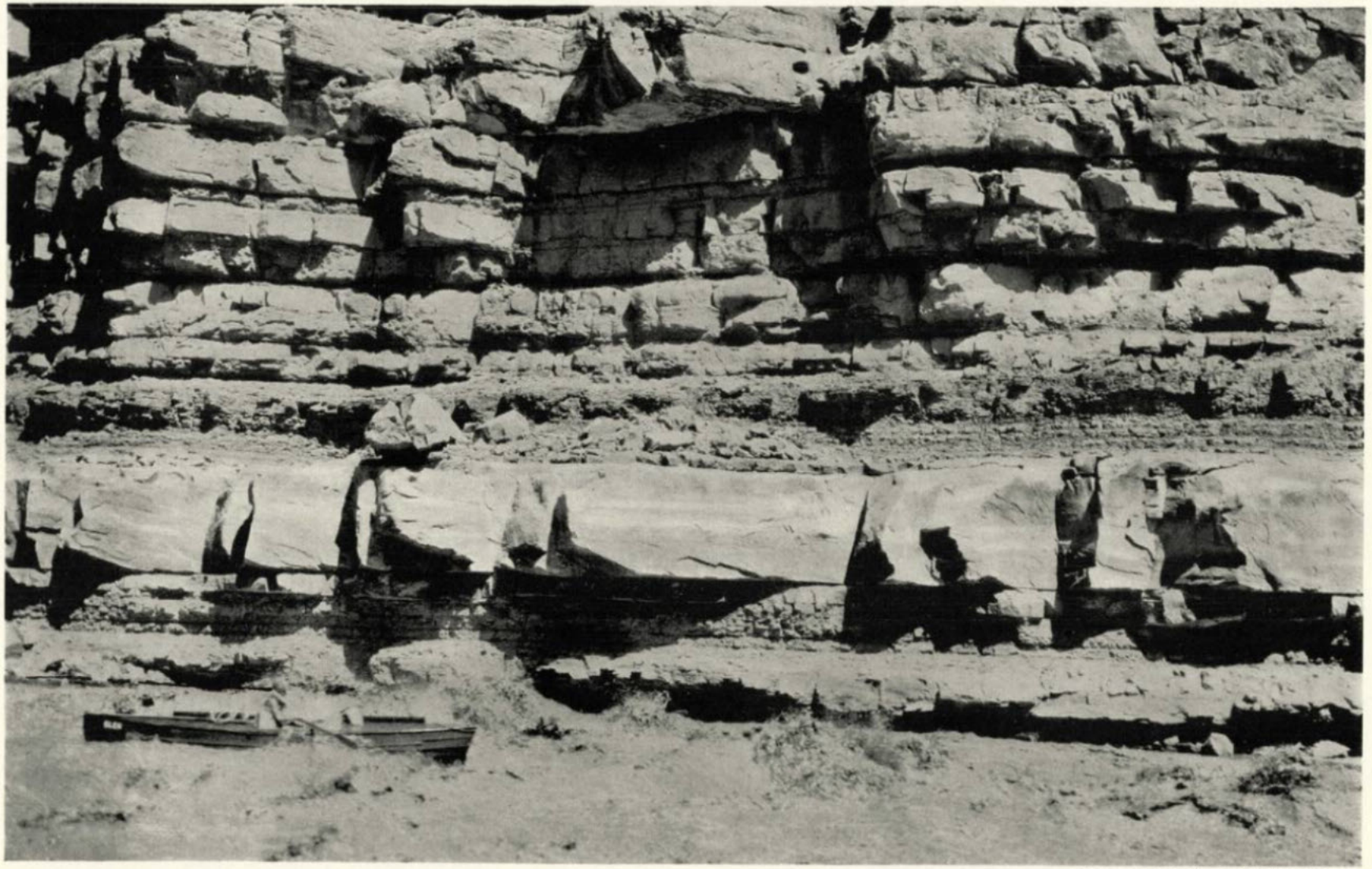
A DOWNSTREAM VIEW OF MARBLE CANYON: AT THE LEFT IS A BIG CAVE (SEE TEXT, PAGE 513)

Just how this condition would affect navigation was problematical. Generally speaking, extreme low water is considered safest, especially where there is much lining or portage to be done. With our heavy boats and loads, however, it seemed quite possible that well-filled gorges and deeply covered rocks might be desirable. This, like a number of other things, remained to be seen.

We had been provided with a manual of navigational information which had been compiled by Herman Stabler, Chief of Land Classification Branch of the Geological Survey, from a study of all available reports and accounts of previous voyages. This manual gave mileage, estimated falls of rapids, and data as to how other voyageurs had surmounted difficulties.

READY FOR THE START

By far the most complete record proved to be that kept by Frederick Dellenbaugh, of the second Powell expedition; but as this ended at the mouth of the Kanab, only about half of the Grand Canyon was covered. Excerpts from Powell's report of his first voyage were also included in Mr. Stabler's interesting record, as well



Photograph by Lewis R. Freeman

THE "GLEN" IN SOAP CREEK RAPID

H. E. Blake, in the cockpit, has about his neck an inflated rubber life preserver, worn by order of the leader while negotiating every dangerous rapid.

as notes from those of Stanton and the Kolb Brothers.

After packing and shaking down outfit most of July 31, we were ready for an early start on the morning of August 1.

The mountainous piles of supplies on the bank seemed sufficient to tax the capacity of a deep-seagoing freighter — enough to swamp our diminutive shallops many times over; but the holds of the latter admitted an astonishing amount of cargo, and we finally took everything needed without having to remove the safety air tanks.

With their full loads, all four boats were well down in the water, especially the *Grand* and the *Boulder,* which were carrying two passengers each. My boat seemed strangely heavy and slow in responding to the oars, as we swung out into the current, but that was partly from the contrast to the way it had responded when empty.

It was a morning of bright sunshine on the river, but above the gay slash of the Vermilion Cliffs piles of snowy cumuli were gathering for the afternoon thunderstorm. To the south the terra-cotta walls of the Echo Cliffs were etched with the cross-lights of the early sun. Astern the yawning mouth of Glen Canyon was a pool of purple shadow; ahead the portal of Marble Canyon was the beginning of a black gash cleaving the plateau like the wound from a giant's kriss.

"Out of the dark and into the dark,
With only a sleep between."

How well the lines described Powell's overnight camp at the mouth of the Paria! Even a boat that was showing an annoying tendency to work in toward the cliff below the old Mormon dugway could not quite take my mind off the pioneer canyon navigator at that moment. He had found easy going in the long quiet reaches of Glen Canyon, but ahead was the Unknown in the most sinister aspect it had yet assumed. He was too good a geologist not to read the warning in the changing formations, for he wrote:

"With some feeling of anxiety we enter a new cañon this morning. We have learned to closely observe the texture of the rock. In softer strata we have a quiet river; in harder, we find rapids and falls. Below us are the limestones and hard sandstones we found in Cataract Cañon. This bodes toil and danger."

To none of the later parties, including our own, was the menace of the canyons ahead what they were to Powell. We had the same rapids to face, to be sure, but their positions had been fairly well charted, and we knew that, in one way or another, they could be passed without prohibitory risk. We had ample food supplies and repairs, with replenishment always waiting a few miles ahead. Powell ran the whole length of the canyons of the Colorado with the shadow of the Unknown just ahead, and all of the Grand Canyon with the specter of Starvation clutching with grisly hand at the steering oar.

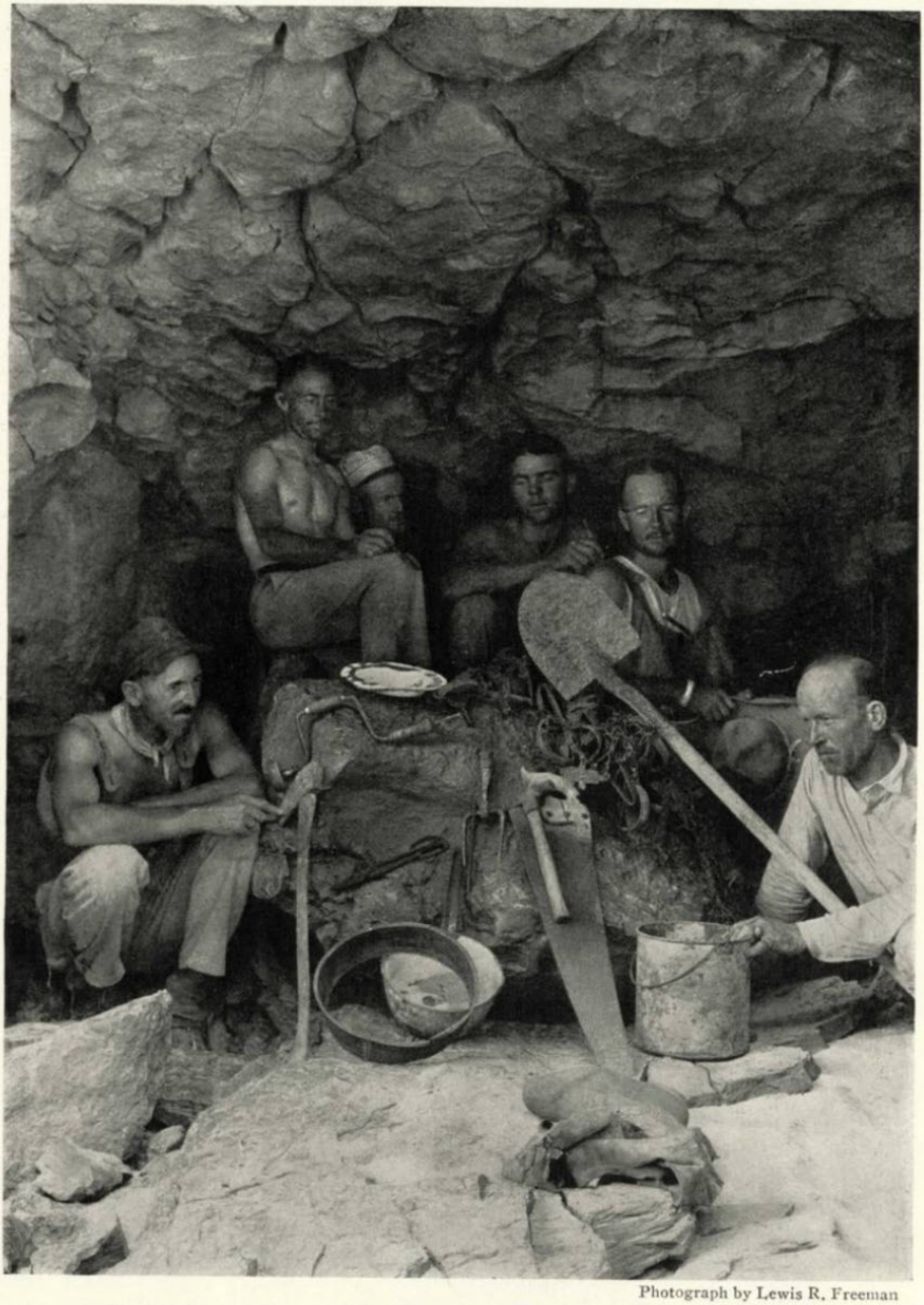
A FAREWELL CAKE

As we dropped down past the old stone houses of the hydrographer's station, Cockroft paddled out in his canoe and delivered a parting gift from his wife in the form of a cake. It bore some sort of a farewell message in white frosting on pink, all pegged on with toothpicks to keep it from slipping when it melted in the mounting heat.

Just below the dugway, where the first outcropping patch of limestone marked the beginning of Marble Canyon, Birdseye and Burchard landed and began work by tying the river line into the completed survey from Glen Canyon.

The rate at which Marble Canyon burrows its way into the bowels of the earth never fails to astonish the traveler entering it for the first time. The uprearing of the walls is due both to the rapid rise of the sundered plateau and to the fall of the river; mostly to the former. The river drops at the rate of about 10 feet to the mile, or 200 feet in 20 miles. At that distance from the head of the canyon the walls are 2,000 feet above the river, having risen at the average rate of 100 feet to the mile. Thus it would appear that, in this section of Marble Canyon, nine-tenths of the height of the walls is due to the rise of the plateau and one-tenth to the descent of the river.

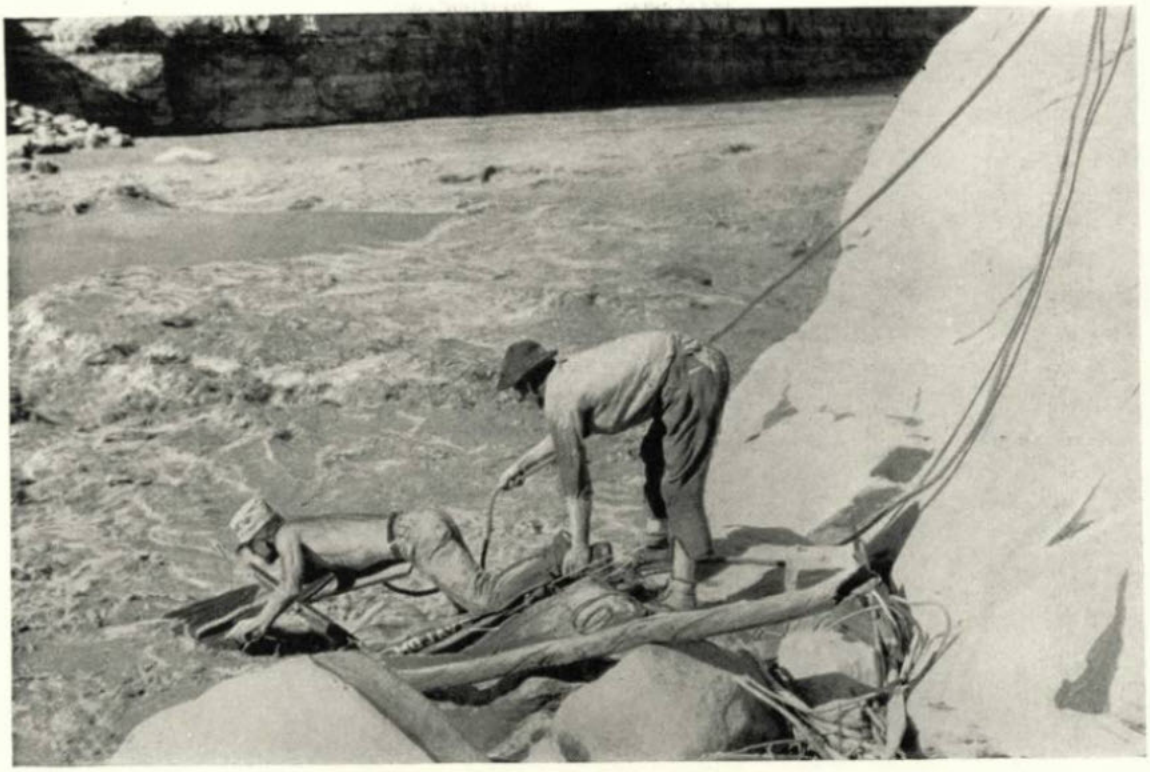
At three miles from the Paria we stopped to look over the first riffle of any size in the canyon. Some rocks showed at the surface near the head on the right, but were easily avoidable. The boats



Photograph by Lewis R. Freeman

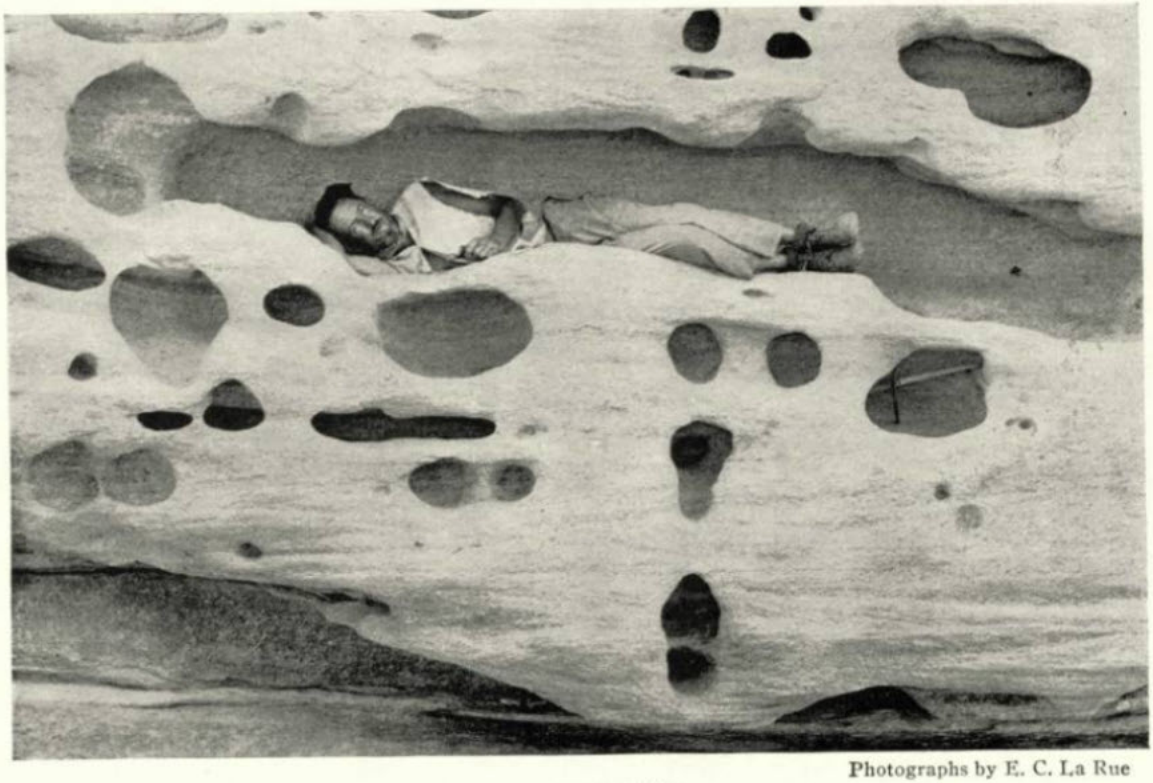
MYSTERY ENVELOPS THE FATE OF THE TRAPPERS WHO LEFT THIS EQUIPMENT

The cave in which these objects were found by the Grand Canyon Expedition is below high water mark, so that lighter articles must have been swept away. It is surmised that the owners' boat was lost in the rough water immediately below, now christened "Cave Rapid" (see text, page 510).



THE CANVAS BOAT "MOJAVE," WRECKED IN CAVE RAPID (SEE TEXT, PAGE 513)

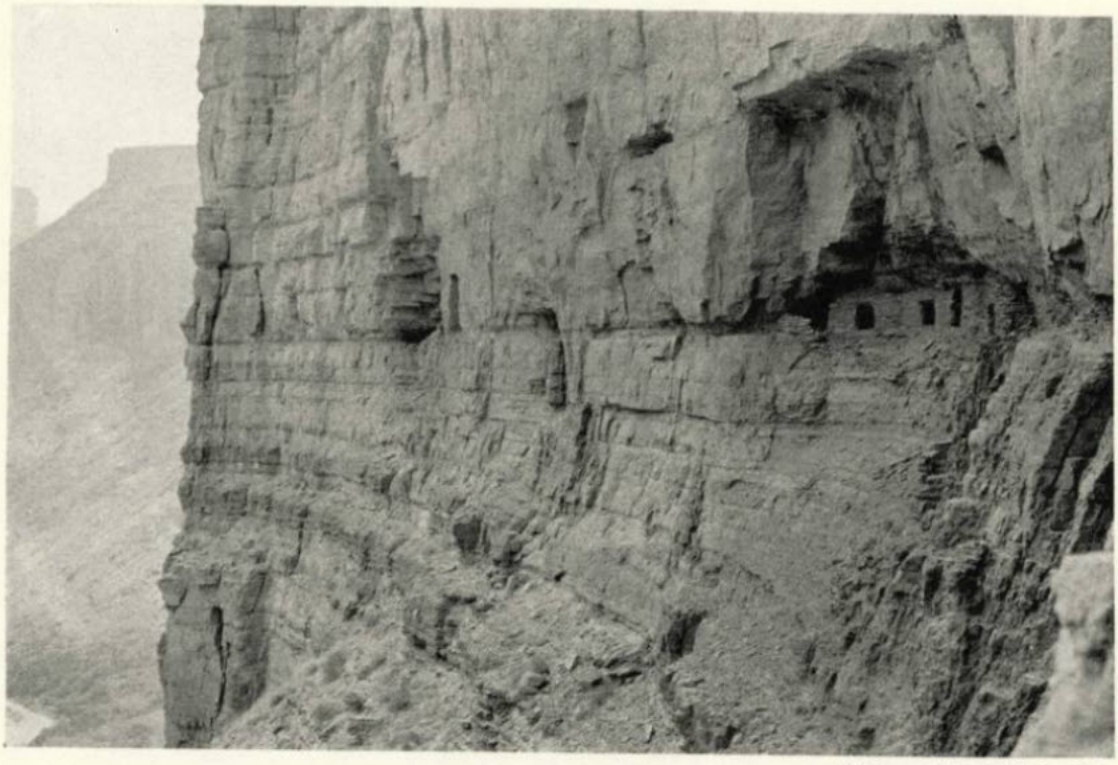
Only one oarlock and some kindling wood were salvaged after the frail craft smashed on the rocks.



Photographs by E. C. La Rue

A HARD BERTH

The water has carved oddly shaped recesses in the limestone which forms the wall one mile below the mouth of the Little Colorado River.



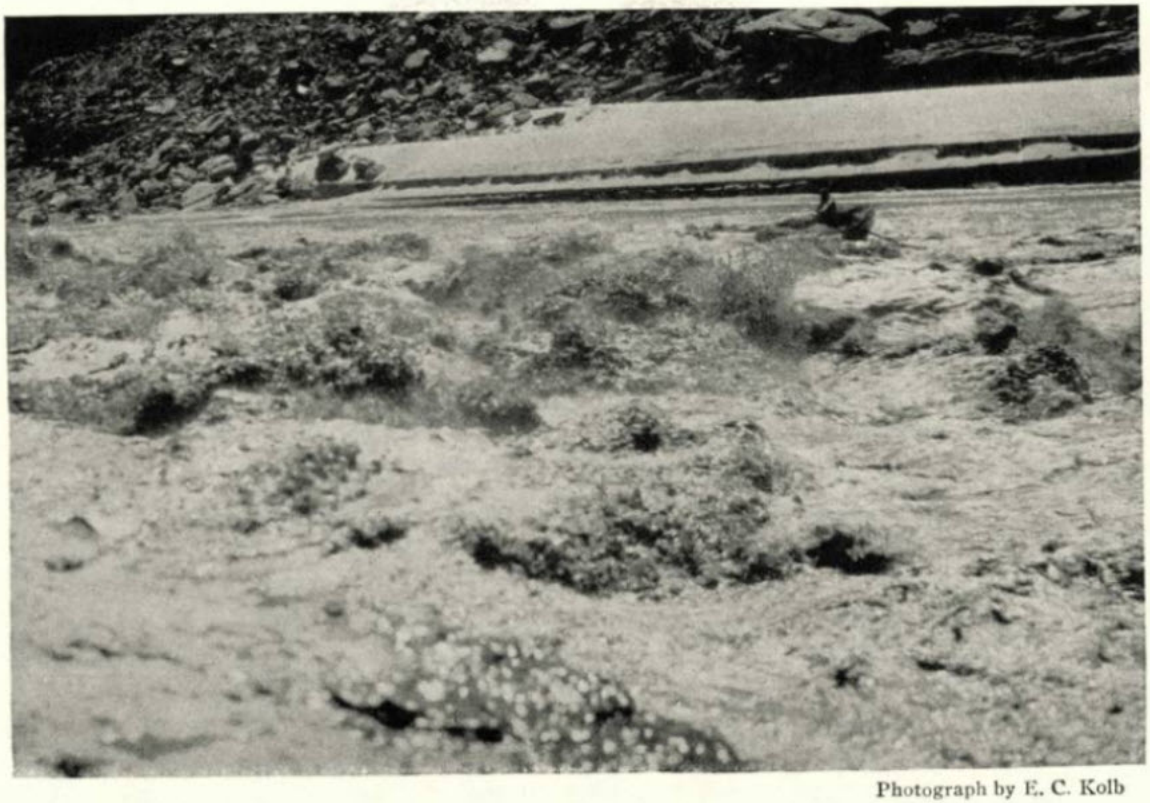
Photograph by E. C. La Rue

CLIFF DWELLINGS 600 FEET ABOVE THE RIVER, ON THE NORTH WALL NEAR NANCOWEAP CREEK, BELOW THE MOUTH OF THE LITTLE COLORADO

Photograph by E. C. Kolb

IN THE "MARBLE" IN KWAGUNT RAPID

The 1923 party encountered rougher water here than had any preceding expedition, due, in all probability, to an accession of boulders brought down the Kwagunt on the crest of some recent cloud-burst.



Photograph by E. C. Kolb

THE "GRAND" IN RAPIDS 11 MILES ABOVE VASEY'S PARADISE

Such a vast amount of sediment is carried down by the swift current of the Colorado that the rapids never froth white, but present uptossed ruffles of gray foam which when photographed resemble churned lava.

bobbed through at a lively rate, but without taking much water. We tied up for lunch at a so-called bridge site a mile farther down the river—a narrow section with abrupt walls nearly 500 feet in height on either side.

The bridge plan is an Arizona project for linking the two sections of that State now almost inseparably divided by the Grand Canyon. If the structure is ever built it will have no rival in height for a long time. It will be approximately 600 feet long and will be 500 feet above the water.

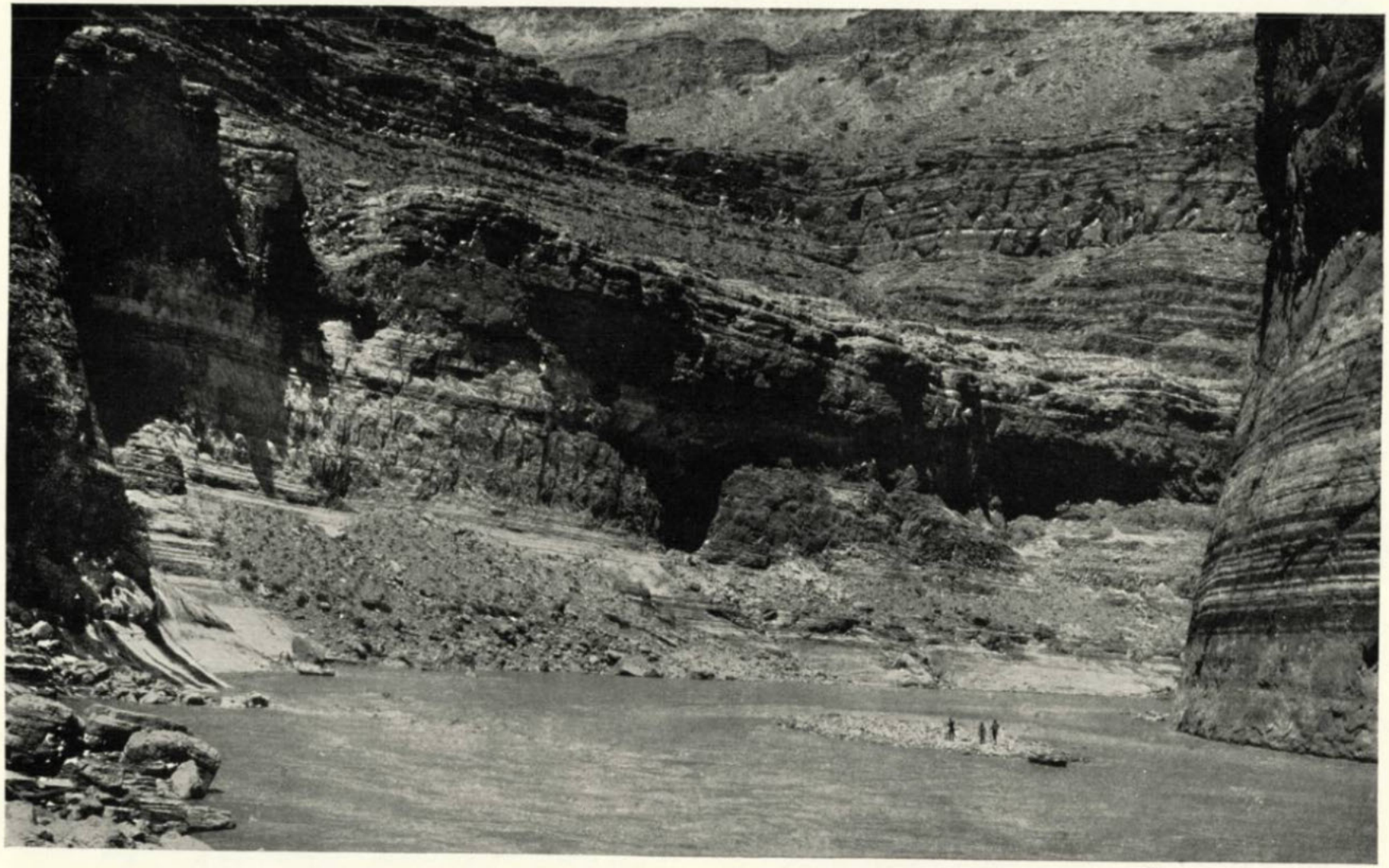
A THUNDERSTORM BETWEEN ROCKY WALLS

After running another small riffle, a half-mile pull in quiet water brought us in sound of a heavy roar which we knew to be that of Badger Creek Rapid. We came in sight of it 20 minutes later—an uptossed ruffle of gray foam (the Colorado's muddy current never froths white) beyond which the river dropped completely from sight.

Pulling in cautiously, we landed in a quiet eddy behind three large rocks, where a clean, white sandbar offered an attractive camp. We were just starting down to look over the rapids when a gathering thunderstorm broke in a heavy squall and forced us to seek shelter under projecting rocks. Thunder is never so impressive as between sheer rocky walls; likewise an incipient cloud-burst, especially when it puts down enough water to turn the opposing canyon rims into twin Niagaras.

One soon learns to seek his shelter away from low drainage depressions or under those parts of the cliffs stained black by transient storm-fed waterfalls. A deep undercut cave in the sandstone or limestone is the best shelter—provided it has no back entrance.

Powell had portaged boats and outfit around Badger Creek Rapid on both his first and second expeditions. Stanton had done likewise, both with the Brown party boats and those of his own expedition. The Kolbs had run with both their boats, but had struck a number of rocks in the course of a very bumpy passage.



Photograph by E. C. Kolb

LA RUE, MOORE, AND FREEMAN ON BOULDER ISLAND AT VASEY'S PARADISE

Delicately rather than brilliantly colored, the subdued pinks and yellows and browns make the cliffs below Vasey's Paradise unrivaled in the whole Grand Canyon, save possibly by those in the vicinity of the mouth of Havasu Creek (see text, page 513).

We were hoping to run if the stage was at all favorable.

Nine-tenths or more of the rapids in the Colorado River canyons are formed by dams of boulders washed out of side creeks. If the section where this occurs is a narrow one, the barrier will extend all the way across, usually making the resultant rapid steep and violent. In a broader section there may be room for the river to swing round the outer curve of the boulder fan with a comparatively unobstructed channel.

A FORBIDDING PROSPECT

At Badger Creek Rapid the dam thrown out from the canyon of that name has been reinforced and heightened by the cloud-burst discharge of a small unnamed canyon immediately opposite.

The rapid appeared decidedly rough as we looked it over, where it rumbled and tumbled in the deepening shadows of the cliffy walls above. From the right bank it was difficult to fix upon a course where a boat could be certain of avoiding rocks all the way through.

From an elevated vantage on the left-hand cliff the passage was more chartable. For two-thirds of the way across from the right bank the fall over the boulder barrier was too abrupt and too broken to give a boat a fighting chance of surviving a run. Then a deeper V of hard-running water cut through before the impassable boulder wall resumed again.

The channel through the V was closely beset by rocks from the very head, while half way to the foot of the rapid it led directly over a shallowly submerged boulder into a hole so deep that the bottom could not be plumbed with the eye. This would have to be avoided after dropping through the channel at the brink of the fall.

There were several places where it was possible for a boat to get into trouble; but with reasonably good luck and careful handling there did not appear enough risk to warrant resorting to the only other alternative — portaging boats and loads over 200 yards of slippery boulders.

PREPARATIONS FOR THE FIRST RUN OF A RAPID

The leader signified that he was willing to risk the boats if the boatmen were game enough to take a chance at a wetting. Half the battle in running a rough and rocky rapid is to put the boat into the head at the most favorable place. In many instances that—and keeping the boat stern-on to the current and waves—is almost all that is necessary.

The simplest way to test the set of the current is to toss driftwood in above and watch its course through the broken water. When this was tried as a preliminary to running, the following morning, the drift sent down the V at the head carried straight into the deep hole part way down to the foot. This meant that sharp pulling would be necessary to keep a boat from plunging into what appeared to be a place of real danger.

The preparations for this first run were made with considerable care. All cameras, instruments, and the radio set were kept out and carried to the foot of the rapid. The remainder of the loads was carefully trimmed before screwing down the hatches. Oarlocks were wired in to prevent the loss of oars in case of an upset, and baling buckets were secured on short lengths of line.

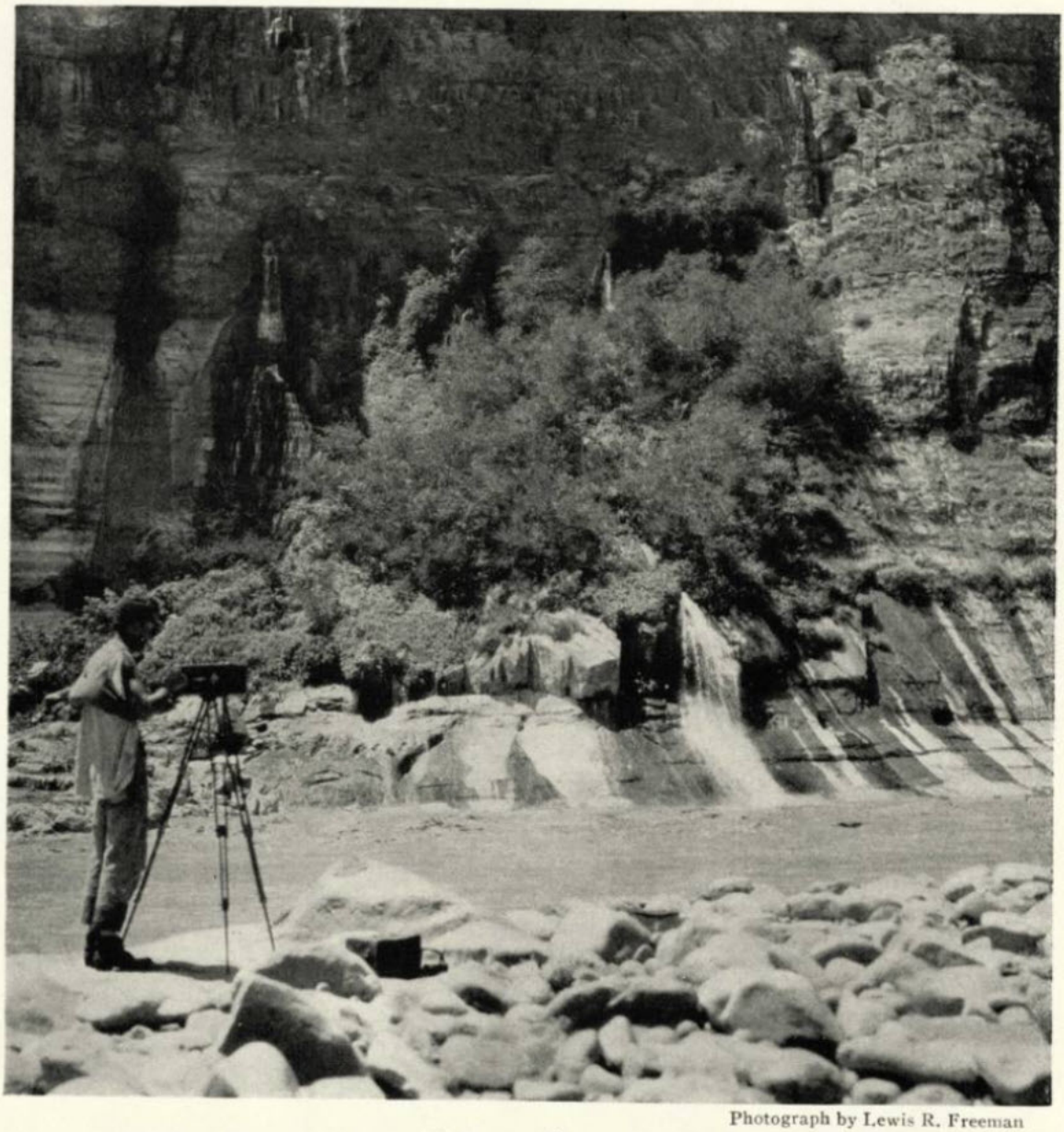
Nothing was left loose in the cockpits save the boatmen. The canvas boat was carried to the foot of the rapid and launched, to be ready in case of need.

KOLB MAKES THE FIRST RUN

The opening run was far from auspicious. Kolb dropped into the V just as planned, so far as avoiding the big boulder on the left was concerned. He missed this by half an oar's length, but failed to reckon with a slightly more deeply submerged rock just below. The *Marble* was not upset or hung up by the obstruction, but the blow dealt the bottom threw it partly out of control and prevented effective pulling. Swung half sidewise, it drifted over a rounded wave and dropped into the deep hole!

Almost disappearing in a cloud of spray, the boat reappeared an instant later, partly filled but still riding buoyantly. Too far to the left to make the foot of the rapid on the right where the cameras and instruments had been portaged, Kolb pulled in and landed in an eddy against the opposite bank (see page 480).

Lint, following in the *Boulder,* hit the



Photograph by Lewis R. Freeman

LA RUE TAKING A PANORAMA AT VASEY'S PARADISE (SEE TEXT, PAGE 513)

"A patch of green shot with gushing jets of clear water."

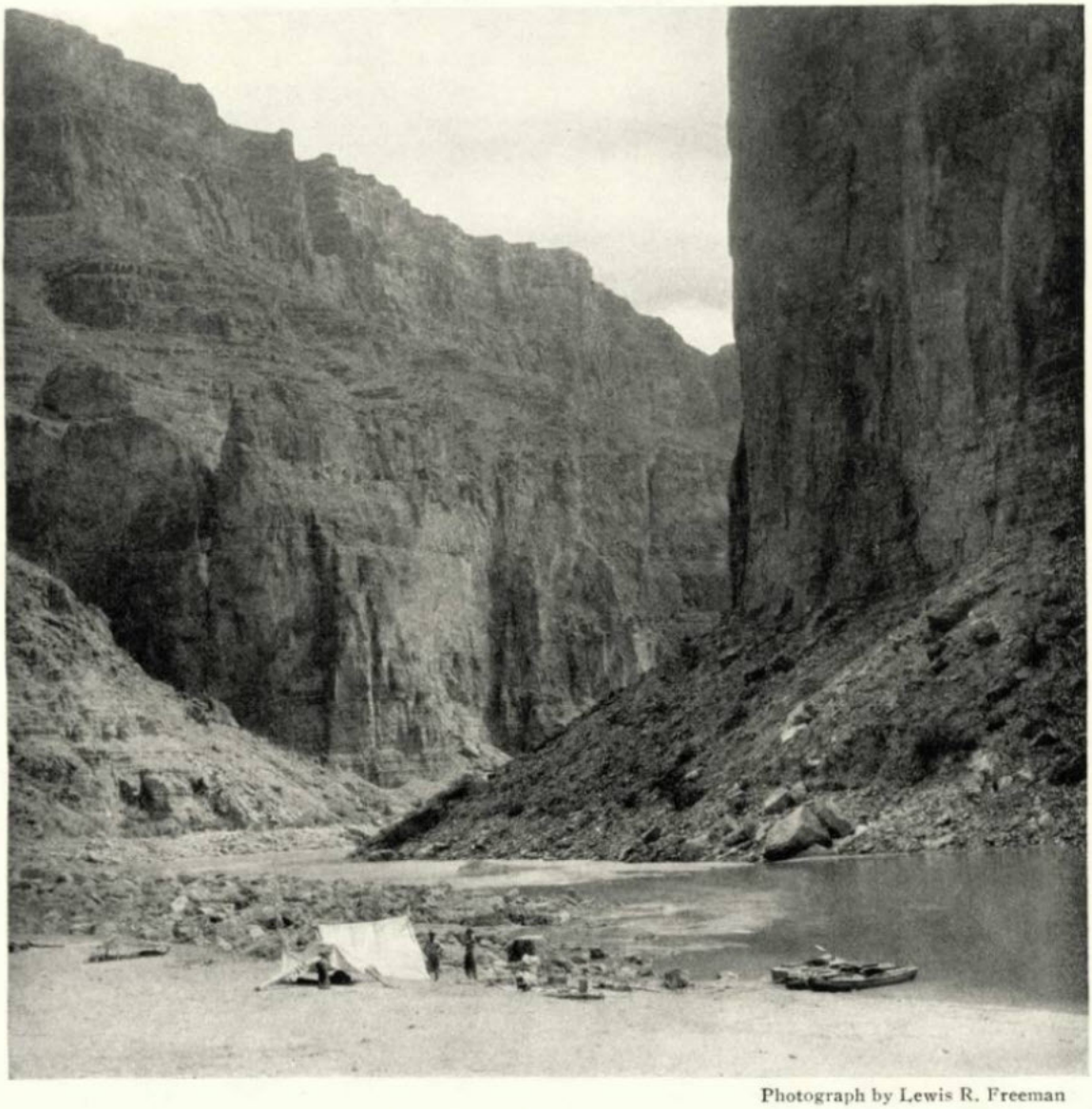
V just right and pulled away from the rocks with plenty to spare.

In drifting down, stern first, I took the *Grand* a few feet too far to the left and was carried back upstream along the bank. Circling round and pulling out of the back water, I swung to the middle of the current and dropped down to the brink of the fall again. The abruptness of the descent made the opening impossible to see until one was almost upon it, and then only by standing up.

Once the V began to open up, I sat down, pulled hard against the current setting toward the jutting rocks, and slid over the top.

The jolt of the first wave was a solid one and there was real weight in the piece of it that came bounding over the stern against my chest. Missing a stroke or two before recovering, I let the *Grand* swing quartering over the next comber, but had no trouble in bringing its head back upstream again and pulling well clear of the bad hole.

Blake, running last, was drawn somewhat to the right of the V, dropping down into a broken wave that swept com-



Photograph by Lewis R. Freeman

SITE OF A TWO DAYS' CAMP: A SANDBAR IN MARBLE CANYON

Here the party spent August 10th, the day set aside for the observance of the funeral of President Harding, news of whose death had been received by radio a few minutes after the tragic event occurred (see text, page 497).

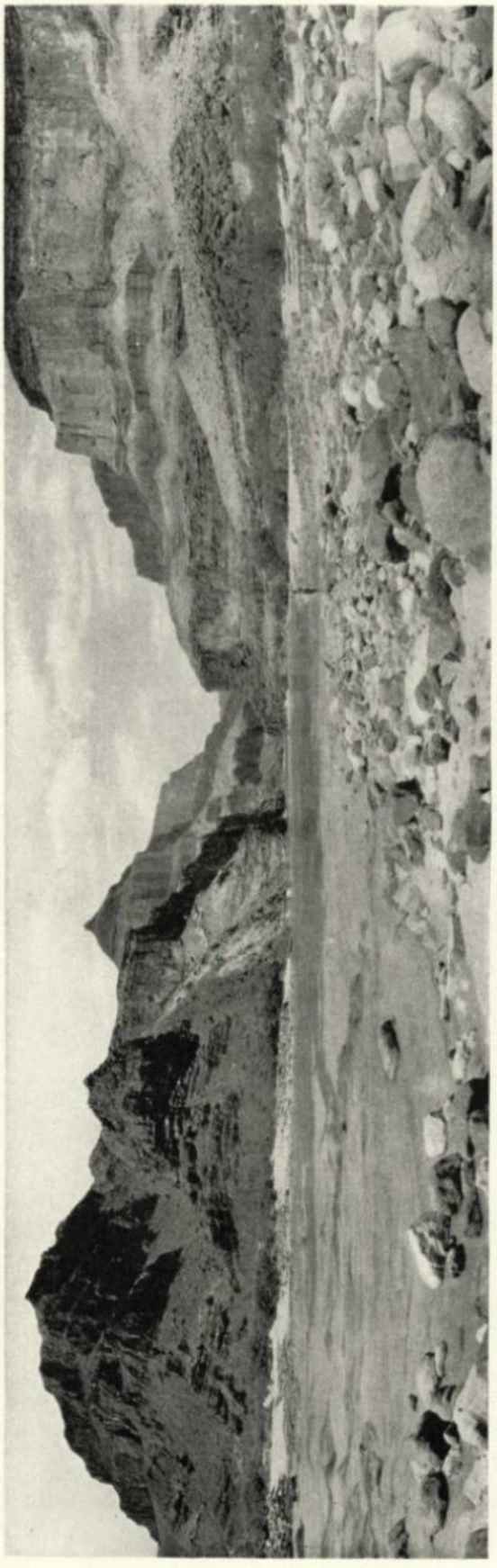
pletely over the *Glen*, hiding it from sight for all of a second or two. It was in rough water for the next hundred feet, and then came out under good control.

KOLB'S BOAT PUNCTURED

When Kolb came to examine his boat he found that the after hold was several inches deep in water. Investigation showed that the bottom had been punctured near the bulkhead, doubtless by the rock hit at the head of the rapid. Sugar, salt, oatmeal, and other things not in rubber sacks at the moment were wet, and considerable water had penetrated to the supposedly water-tight map cases. Fortunately, none of the sheets of the new survey had yet been transferred to the cases.

Powell had estimated the fall of Badger Creek Rapid to be 18 feet, while the Kolbs put it at 20. Burchard, of our party, found it to be 13.

Ours was the first voyage on which the fall of the rapids of the lower Colorado canyons was measured with precise instruments. From beginning to end, the earlier estimates were found to be far too



Photograph by E. C. La Rue

UPSTREAM VIEW OF THE GRAND CANYON FROM A POINT FOUR MILES BELOW THE LITTLE COLORADO RIVER

liberal. A guess at the fall of a rapid is almost invariably too high. The fall of a river in a given distance varies slightly between high and low water, it is true, but not enough to account for the difference between the actual descents and the estimates of earlier voyageurs. Moreover, both of Powell's voyages were made at approximately the same water stage as was that of last summer's survey.

The walls of the canyon, which were 730 feet above the river at Badger Creek, increased steadily in height as we proceeded, with an ever broader streak of maroon-chocolate Hermit shale showing as we penetrated deeper into the gorge.

About two miles below Badger Creek we came to a striking monument of dolomite in the middle of the river. It looked solid enough to be an outcropping of bedrock, but must have fallen from one of the higher formations. As it is not mentioned by previous navigators, and as the fracture from which it appears to have come has not weathered greatly, it is probably of very recent origin.

Upon reaching a long, straight stretch of canyon running east and west, we landed to photograph a great rectangular cliff which towered against the sky-line, revealing breaks at both ends, neither of which was positively identifiable as the course of the river.

A PORTAGE AT FATAL SOAP CREEK RAPID

A heavy roar became audible as we neared the bend, indicating the presence of the major rapid below Soap Creek—a mile or two nearer to Badger Creek than was shown by existing maps.

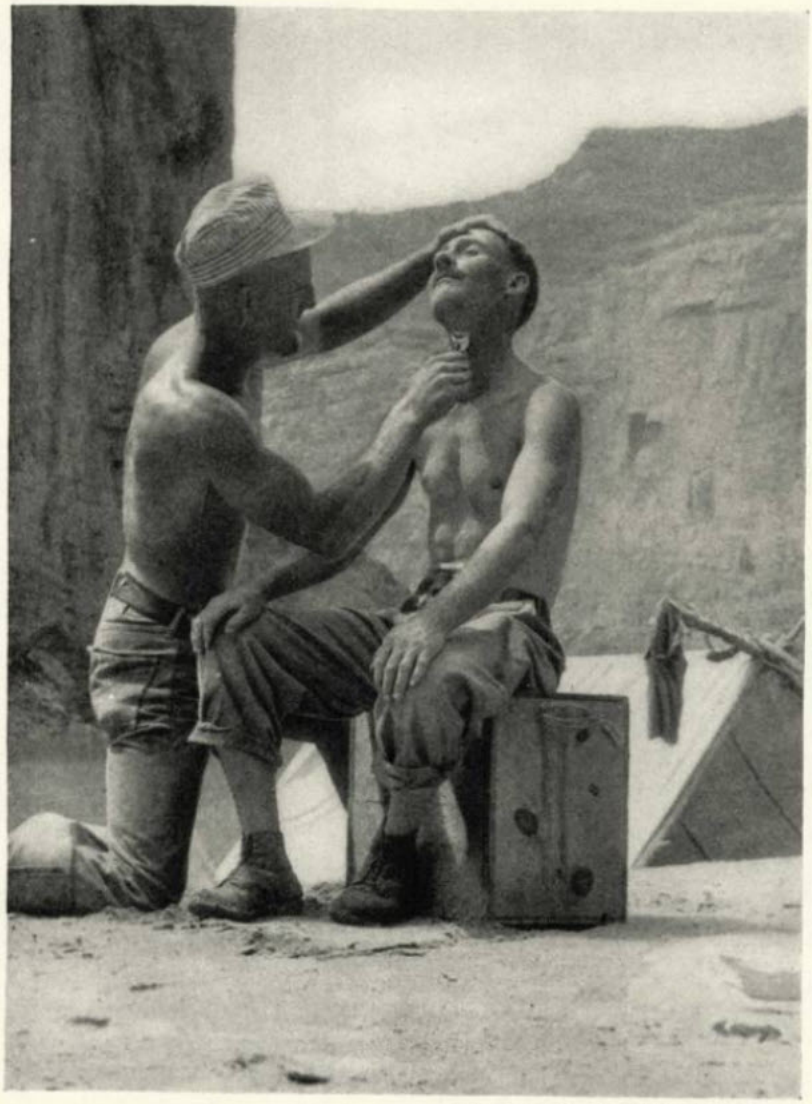
An extensive fan of white boulders — limestone — completed the identification of a rapid with one of the worst reputations on the Colorado.

Landing, we picked a camp site on the right bank 100 yards above the break of the fall.

Photograph by E. C. LaRue

DOWNSTREAM VIEW OF GRAND CANYON FROM THE LEFT BANK AT A POINT 88 MILES BELOW THE LITTLE COLORADO

Navigation was comparatively easy in this stretch of the river, and from the mouth of the Little Colorado to the mouth of Havasu Creek (through Grand Canyon National Park), the expedition was usually three or four days ahead of schedule, making from five to ten miles a day compared with three or four in Marble Canyon (see text, page 520).



Photograph by Lewis R. Freeman

SPRUCING UP: DODGE CLIPPING KOLB'S BEARD

There is ample room to portage on the boulders to the right of Soap Creek Rapid, and both Powell expeditions had avoided the savage tumble of rough water in that way.

The railroad surveying party of 1889 also portaged its boats round the main fall, but shortly after launching them in the swirling waters below an upset occurred in which Brown, the president of the company, was drowned. Stanton did not attempt to run the main rapid when he came along in 1890, and Ellsworth Kolb in trying to do so suffered successive upsets with two boats. This sinister record has given Soap Creek Rapid a bad name.

At first sight, while plainly of a greater and more violent fall than that of Badger Creek, Soap Creek Rapid looks no more dangerous to run. This is probably because the entering V is more clearly defined than in the rapid above and leaves but one course open; also due to the fact that the boulders under the great waves at the head are deeply submerged, except at extreme low water.

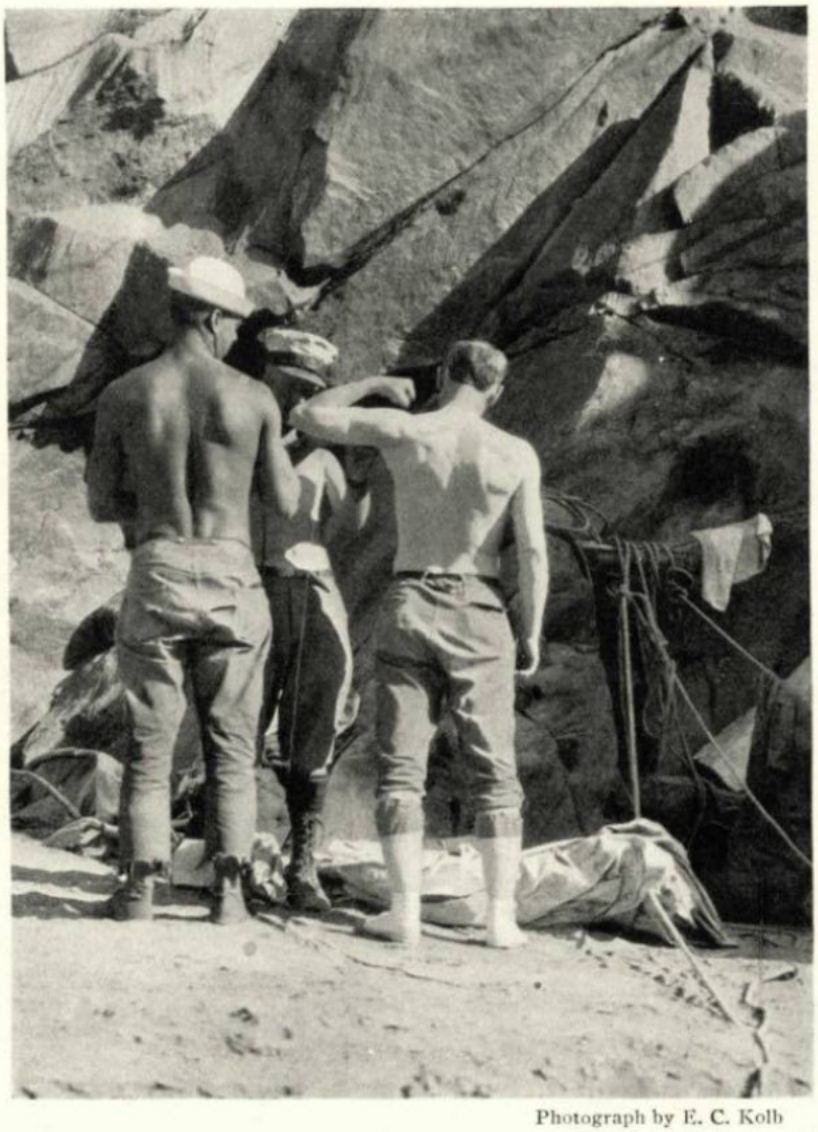
We loaded up in the expectation of running the following morning, but at the last moment Kolb returned from a trip across the river to announce that he considered it too risky; that he believed a boat would be almost certain to upset in one of the first two waves, and after that to drive upon rocks not visible to us from the right bank.

There was some disappointment at missing the chance to attempt what might have been the first successful run of this notorious rapid, but there would have been no point in taking undue risks with an outfit like ours, especially so early in the voyage.

The portage was a short one and the method of effecting it the same in the case of each boat. *Glen,* the cook-boat, was the first to go. It was taken down 200 feet under oars, lined another 100 feet farther, and unloaded. It was then lined empty 50 feet more to the head of the portage. This was across large boulders, over and between which large logs were laid at frequent intervals to prevent the sides of the boats from being crushed in as they were slid down. It was heavy work, yet not so punishing as it would

have been with fewer men available (see illustrations, pages 481 and 482).

The boat was then lowered over a five-foot waterfall to a quiet pool at the end of the portage. Here it was launched and reloaded. It was then backed out of a sort of natural portal between two large rocks, and the rapid was entered on the right, just below the two big waves which had been avoided. The next 200 yards comprised a rough but not dangerous run. Then the boat was pulled into an eddy to a beach along the right bank. The *Grand* was brought down while dinner was cooking, and the two remaining boats in the afternoon, after which there was still time for a cooling swim and a rest before supper.



Photograph by E. C. Kolb

A STUDY IN TAN AND WHITE

Moore, during a noonday halt, is measuring the arms of Lint, browned by exposure, and Stabler, who had just joined the expedition.

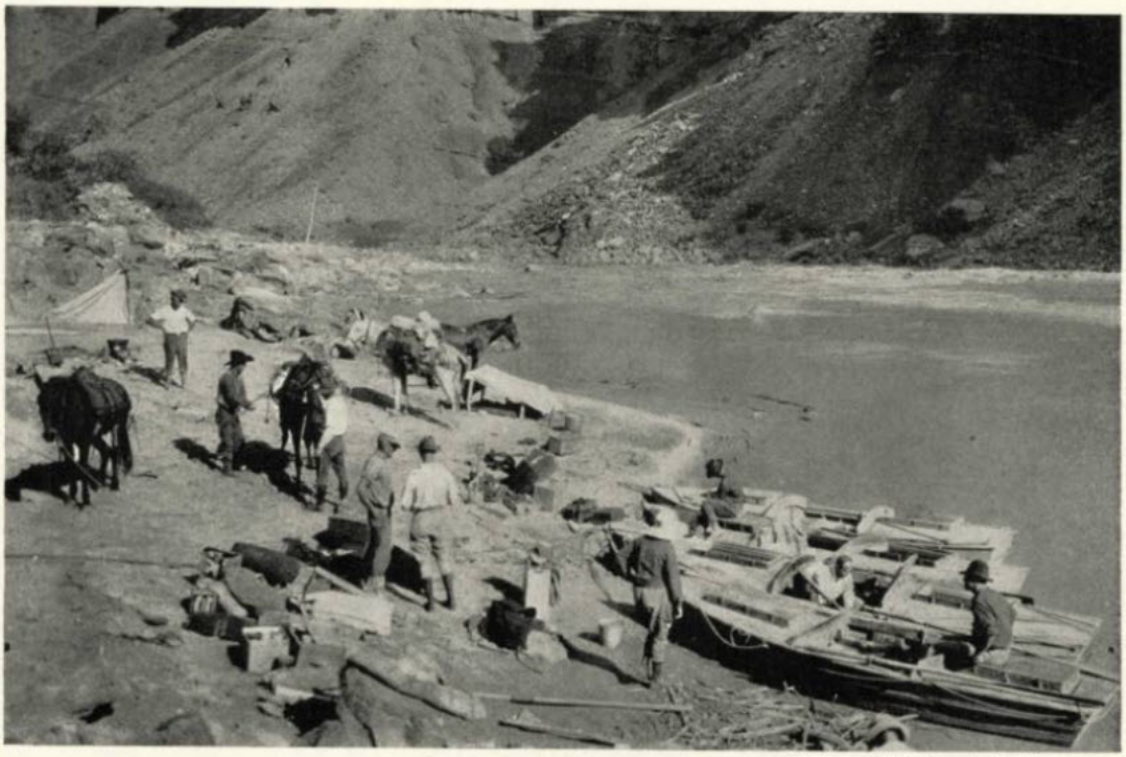
A TRAGIC RADIO MESSAGE

Radio had come in strongly at Badger Creek, but it remained for the 1,000-feet-deep section at Soap Creek to furnish conclusive proof of the fallacy of the theory that so profound a natural depression would prevent radio communication with the outside world. Station KHJ had warned us the previous night that it was planning to broadcast special messages to us on the evening of August 2. That was the night of our arrival at Soap Creek.

In preparation for the gala occasion, the aërial was carefully set up, with one end high on the side of a cliff, and orientated on Los Angeles. KHJ came in strong promptly at 9 o'clock, Mountain time, with little interference either from static or from the crashing roar of the near-by rapid. The lightning of distant thunderstorms was jazzing up the purple wedge of sky between the up-river cliffs, but, strangely enough, with scarcely any reaction on the instrument.

Baseball scores had come in and the daily grist of news was halfway through, when there came a sudden break, followed by a brief space of charged silence.

When the announcer resumed it was to state with deep emotion that news had just been received of the death of President Harding in San Francisco. This word was winged a dozen times or more during the next hour, once directly



Photograph by Lewis R. Freeman

PACKING UP FOR PORTAGE AT THE HEAD OF HANCE RAPID (SEE TEXT, PAGE 520)

Photograph by E. C. La Rue

RADIO MESSAGES CAME IN CLEAR AT ALL POINTS IN THE GRAND CANYON WHEN THE OUTFIT WAS SET UP

H. Stabler and C. H. Birdseye are "listening in" at Tapeats Creek. At El Tovar the leader of the expedition sent a telegram to Washington announcing that the party was safe; two hours later, in the depths of the canyon, he heard by radio his own message, as it was broadcast to the country.

THE PAINTED DESERT AND HOPI LAND IN THE DISTANCE

The view is from Navajo Point, on the edge of the Coconino Plateau (see map, page 474).

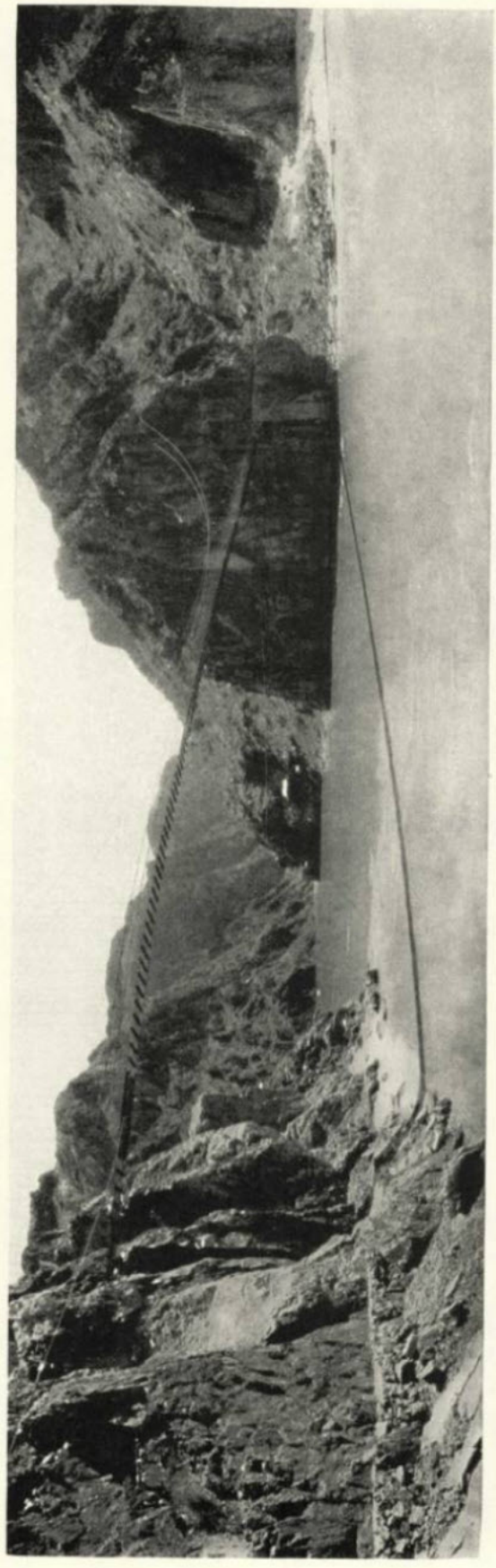
addressed to "the engineers braving the rapids of the Colorado." We had received our special message, though not the one expected.

RADIO WORKED PERFECTLY AT DEPTH OF A MILE

The first news of the President's death was received at about 8.15, Pacific time—perhaps forty-five minutes after the tragic event. Not one in ten thousand of the city dwellers of the country could have had the news at so early a moment. Colonel Birdseye announced at once that a day of rest would be taken by the expedition out of respect to the memory of the President. The exact date would be decided later, when the day of the funeral was learned over the radio.

Almost unconsciously the radio had come to be accepted as a regularly functioning unit of the outfit. Although occasionally affected by heat and local electrical storms, it continued to work just as well when the gorge of the Grand Canyon had deepened to a mile as it did the night it brought us the momentous message in the camp at Soap Creek Rapid. That it failed to pick up the many warnings of impending flood that were broadcast to us was not the fault of the outfit. It was enjoying a temporary rest while fresh batteries were being sent in (see page 524).

The fall of Soap Creek Rapid was found to be 18 feet. Earlier explorers had put it at 25, with waves 12 feet high.



Photograph by E. C. La Rue

LOOKING UP LOWER GRANITE GORGE FROM THE MOUTH OF BRIGHT ANGEL CREEK, SHOWING BRIGHT ANGEL SUSPENSION BRIDGE

For an account of the construction of this bridge, which is 500 feet long and hangs 60 feet above the river in normal flow and 13 feet above the highest known water mark, see "The Grand Canyon Bridge," by Harriet Chalmers Adams, in THE GEOGRAPHIC for June, 1921.

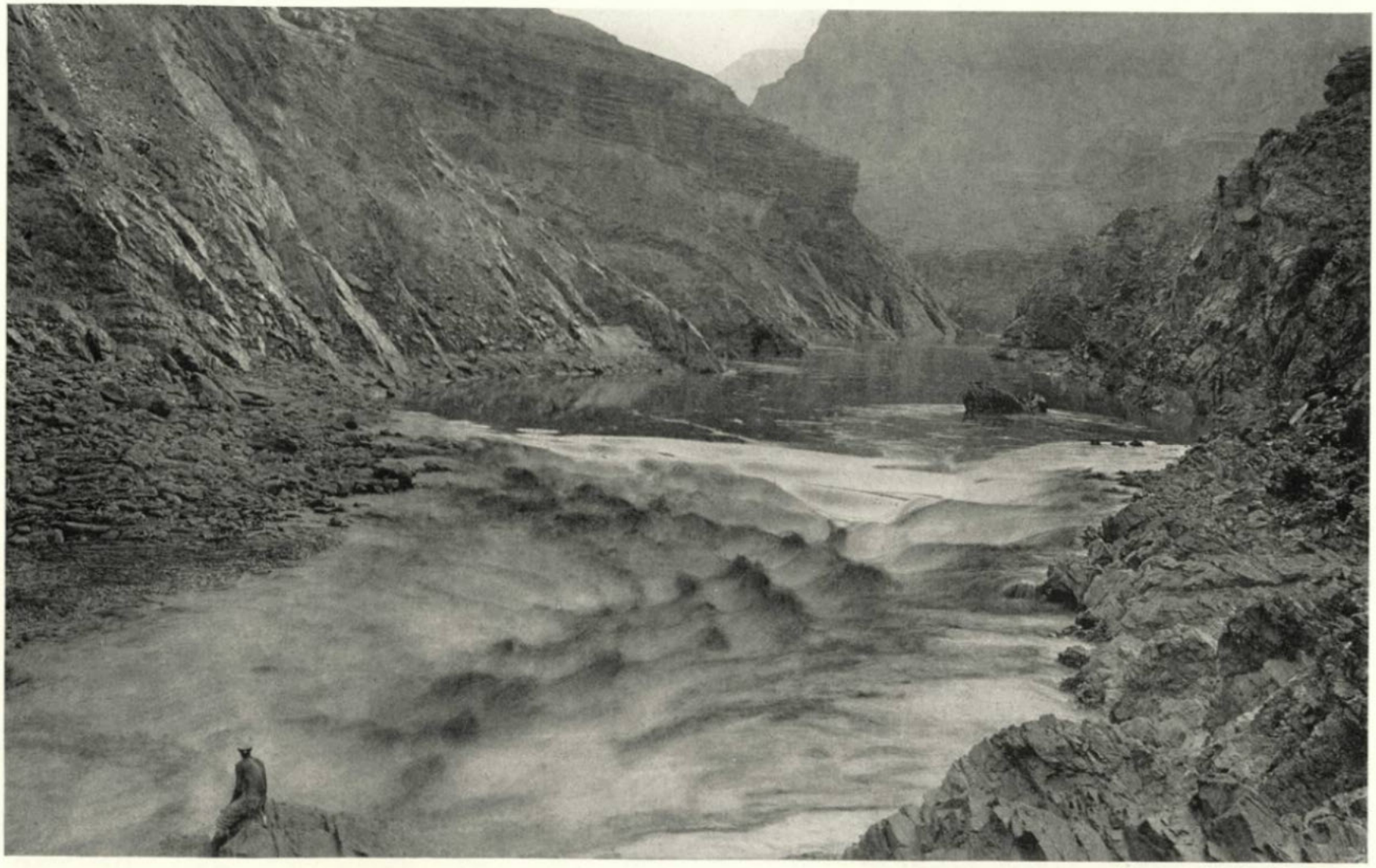
The latter estimate is conservative, especially regarding the two big waves at the head of the first steep drop.

The waves of rapids are very difficult to measure. Estimates of the height of many we ran or narrowly avoided varied considerably, even among the engineers of the party.

For several miles below Soap Creek there is no water through which a well-handled open boat cannot be run without serious danger. The fact that an upset was responsible for the death of Brown, president of the company planning to build a railway through the Grand Canyon, is proof of the inadequate boats of his party. Stanton's perseverance with so poor an outfit, after the death of Brown, is one of the finest examples of fortitude in Colorado River history.

At noon on the 4th we halted for lunch on a shelf 100 yards above the head of a long and fairly rough rapid, the walls on both sides of which were so sheer that there was no chance of working along to reconnoiter. From the most favorable vantage point attainable, the upper section appeared to be readily runnable; a second riffle, disappearing around a bend below, could only be guessed at.

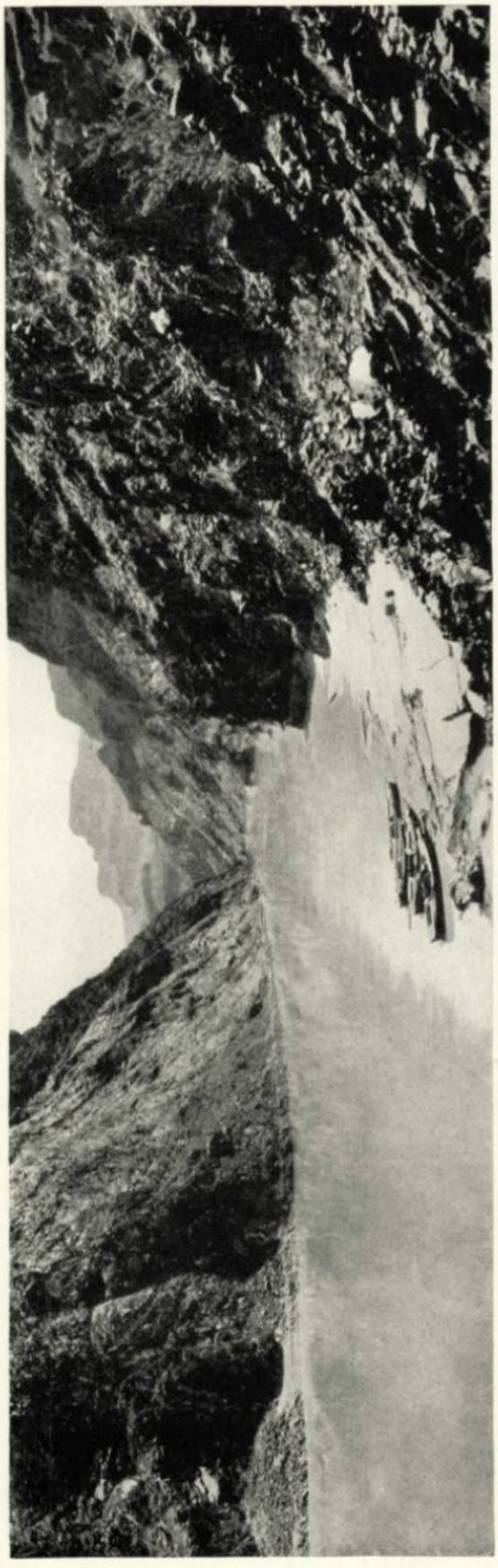
To Powell, on his first voyage, the place was calculated to awaken serious apprehension, and he ran it only after working his boats down along the wall to the head by a very ingenious and intricate piece of lining. In our case, knowing the rapid had been run a number of times without trouble, there was little to give pause.



Photograph by E. C. La Rue

UPSTREAM VIEW OF A RAPID FIVE MILES ABOVE THE MOUTH OF TAPEATS CREEK

It was in this rapid that the author's boat, the *Grand*, came into collision with a boulder. The blow was so violent that he imagined his craft had "actually bounced back upstream from the impact." An incipient leak was effectually closed with a patch of canvas and some white lead.



Photograph by E. C. La Rue

UPSTREAM VIEW OF THE GRAND CANYON FROM THE LEFT BANK, AT THE MOUTH OF BOUCHER CREEK, ABOUT NINE MILES BELOW BRIGHT ANGEL CREEK

The *Grand* was the last boat to start. La Rue, who was casting off the painter, slipped on the smooth rock and all but let us swing off into the swift current without him. As there was no chance of going back, either by land or river, we never quite worked out how the party would have recovered its hydraulic engineer had he marooned himself.

The canyon displayed points of rare beauty, with the Supai sandstone rising higher and higher from the water, and the Kaibab limestone and Hermit shale beginning to form a secondary wall behind.

Many caves had been formed by the undercutting of the cliffs. Pulling back into one of these to await the instrument, we lounged for half an hour in the cool depths, singing lustily to while away the time. Amazingly mellow-voiced we all were—thanks to the softening effects of the cavernous echoes.

We ran a rough major rapid just before going into camp that night, and a second immediately after lunch the following day. Both were much like Soap Creek in the way they rolled down steep pitches to undercut curving cliffs of the left bank.

All previous parties, including the Kolbs, had portaged at least one boat at the head of the latter rapid, which was somewhat more menacing from the fact that a second riffle began not far below to disappear in a tumble of broken water around the next bend. I had my first experience with the solidity of the bottom of the Colorado River at this point.

A heavy sandstorm was blowing out of the side canyon to the right as I drifted down to the head of the rapid, and in pulling against it I worked too far to the right and found the *Grand* dropping upon a bad mess of boulders almost under the bank. Hard

Photograph by Lewis R. Freeman

THE "BOULDER" IN WALTHENBURG CREEK RAPID

Although this rapid has a fall of 13 feet in a very short distance, making it one of the steepest of the Colorado River, it did not prove especially difficult to the Grand Canyon Expedition at the stage of water which the party encountered.

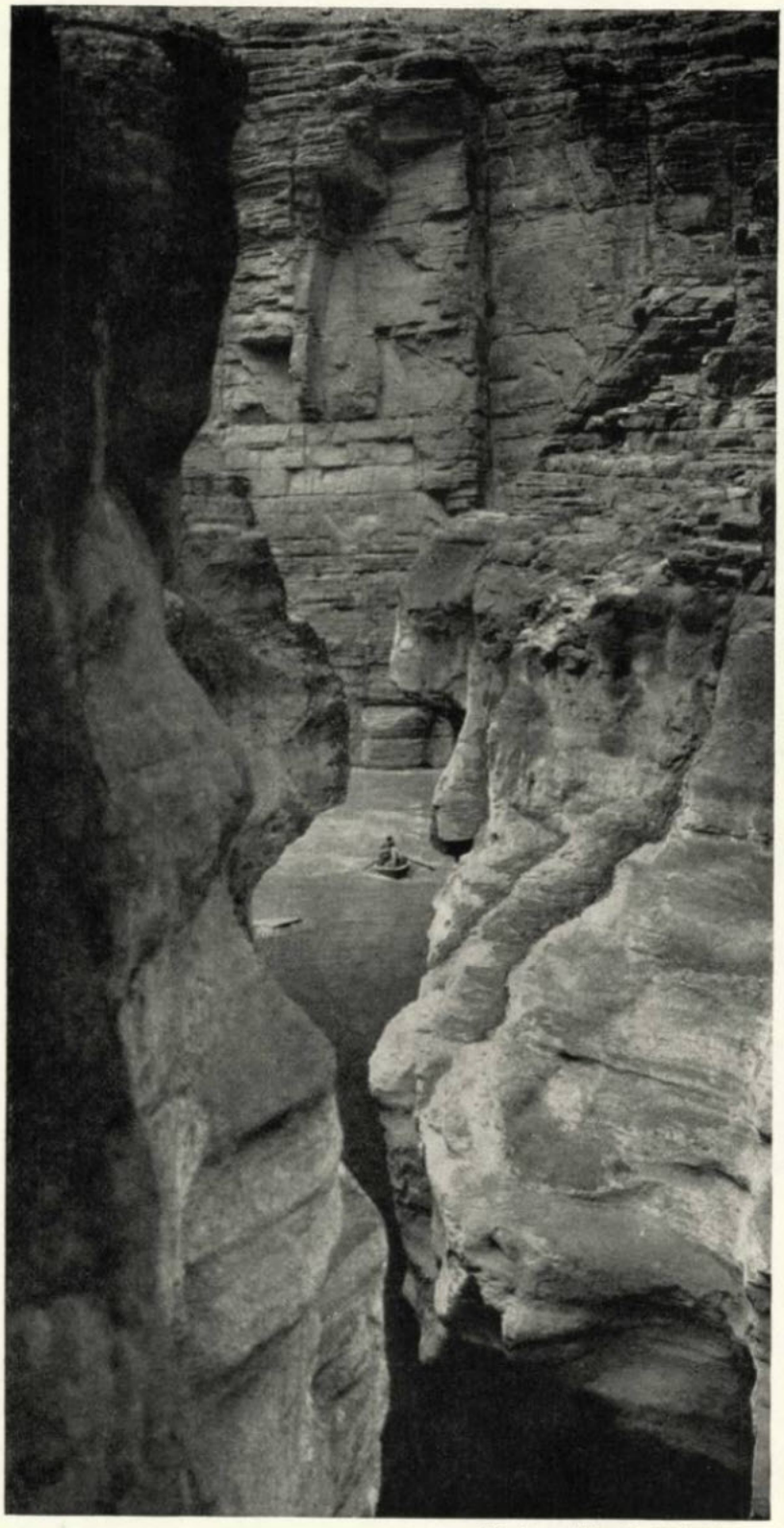
Photograph by Lewis R. Freeman

THE "MARBLE" IN WALTHENBURG RAPID, TWO MILES ABOVE TAPEATS CREEK

Photograph by Lewis R. Freeman

HANDLING THE SURVEYOR'S ROD AT WALTHENBURG RAPID

It was here that the Kolbs, on their photographic expedition of 1914, experienced a serious upset, with considerable damage to one of their boats.



Photograph by E. C. La Rue

DOWNSTREAM VIEW OF HAVASU CREEK, WITH THE COLORADO RIVER IN THE BACKGROUND

Framed between the overhanging walls is the *Boulder*, ready to land for supplies.

pulling did not quite carry me back to the channel, and as a consequence a corner of the stern bumped solidly against a rock, allowing the boat to swing completely round.

The boat drove through the next couple of waves bow on and then slid away from the heavy rollers under good control. Pulling across the current of the tail of the rapid, I beached the boat on the left bank, to find that it had suffered no damage from the collision.

The *Grand* had the driest run through of any of the boats; nevertheless getting in where I did at the head was not creditable, even in the face of a sandstorm.

CAMPING ON A STEEP TERRACE

Camp was pitched on a steeply sloping terrace of rocks and sand at the head of a big back-sweeping eddy. The sand was bound and held in place by the roots of salt grass, very fresh and green in appearance. Room for our beds had to be cut with the spade out of the silt and sand. The bank from which mine was sliced had a 60-degree slope to the river.

Moore lay feet-to-feet with me, while the Chief kicked sand impartially on both

A WATERFALL IN HAVASU CANYON: GRAND CANYON NATIONAL PARK

In this deep gorge are several of the most beautiful falls in the world. Their number and beauty led the explorers who first saw them to call the gorge Cataract Canyon, a name by which it is still known upon some maps, but which is officially used now to designate the stretch of the Colorado above Marble Canyon.

Photograph by E. C. La Rue

"WHERE WOOD CUTS STONE"

A willow log six inches in diameter has eaten into a hard limestone boulder, four miles below the mouth of Havasu Creek. The log was not worn, which demonstrates that the water acts as a cushion, protecting the wood, while the silt in the water does the cutting.

of us from his niche above. Radio came in as clearly as ever, in spite of the fact that the rim of the Kaibab now towered more than 2,000 feet above us. There was a Sunday evening concert of real quality over KHJ; also an announcement that the date of President Harding's funeral had been fixed for the 10th.

From a boating standpoint, August 6 was one of the liveliest days of the voyage. Three or four major rapids and a number of riffles were run, in nearly every instance the head of one being in sight from the foot of the preceding. The total distance made was three miles, with a descent of 50 feet. This stretch has probably the heaviest average fall in Marble Canyon.

As the *Grand* approached the second rapid with Moore and La Rue riding, Kolb, who had landed to look it over, signaled me that it was all right to go on through. It was a straight run down the middle, with no chance of hitting rocks—only big water.

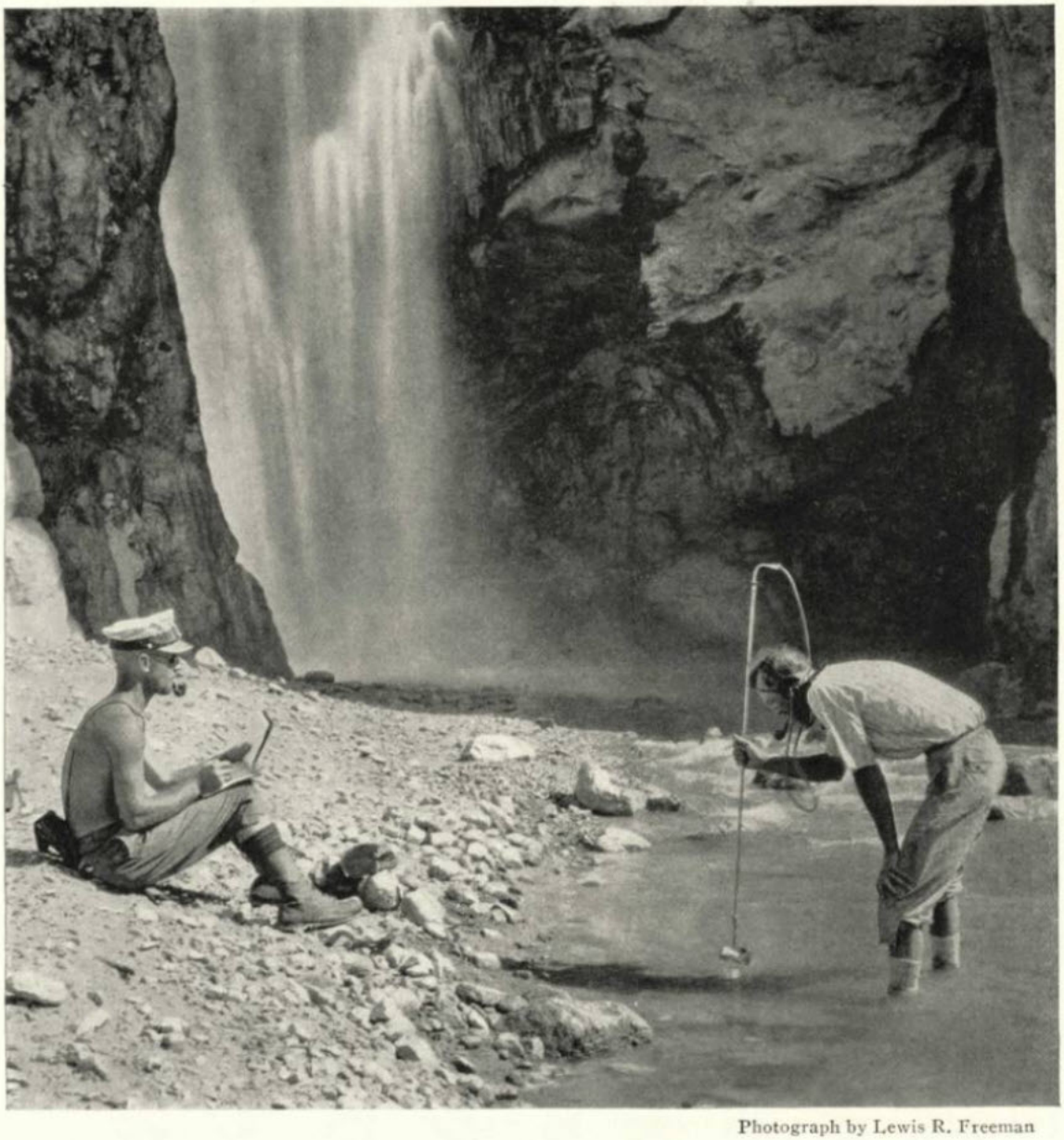
The opportunity to see what the boat would do in really heavy waves, where there was no chance of banging it up, was too good to miss. Sooner or later it would be swamped, anyhow, I told myself, and it would be a good plan to find out what weight of water would do it. Unfortunately, I was so confident of riding this particular chute without filling that I did not take the precaution of putting my camera under cover.

SWEPT BY WAVE AFTER WAVE

The middle V rolled over smooth and solid, like the brink of a real cataract, and it was not until we were almost at the upflung comber at the bottom of it that I had an inkling of what we were in for. The *Grand* had an easy rise to the first wave, and went through it without tearing more than a bucketful off the top.

The next was a sidewinder from the right, however, and came banging over the quarter savage and solid. La Rue's writhing anatomy stopped a lot of it, but enough rolled on to fill the cockpit up to the seat. A third wave completed the job and left the gunwales awash. We barged down the rest of the rapid after the fashion of a raft, with wave after wave sweeping us fore and aft.

As the water was warm, there was no particular discomfort. The boat rolled much worse than normally, dipping a gunwale under at every roll; but she was still responsive to the oars and I had no trouble in bringing her into an eddy and



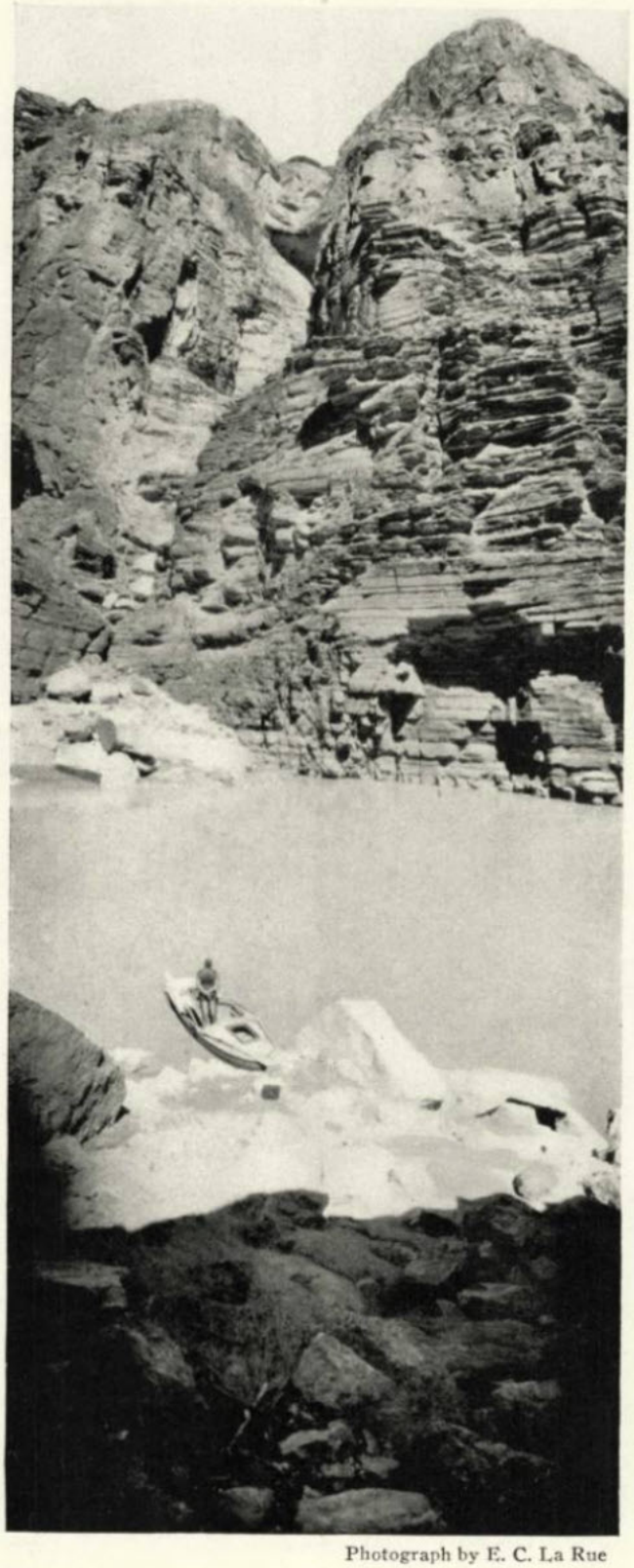
Photograph by Lewis R. Freeman

LA RUE, WITH A CURRENT METER, MEASURES THE FLOW OF A SIDE STREAM

up to the left bank well above the head of the next rapid. After ten minutes of baling, the cockpit was dry again. The water-tight box under the seat in which some of our cameras were kept was as good as its name.

The small camera, which had sloshed around the cockpit for a couple of minutes, was soaked and the film spoiled. Except for that, the experience was a valuable one in giving a line on the boat's capabilities in heavy water. Plainly, a swamping was a matter of no serious moment, provided there were no bad rocks below. To me the incident was distinctly reassuring, though it took some argument to bring my saturated passenger on the after hatch round to the same way of thinking.

The other three boats, with one passenger each, made the run through the rapid without incident, but Dodge, with the canvas boat, capsized in the first wave, dropping out of sight for two or three seconds. Bobbing up again farther down, he appeared to be holding to the overturned boat and working it toward an eddy along the right bank. Lint and I pulled across to him, but he had the canoe against the rocks and was trying to right



Photograph by E. C. La Rue

THE GRAND CANYON ONE AND A HALF MILES ABOVE HAVASU CREEK

This is near the west boundary of the Grand Canyon National Park. Note the "face" in the notch of the canyon wall.

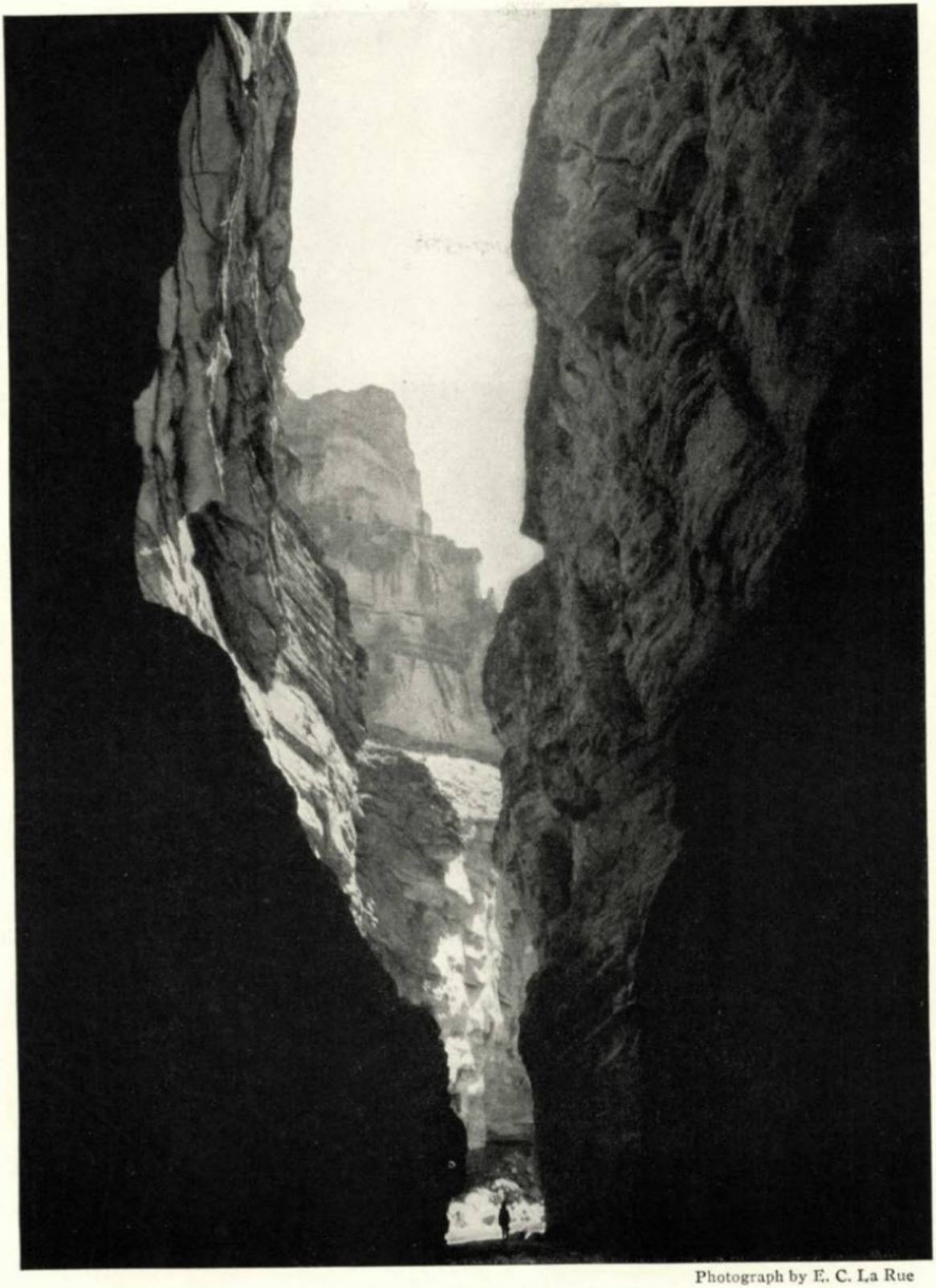
it before we arrived. It was a hard place in which to work on account of the packed driftwood, but a few minutes sufficed to have the *Mojave* in commission again. To Dodge, who was born in Hawaii and half raised in the water, the upset was no more of an incident than his morning bath.

Drifting past an undercut cliff, I noticed for the first time the water-polished limestone which had led Powell to apply the name of Marble Canyon to the gorge which is properly the upper end of the Grand Canyon. This is not a real marble, according to Moore, but it is very hard, takes a beautiful finish, and would undoubtedly make a fine building stone. I passed within oar-length of some brilliant outcroppings of rock crystals, and at one point about 40 feet above the water was the mouth of a cave of considerable depth.

A TRAPPER'S OUTFIT FOUND IN A CAVE

We ran on to a camp at the head of an abrupt and noisy rapid, where the seepage from a steep canyon formed a number of clear springs, while a rising series of hard sand terraces gave good sleeping room. Climbing over the rocks to look at the rapid, we found a trapper's complete outfit half buried in the sand of the floor of a large cave. Traps, cooking utensils, brace and bits, saw, files, awls, coffee mill, and a number of other things were listed and laid out for a photograph (see page 486). The only article of wearing apparel was a rubber boot.

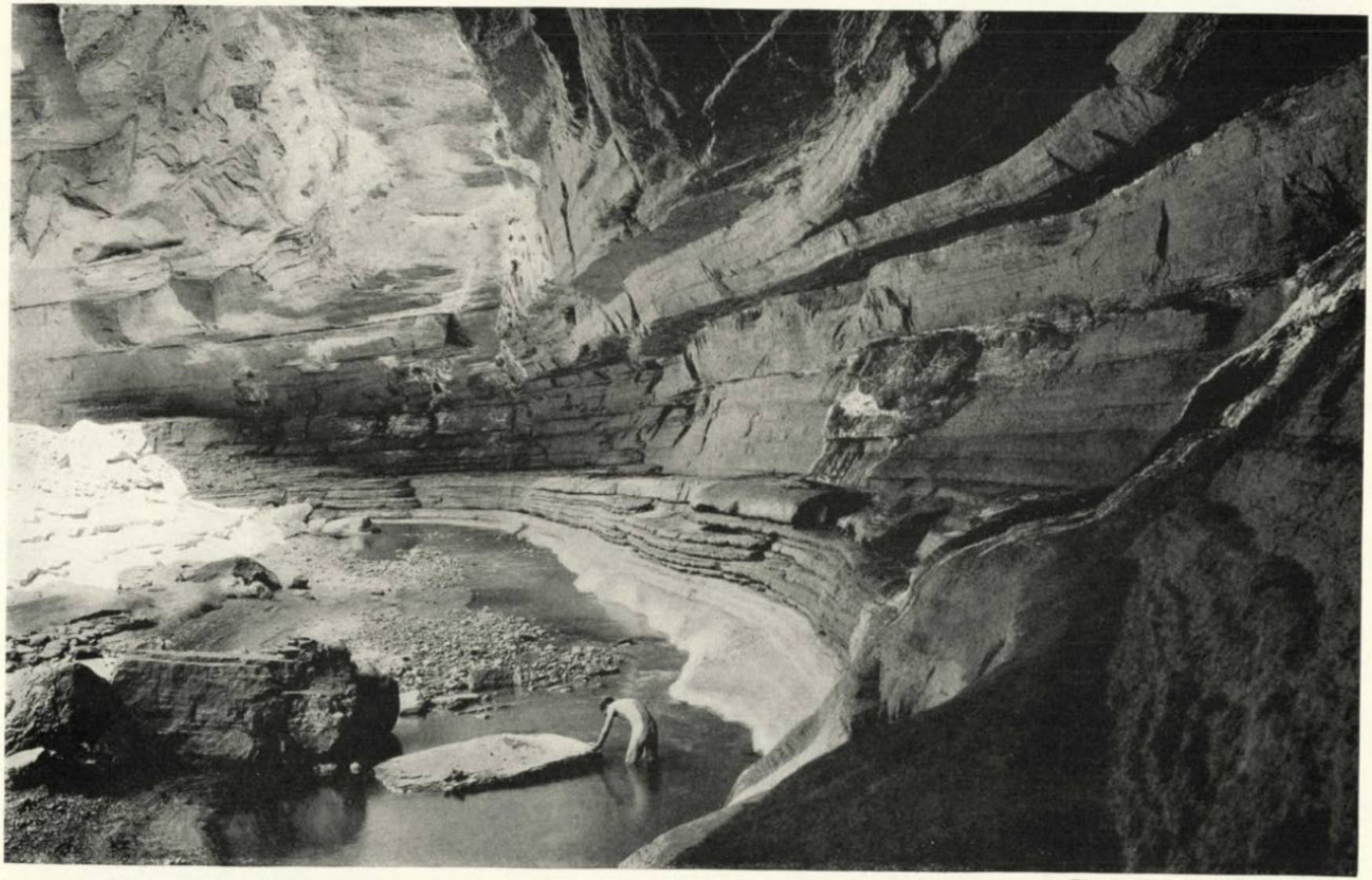
As the cave was below high watermark, it appeared probable that all of the lighter objects had been carried away. We could only conjecture as to the fate of the trapper or trappers. As there is no record of any such party reaching or passing Bright Angel,



Photograph by E. C. La Rue

LOOKING DOWN FERN GLEN CANYON

This canyon joins the Grand Canyon on the right bank, 11 miles below the mouth of Havasu Creek.



Photograph by Lewis R. Freeman

BATHING IN KANAB CREEK

The end-of-the-day plunge was a regular feature of the party's program for many weeks The water was usually red with mud, but it was "a clean sort of mud" and came off readily under vigorous toweling.

it seemed practically certain that the owner or owners were lost, with their boat, in the rapids below. Indeed, we had a graphic illustration of what may have happened to the trappers' boat while preparing to run the following morning what it had been decided to call "Cave Rapid."

Burchard, Dodge, and Kolb were just starting to line the canvas boat down the right side of the rapid, to have it available below in case of emergency, when, the painter being slacked too quickly, the little craft carried over a rock, filled, and was smashed into a shapeless mass.

An hour's work by the whole party salvaged only one oarlock and some kindling wood from the *Mojave*. We were unable to drag the canvas skin from where the current had wrapped it round a boulder. The little boat had been very useful, but was far from indispensable; its early loss, moreover, had been anticipated (see illustration, page 487).

Dodge and the rod henceforth rode on the *Glen*, while the cook was shifted to the *Marble*.

The four boats ran Cave Rapid without passengers.

We had a pleasant camp that night on a beach between two winding rapids, with the seep from a canyon supplying good drinking water again. Burchard, after completing his surveying, stated that he was inclined to the belief that this camp was in the vicinity of Stanton's Point Retreat, and that the canyon behind it was the one by which he had left the river after the culminating disaster had resulted in the drowning of two members of the Brown party of 1889.

Running several easy riffles, we came, just before noon the next day, to one which disappeared around a bend and was divided by the first midstream boulder bar we had encountered. A brilliant patch of verdure against the side of an amphitheater at the right of the bend recalled the leafy bowers of Glen Canyon. A hundred feet farther down the side another patch of green, shot with gushing jets of clear water, revealed the place as Vasey's Paradise, named by Powell after a botanist associate (see illustration, page 492).

The cliffs below Vasey's Paradise are unrivaled in the whole Grand Canyon series, save possibly by those in the vicinity of the mouth of Havasu Creek. Delicately rather than brilliantly colored, their subdued pinks and yellows and browns throw back to the depths of the gorge a mellow blend of lilac, pearl, and amethyst that has almost the palpable fluency of poured wine.

CANYON WALLS UNRIVALED IN COLOR

Plummets of sunlight alchemized frequent wedges of swirling water to arrowheads of liquid gold, with saffron-bright motes weaving in a saraband on the wall above in the dusky purple shadows of a cave mouth. Quiet, smooth-flowing water gave us opportunity to revel in the veritable symphony of colors undisturbed by navigational worries.

We found cold springs spouting out of the rock at a number of points. Some of the most ambitious of these had built themselves little turreted houses from the mineral salts carried in solution—real miniature shower-baths, with the glint of falling water and the rattle of spray always in evidence as we drifted down past their mist-curtained windows.

Grass and flowers were lush and green within spattering range of the flying drops, and it was no end of a delight to drop in from the scorching sunshine of mid-river, to lounge for a few minutes and perhaps strip for a hasty bath in clear water. When one wears only half a pair of pants, or thereabouts, taking a bath is not a matter of extended preparation.

Farther along this same stretch of canyon we came to a fantastic jumble of windows, gables, turrets, and buttresses for which the name of "Goblins' Castle" would be highly appropriate. It had one small hole looking out to the sky through its cliffy roof, and about midday this must let a beam of sunlight through to dance upon the waves of the riffle that is trying to undermine the limestone foundations of the crazy pile.

Toward the end of the afternoon we landed to explore a large undercut cave or amphitheater beneath the left-hand cliff. The roof rose steadily until it overhung the middle of the river at a height of 200 feet. The floor was a succession of terraces of hard, smooth sand, rising like the seats of a stadium until the

Photograph by E. C. La Rue

EAT, NOT SWAT, THE FLY

This pet lizard, in the cabin of the Geological Survey engineer who measures the discharge of the Colorado at Bright Angel (see illustration, page 500), keeps the insects busy.

highest touched the vault of the limestone roof. Powell was in error in locating this cave above rather than below Vasey's Paradise and his estimate of a seating capacity of 50,000 was liberal (page 483).

THE FIRST DEER ENCOUNTERED

On the 9th we passed the first mesquite trees and sighted the first deer. We tried to corner the latter on a talus for the movie camera, but they were too shifty to make close-ups possible. A doe escaped by swimming the river, part of the distance through a fairly swift riffle.

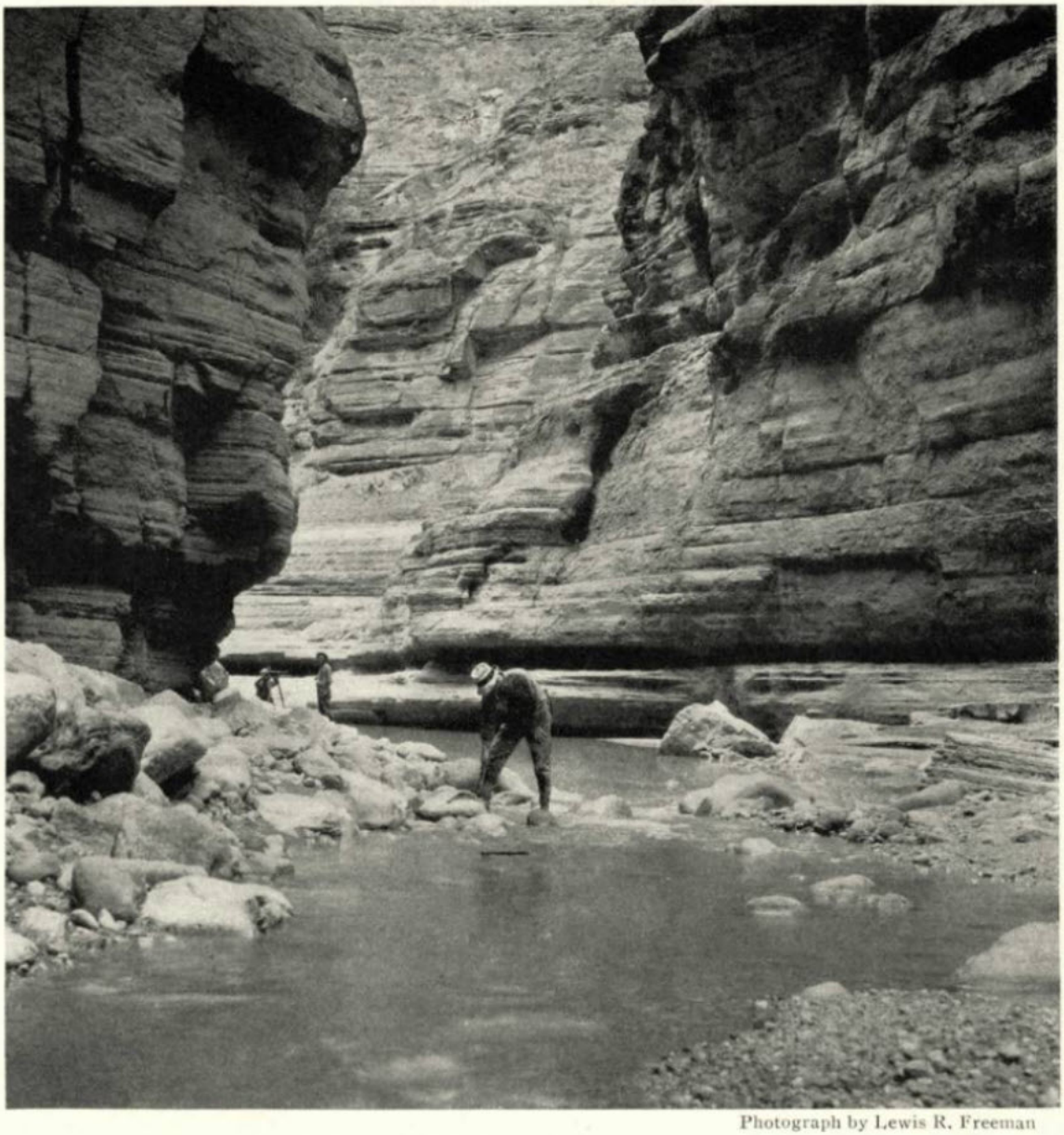
A huge boulder planted squarely in the middle of a short but savage rapid halted us early in the afternoon at a bend which was identified beyond a doubt as Stanton's "Point Hausbrough." As the obstruction ahead plainly needed careful study before passing and as the 10th had been set aside for observance of the memory of the late President, a two-day camp was made on the sandbar opposite the historic landmark (see illustration, page 493).

VIOLENT STORMS

A series of terrific wind squalls swept the river just after we landed, at the height of which water was blown far up the beach where we had begun to pitch camp. The cliffs were masked with clouds of blown sand, and the foam above the water thrown back from the great midstream boulder was carried high up against the leeward walls. Black, swollen thunderheads began gathering in the wake of the squalls and the main storm broke just as supper was over.

There was a lively scramble to keep beds from blowing away. After the wind the rain set in, first in violent squalls, then in a steady downpour. No shelters had been set up. Some of us swathed ourselves in pieces of canvas; others crawled into sleeping-bags and covered up; two crept into the emptied holds of the boats. Probably the best solution was hit upon by those who stacked their stuff under tarpaulins and cavorted about in the warm rain *au naturel*.

Violent storms of this character continued to sweep our camps at frequent intervals until about the middle of September, when the cooler weather of early fall put an end to the seasonal disturbances.



Photograph by Lewis R. Freeman

IN KANAB CANYON—1,800-FOOT LEVEL

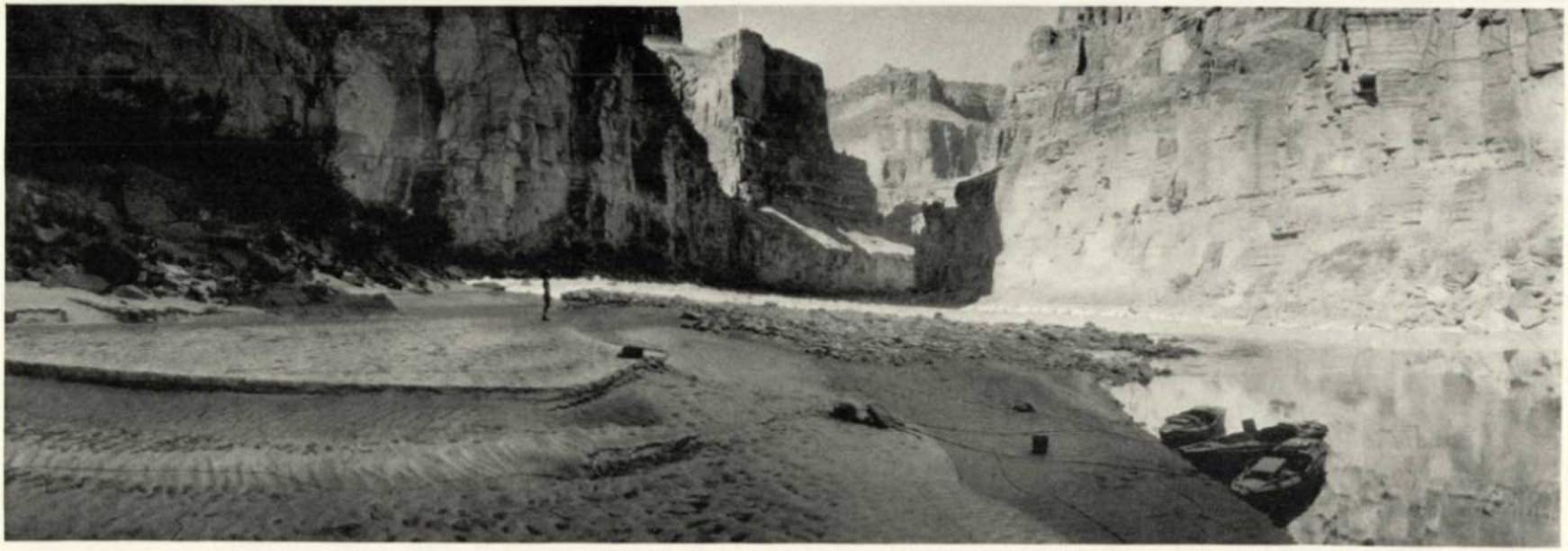
Between Kanab Canyon and Havasu Creek the expedition encountered a hitherto-unnamed rapid. In commemoration of the first upset of the trip (in which neither boatman nor boat was injured), it was christened "Upset Rapid" (see text, page 524).

Of the burial of Peter Hausbrough, drowned about ten miles above, Stanton wrote:

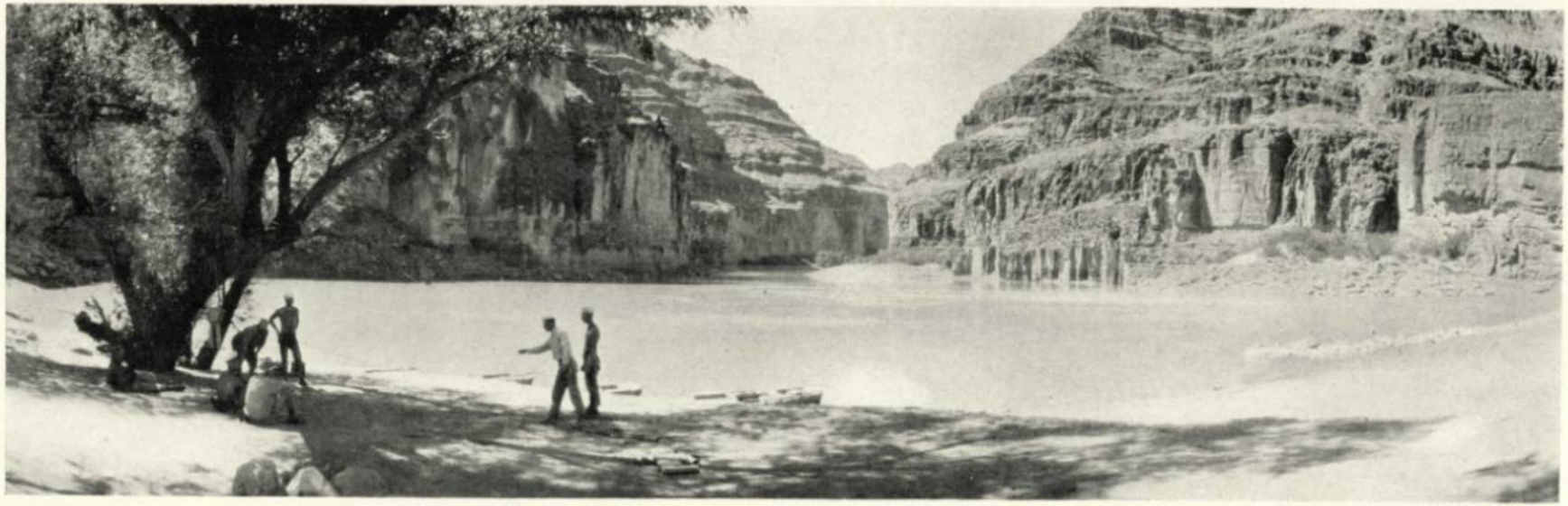
"We stood around the grave while one short prayer was offered, and we left him with a shaft of pure marble for his headstone, 700 feet high, with his name cut upon the base; and in honor of his memory we named a magnificent point opposite Point Hausbrough."

Although the grave must have been immediately behind our camp, careful search failed to reveal it, doubtless because the talus at the foot of the cliff had been built up a number of feet in the third of a century which had elapsed since the inscription was carved.

The rock-obstructed rapid which we encountered below this camp is evidently of recent formation. No mention of it is made in the records of any of the earlier voyageurs, and Kolb said he had no recollection of it from his passage of but little more than a decade ago. There appeared to have been a straight, steep chute here in the first place, and this had been

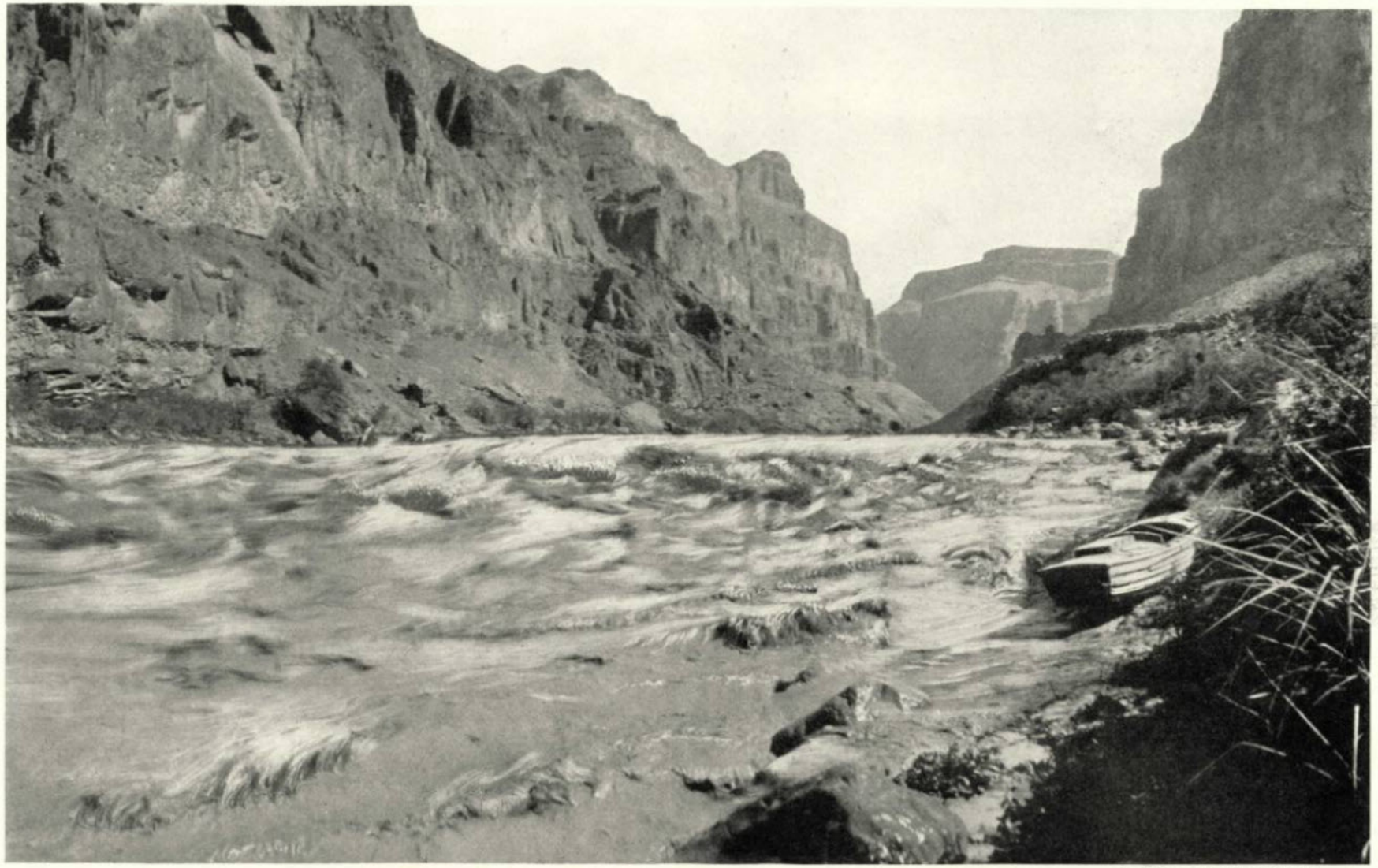


DOWNSTREAM VIEW OF THE GRAND CANYON 2.6 MILES BELOW HAVASU CREEK. THE CANYON OF CATARACT CREEK ENTERS AT THE LEFT



Photographs by E. C. La Rue

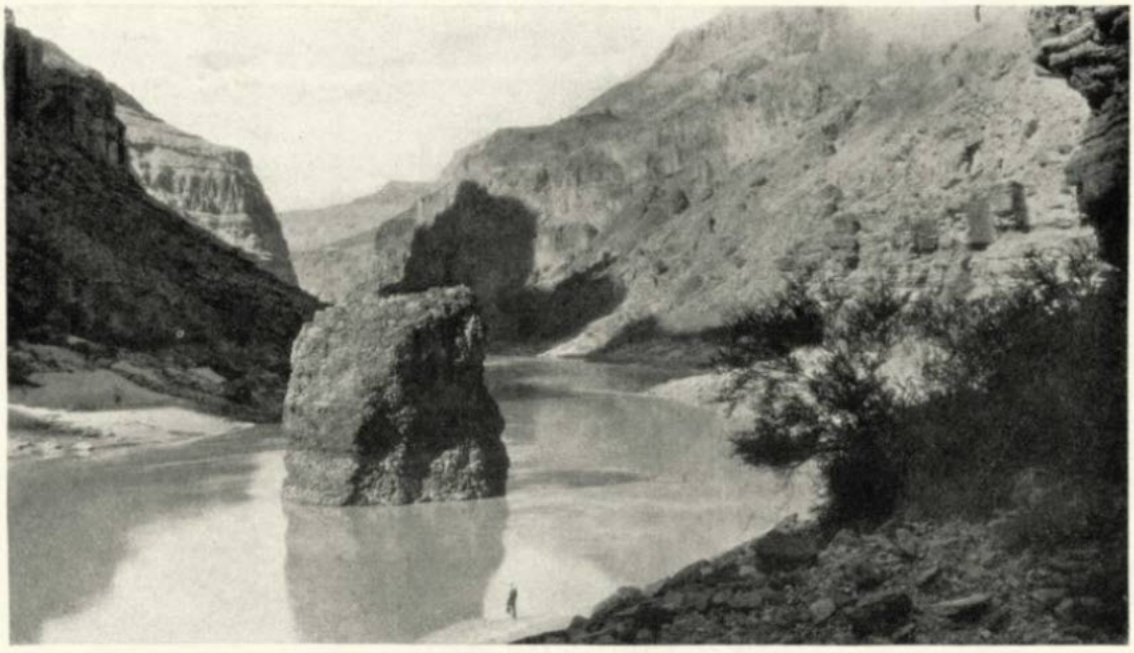
THE MEN AT PLAY 40 MILES BELOW THE MOUTH OF HAVASU CREEK, WHILE WAITING FOR THE ENGINEERS TO COMPLETE A SIDE CANYON SURVEY



Photograph by E. C. La Rue

THE FLOOD AT LAVA FALLS (SEE TEXT, PAGES 524-5)

Unwarned, the party was taken unawares at a point far from favorable—twilight on the brink of the falls.



Photograph by E. C. Kolb

LAVA ROCK ISLAND, ABOVE LAVA FALLS

Lava Falls are three and a half days' journey below Havasu Creek (see also text, page 524, and illustration, page 517). The man in the foreground provides the scale.

dammed by a great slide from the right-hand wall—Point Hausbrough. Immediately after the slide the obstruction must have extended from bank to bank, doubtless backing up the water for a considerable distance upstream. Then this broke and carried down the looser débris, leaving only the huge block of limestone planted squarely in the middle of a fierce tumble of broken water.

BOATMAN HURDLES THROUGH THE AIR

Above the rock was a back-thrown wave of water more than 10 feet in height; below it a whirlpool with a depression half as deep as the comber was high. On account of the throw-off of the wave, an actual collision with the rock itself was improbable, if not impossible; the danger was in an upset which would allow the overturned boat and its boatman to be drawn into the whirlpool below, where an uncomfortably rough and protracted stay could hardly be avoided.

After studying the rapid from every angle during our rest day, it was decided to run the right-hand channel. The down-rushing chute appeared to divide almost equally upon the great rock, but there seemed to be a shade greater concentration of current on the side toward Point Hausbrough. We pulled all four boats up the eddy, crossed over, and tied up on the right bank 200 yards above the head of the rapid. Kolb ran bow first, getting as much way on as possible, shooting down the right side of the V and continuing to pull away from the back-curling wave thrown off by the rock. His boat had a hard slap, as did the *Boulder,* which followed, but neither was near to serious trouble.

Blake, running next, evidently failed to get far enough to the right. The *Glen* was driven down against the back-thrown wave side-on, and missed capsizing by a hair. Looking back from above the rapid where I was about to push off with the *Grand,* I saw all the bottom boards of the boat as it was flung on its side; then the flick of a flying oar and the sprawling body of a man silhouetted against the cliff below, as it hurtled through the air. An instant later all had disappeared, and I had to run through myself to learn what had happened.

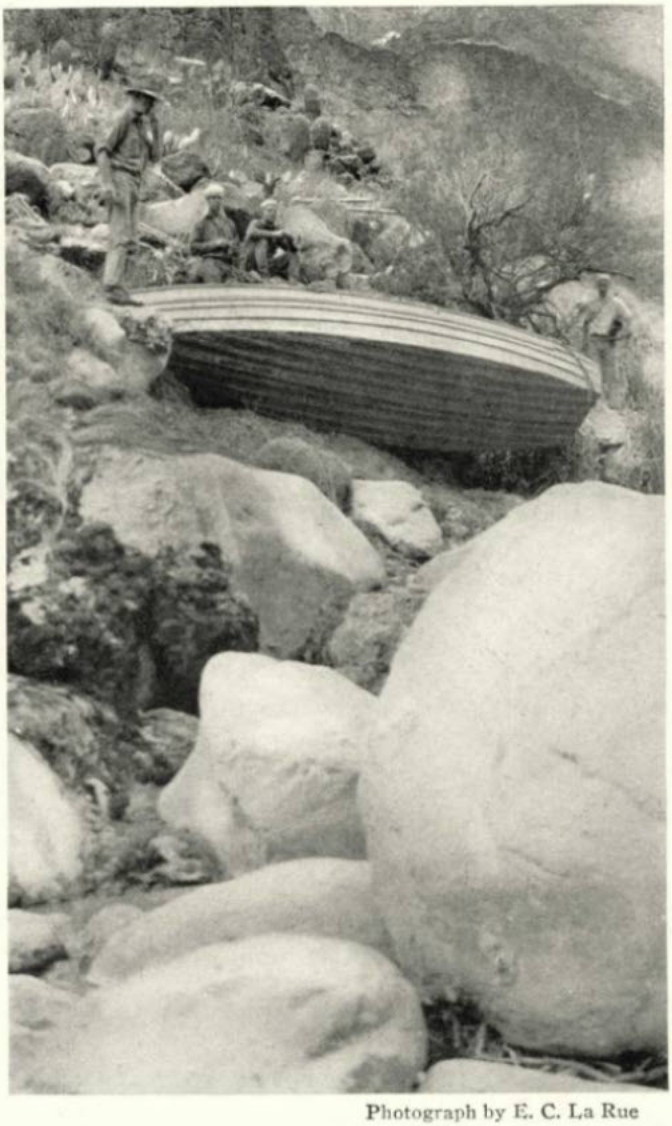
I eased pulling a bit sooner than was desirable, after dropping over the brink of the chute, and so came in for a harder slap from the wave than there was occasion for. The blow was scarcely less solid than that from actually striking a rock,

and the geyser of tumbling water inflicting it looked even less friendly rearing up above my head than when seen from the bank.

My heavily loaded boat righted quickly, however, and shipped very little water. As it shot past the rock I caught a fleeting glimpse of the hole below out of the tail of my eye. That was another little corner that did not improve with closer acquaintance, especially with the whirlpool showing off what it could do by bumping a captive log of driftwood up against the rock. The cat-and-mouse game looked as if it might have been going on a long time.

The maelstrom seemed to be "whoufing" with glee, as if it could keep up its end of the sport indefinitely, and until it relaxed its hold the only chance the log appeared to have of escaping was through being battered to bits against the boulder. I was glad to pass the outer tips of the indrawing tentacles of the octopus by a comfortable oar's length.

I found the *Glen* right side up in an eddy, with its boatman bailing the cockpit. He confirmed the impression I had received from above: that the force of the blow on the side of the boat had flung him over the gunwale without touching it. Unhurt, he had climbed back aboard after his boat had cleared the whirlpool, replaced a lost oar, and pulled into quiet water.



Photograph by E. C. La Rue

SAVED FROM THE FLOOD

The *Marble*, drawn up 21 feet above the river after the high waters of September 18 had receded (see text, page 530).

Three days more of boating took us to and past the mouth of the Little Colorado, which showed signs of having been in flood and was still flowing an unseasonably high stream of vile-smelling mud.

The main stream was never quite as pleasant bathing after receiving this sewerlike discharge, the rank, offensive smell of which we were destined to experience on one or two later occasions.

The survey showed the length of Marble Canyon to be slightly more than 61 miles, and the elevation of the mouth of the Little Colorado as 2,718 feet. Dellenbaugh had estimated Marble Canyon to be 65 miles long. This discrepancy is not great, considering the conditions under which the Powell expeditions made their calculations.

ENTERING GRAND CANYON NATIONAL PARK

There was nothing at the mouth of the Little Colorado resembling the great whirlpool located there by James White in his lurid account of a raft voyage through the Grand Canyon in 1867, two years before Powell.

Nine miles above the mouth of the Lit-

Photograph by E. C. La Rue

ALL THE COMFORTS OF THE CANYON

Moore enjoying life while activities are suspended for three days, until the flood waters subside (see text, page 530).

tle Colorado we entered the Grand Canyon National Park. As the several sheets covering the course of the Colorado through the National Park are rated as perhaps the finest examples of topographical mapping in existence,* the work of the river party was greatly simplified for most of the next 100 miles.

There was no longer need to survey side canyons, while the amount of topographical work on the main river was materially reduced. This left the carrying of the river line as the principal work of the topographic engineers of the expedition, greatly accelerating our rate of progress.

Where three or four miles was a good average day's work in Marble Canyon, from five to ten could be covered through the National Park. We were usually three or four days ahead of schedule all the way from the Little Colorado to the mouth of Havasu Creek.

There is swift water and a heavy fall to the river all the way from the mouth of the Little Colorado to the head of the Granite Gorge, but only three or four major rapids. The last of these is the Hance, at the foot of the trail of that name.

We had lively boating in a storm-swollen river all the way down this 15-mile stretch, but no serious mishaps, and reached the foot of the old and long-disused Hance Trail in the forenoon of the 16th, four days ahead of the time our pack-train had been ordered to come down with fresh supplies. In the interval we sent out to El Tovar for new and stronger oarlocks in anticipation of rough work in the Granite Gorge below.

RUNNING THE DANGEROUS HANCE RAPID

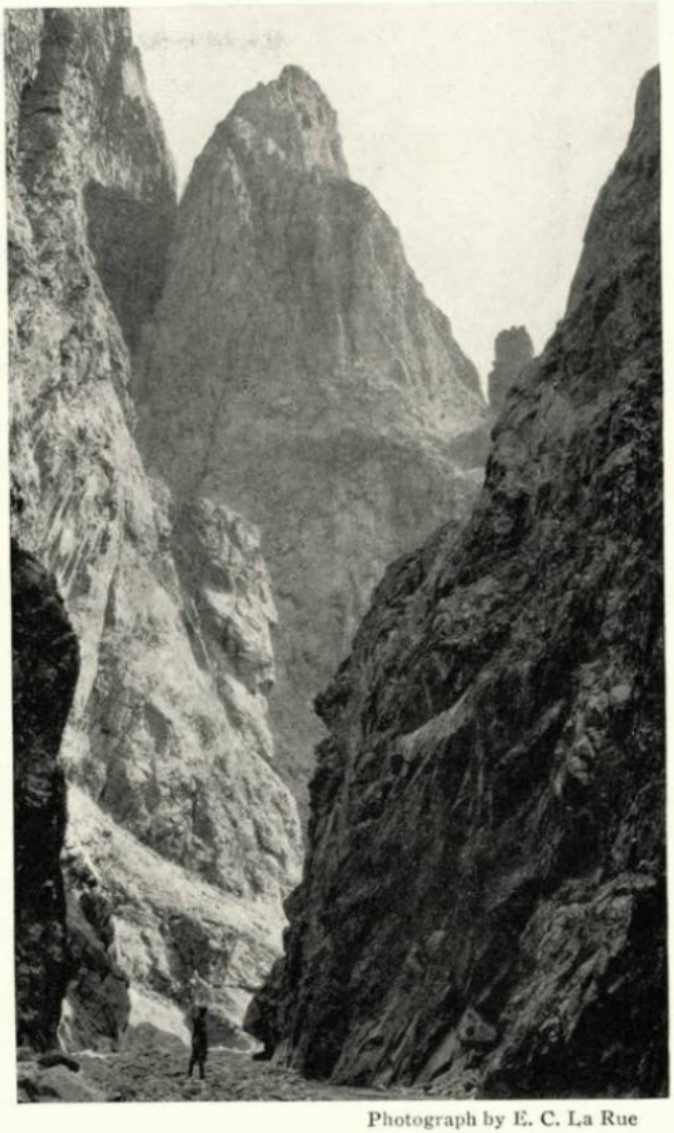
As far as our records showed, no previous party had run all of its boats through the Hance Rapid with its 28-foot fall in the upper section. The portage being a long one and conditions for lining down the side almost impossible at the present

* The Vishnu, Bright Angel, and Shinumo sheets of the Geological Survey represent many years' work by François Matthes and Richard T. Evans, topographic engineers. They are considered equal, if not superior, to the finest work of Swiss, French, and Italian topographers in mapping the Alps.

stage, running seemed worth trying, especially as the mules of the pack-train were available to carry our loads down.

The decision was justified. The emptying of the holds of the boats made an unbelievable difference, not only in their responsiveness to the oars, but also in their ability to ride over waves which would otherwise have buried them. It was a fine sporting run.

After a day spent in going over our boats, we pushed off again on the morning of August 21. A light drizzle of rain was falling as we entered Granite Gorge, but even with that the walls had a less sinister aspect than one expected after Powell's description.



Photograph by E. C. La Rue

LOOKING UP DIAMOND CREEK GORGE FROM A POINT THREE MILES FROM THE RIVER

OVER THE FAMOUS SOCKDOLOGER

An impression of that kind is largely psychological, no doubt. Powell, with dwindling, half-spoiled supplies and battered boats, was facing both starvation and the Unknown; we, with a fully equipped outfit, were pushing on for the foot of the Bright Angel Trail with the prospect of a three-day rest at the hotel on the rim. No wonder we had eyes for the gleaming brightness of quartz, feldspar and mica where the pioneer explorer saw only the forbidding loom of dark walls of igneous rock.

A mile in heavy swirling water took us to the head of the Sockdologer Rapid. Landing 200 yards above the first drop, we climbed down along the right-hand wall to the nearest point attainable to the brink of the opening drop.

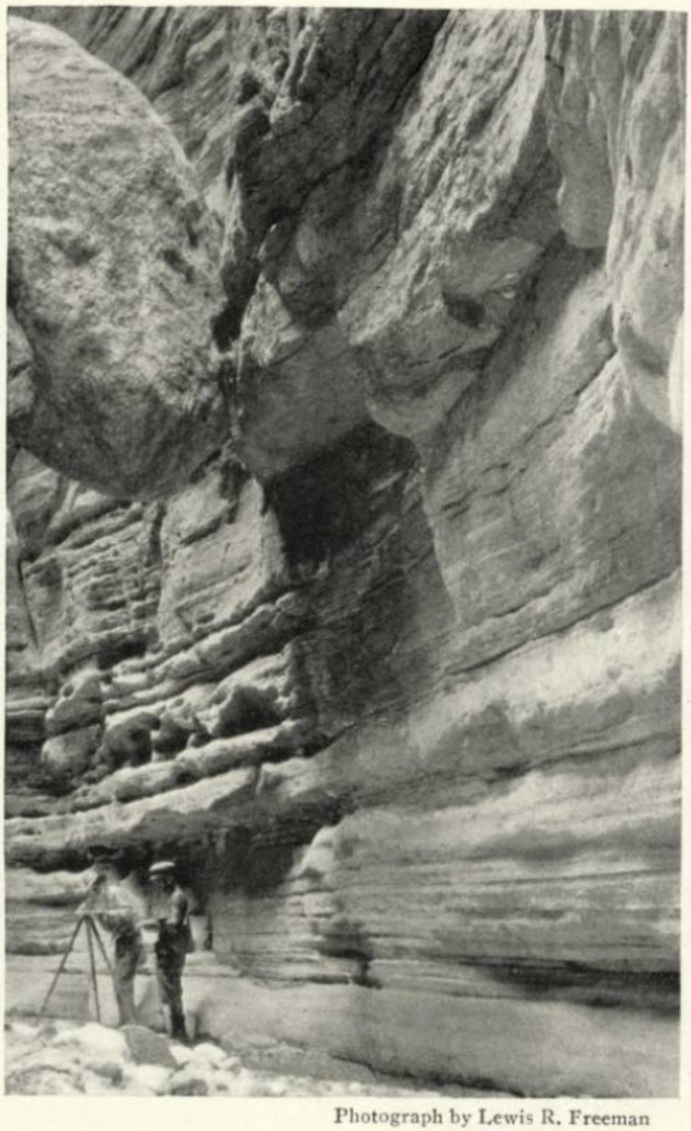
Powell's and Dellenbaugh's estimates of a fall of from 80 to 100 feet in a third of a mile, with waves 30 feet high and spray dashing double that height, prepared us for something on a big scale, though we knew that these figures were rather liberal.

The fact that this was the first major rapid, where the impossibility of climbing round made it necessary to carry the whole party on the boats, lent added interest to the Sockdologer.

The famous rapid was not an entire disappointment, for the initial fall proved extremely abrupt and the waves below were very high; but it was all deep water in mid-channel, with the combers by no means so sharp and broken as when underlaid by boulders. There was plainly no such menace in the rapid as in the Hance and several others already run, where the fall was over rocky obstructions.

As there was no chance to land to set up rods or instruments for nearly a quarter of a mile, some difficulty was experienced in running the survey line, but this was finally accomplished.

Blake and Kolb ran through with one



Photograph by Lewis R. Freeman

MOORE AND BIRDSEYE IN AN UNNAMED SIDE CANYON ABOUT 20 MILES ABOVE DIAMOND CREEK

passenger each; Lint and I with two. The height of the waves was much greater than any we had previously seen, but their evener run gave the boats just enough time to lift over without burying themselves, as in the broken water of boulder rapids. La Rue was not much splashed on the stern of the *Grand;* Moore, on the bow, was bone dry. Not more than the usual amount of water came over the side to drench me and the cockpit. There were only three or four inches covering the bottom boards when I pulled into an eddy under the left-hand wall at the foot of the rapid.

All in all, the run through the Sockdologer was the best sport, from a boatman's standpoint, of any of the voyage, partly because of the great height of the waves and partly because we knew there were no rocks under them to bother about.

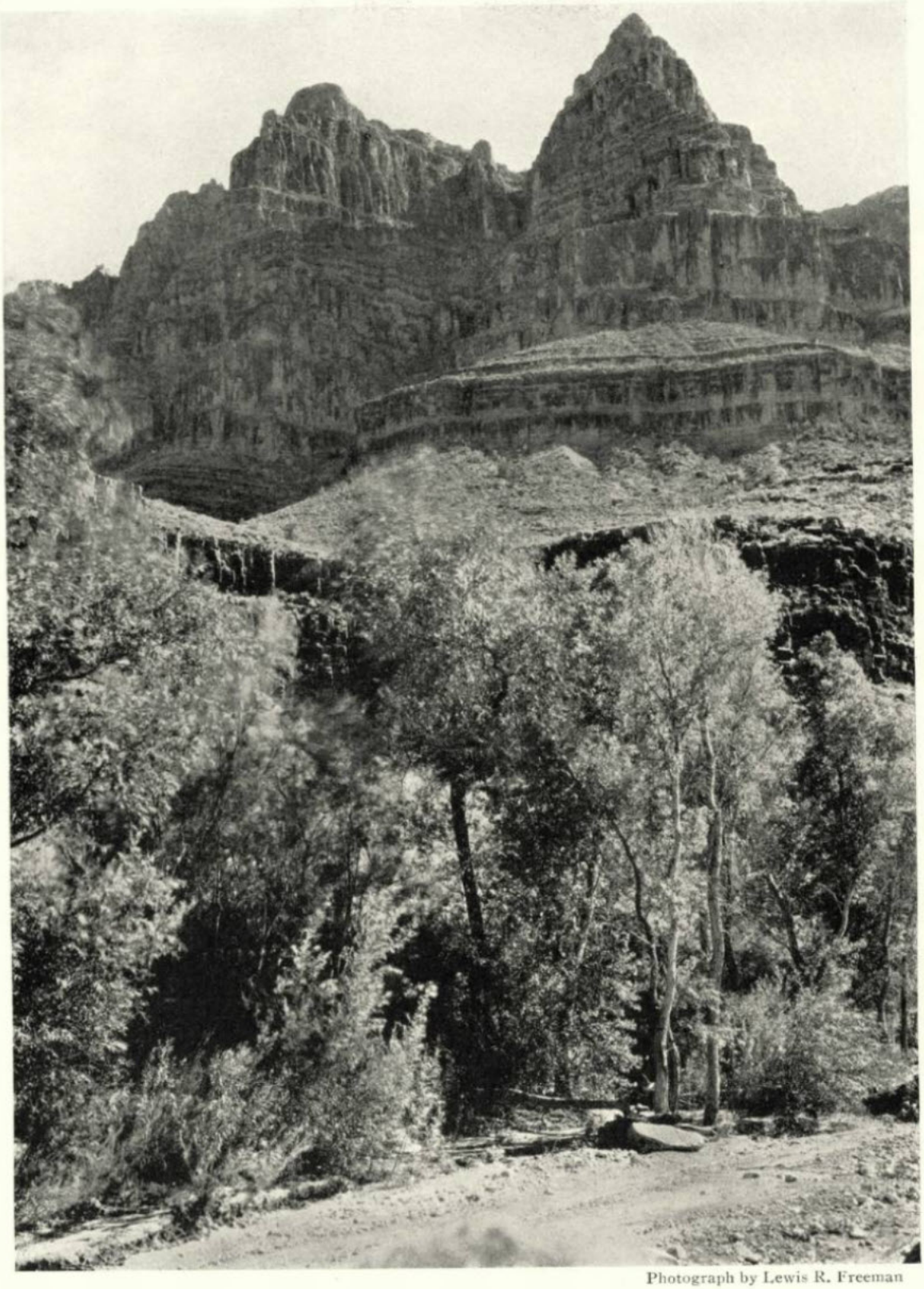
Burchard announced the fall of the Sockdologer as 19 feet—less than a quarter of Powell's original estimate and a little more than half of that of the conservative Julius Stone. My own rather vague impression of the height of the waves was from 10 to 12 feet; some of the engineers, with trained eyes for estimating, were inclined to think the largest combers were higher from trough to crest than the length of the boats—perhaps 20 feet.

The Grapevine Rapid, a few miles below the Sockdologer, proved of much the same character as the latter and gave us the same exhilarating runs. The remainder of the run to the mouth of Bright Angel Creek was lively, but not difficult boating.

After three days at El Tovar, the voyage was resumed from the Suspension Bridge (see page 500) on August 27. Hermann Stabler (see page 497) joined the party at the foot of Bright Angel Trail the following day. He was a valuable addition to the expedition.

The 70 miles of canyon between Bright Angel Creek and Havasu Creek, the lower boundary of the National Park, were marked by frequent major rapids, many of considerable violence. In spite of the fact that most of the previous navigators had met with serious disasters at various points in this rugged stretch of gorge, our good luck held and our mishaps were largely of a minor character.

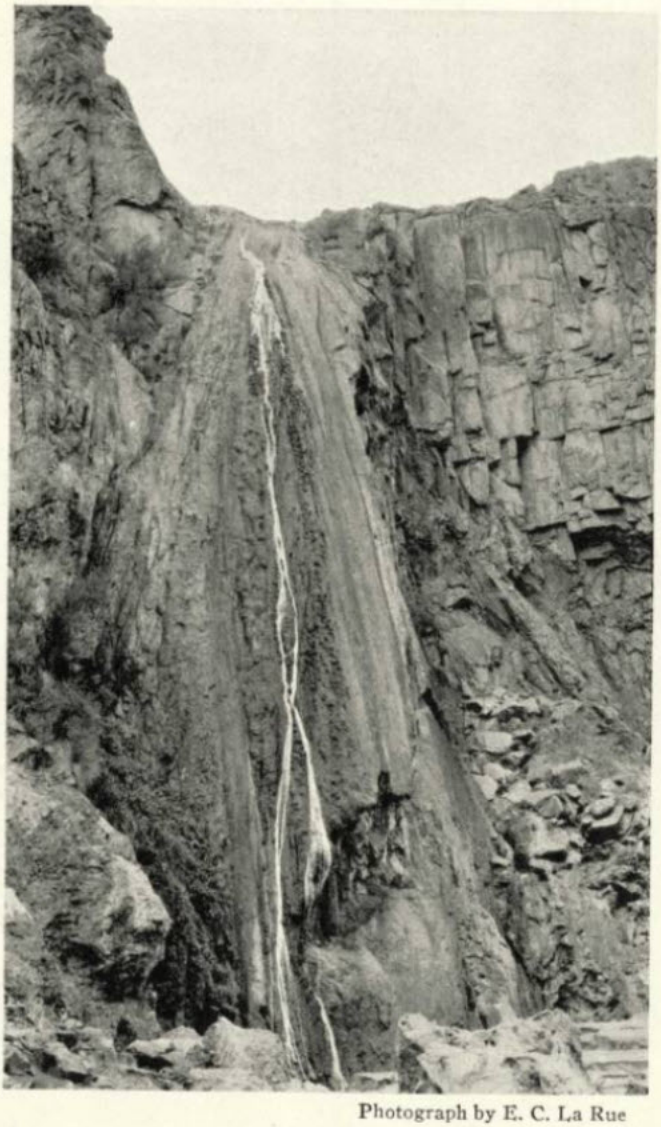
Monument Creek Rapid, with seventeen-foot fall, and Hermit Creek, with sixteen, gave us fine slap-banging runs, but nothing worse than good soakings. Hermit Creek, the one major rapid in the Grand Canyon readily accessible by trail



Photograph by Lewis R. Freeman

A GLADE AT THE HEAD OF DIAMOND CREEK

Owing to the flood, the party was four days behind schedule in reaching this point, giving rise to the report that the expedition had met with disaster (see text, page 530).



Photograph by E. C. La Rue

TRAVERTINE FALLS, FIVE MILES BELOW THE MOUTH OF DIAMOND CREEK

from the rim, was run in the presence of a large and distinguished gallery from El Tovar—rather a novel experience for both parties.

KOLB HAS AN UPSET

The distinction of the first upset fell to Kolb while trying to run a rough and hitherto unnamed rapid a few miles above Havasu Creek. It occurred as a consequence of allowing his boat to draw into a deep hole under a large boulder, where it capsized, cupping him under the cockpit. He bobbed up 100 feet farther down and climbed out on the bottom of the overturned boat. With the assistance of Dodge, who jumped in and swam out to the derelict, it was brought to the bank 300 yards below the foot of the portage, and subsequently lined back. Neither boat nor boatman was injured. The event was commemorated in the name of the rapid—"Upset."

At the mouth of Havasu Creek 20 Havasupai Indians, under the direction of Roger Birdseye, brought down 800 pounds of provisions for the long stage to Diamond Creek. Here the cook, who had started with the party from Lees Ferry and who had asked to be relieved some weeks previously, was replaced by a genial Pole, Felix Koms, who completed the voyage with us. The unfailing good nature of the new chef, under conditions which must have been very trying to a roly-poly dumpling of a man weighing 225 pounds, won the affection of every one in the party.

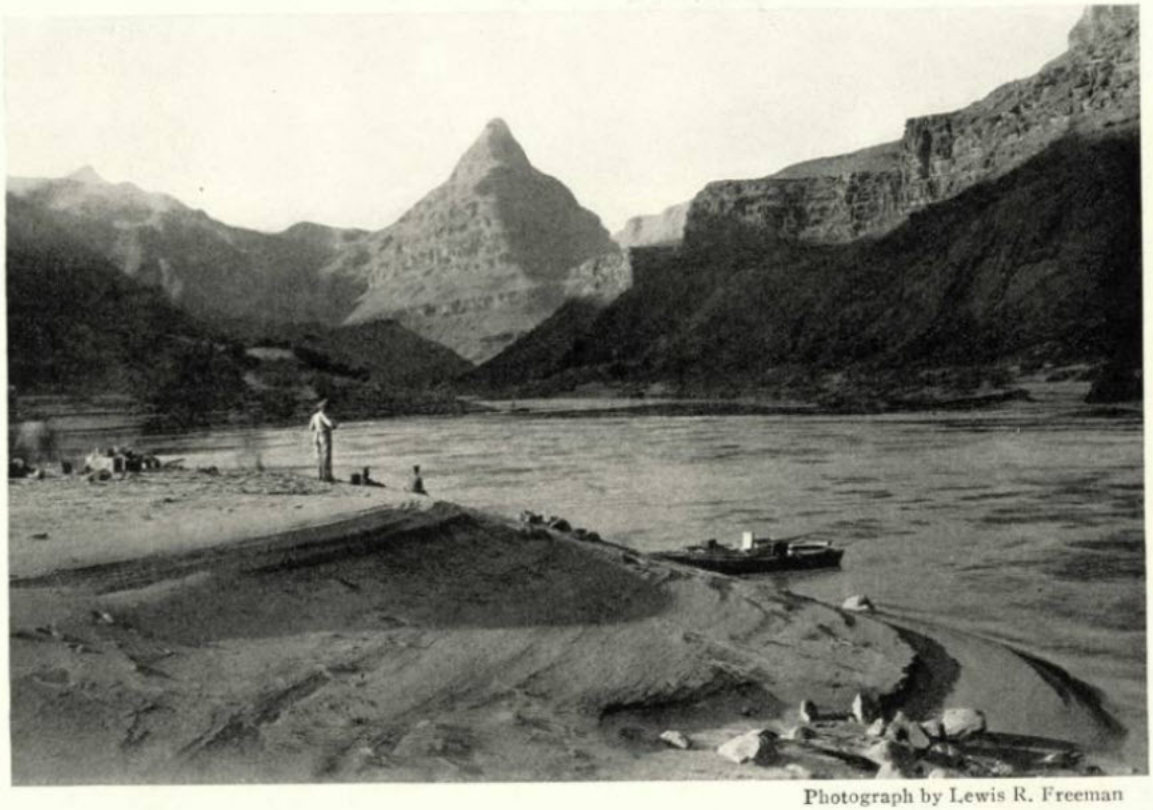
The radio set was sent out from Havasu for repairs, to be brought back to us at Diamond Creek, 70 miles below.

FLOOD SWEEPS DOWN; WARNING NOT RECEIVED

Pushing off from Havasu with deeply loaded boats on the morning of September 15, we came, after three and a half days, to the head of Lava Falls. The skies had been clear most of the way, but violent wind squalls indicated that equinoctial storms were gathering to break upon the plateau region behind us.

If the radio set had been with us we would have received numerous messages broadcast from several stations in response to wires from Washington advising us that one of the heaviest storms of recent years had broken upon the basin of the Little Colorado and warning us to be on the lookout for the waters of a very heavy flood.

If such warnings had been received, we would have selected a broad open section, with ample room to back away from a rise, and waited for the flood to pass. Unwarned, we were surprised at a time



Photograph by Lewis R. Freeman

SHARP PINNACLE NEAR THE MOUTH OF DIAMOND CREEK, FROM FIVE MILES UP RIVER

and place far from favorable—twilight on the brink of Lava Falls.

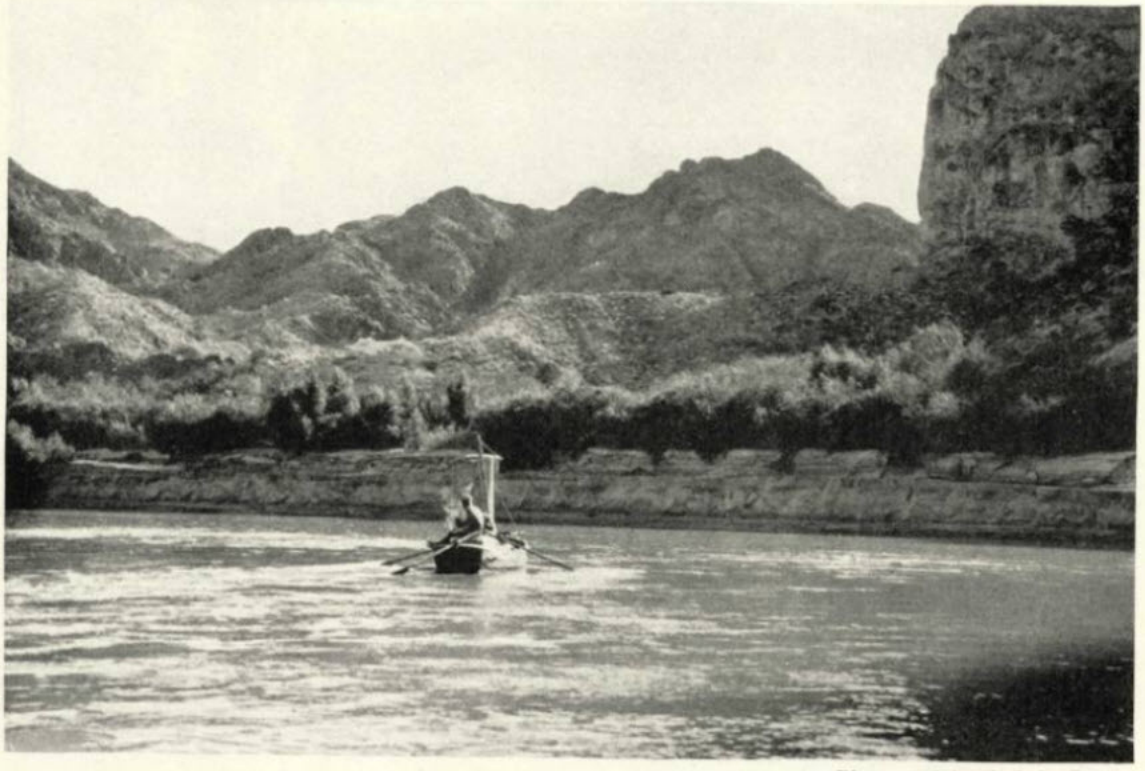
As the boulder barrier at the head of the rapid offered no runnable channel, the boats were lined down the right side of the most violent section to a narrow crescent of beach below. Beds and cooking outfit were left at the head of the falls, where a few patches of sand among the boulders offered the only feasible camp site. The rest of the outfit was carried down to the boats and restowed in preparation for an early start in the morning. The portage was completed an hour before dark.

Immediately after supper it was noticed that the boats were awash at their moorings, and a few minutes later the beach upon which they had rested was completely submerged by the rising river. As there was no place but the sharply sloping hot-springs formations on which to pull them up, they soon began banging heavily, while the waves from the rapid increased in weight. The *Grand* was in the worst position, being immediately under a ten-foot wall of travertine, with boulders all about. The other boats, for a while, could be drawn up a foot or two at a time as the water rose.

I buffered the *Grand* off the rocks with driftwood until the water was midthigh deep, and then crowded her in to take her chance with the other boats. Meanwhile it had become evident that a better mooring place would have to be found at once, as there was room for only one boat upon the shelf to which the water had now risen, and only an empty one could be handled even there. This would have to be the cook-boat, *Marble,* as the other three were heavily loaded.

FINDING AN ANCHORAGE IN THE DARK

It was now quite dark. All chance of seeking a safer mooring by daylight had been lost. The rest was a night job. Lint and Kolb pushed off in the *Boulder,* the latter carrying an acetylene lantern, and the former pulling cautiously down the eddy beside the lower end of the rapid. The rest of us were kept busy pulling in the three remaining boats and preventing their destruction on the rocks. Lint and Kolb returned in half an hour; they had left the *Boulder* on a sloping beach of



Photograph by E. C. La Rue

SAILING IN THE QUIET WATERS OF BLACK CANYON, BELOW DIAMOND CREEK

limestone a third of a mile below, and recommended that the *Grand* and *Glen* be taken down also.

Kolb rode with me on the bow of the *Grand;* Lint with Blake on the *Glen.* The moon was shining on the opposite wall and a part of the rapid. The latter had lengthened greatly and was booming louder every minute. The illuminated strip of rollers was a ghostly gray and the effect curiously like that of wind-billowed canvas.

We ran as close as we dared to the left bank of travertine, over which streams from the hot springs were falling, gleaming white in the reflected moonlight. There was not much current in the eddy, but a heavy lop from the main chute of the rapid splashed against and occasionally into the boat.

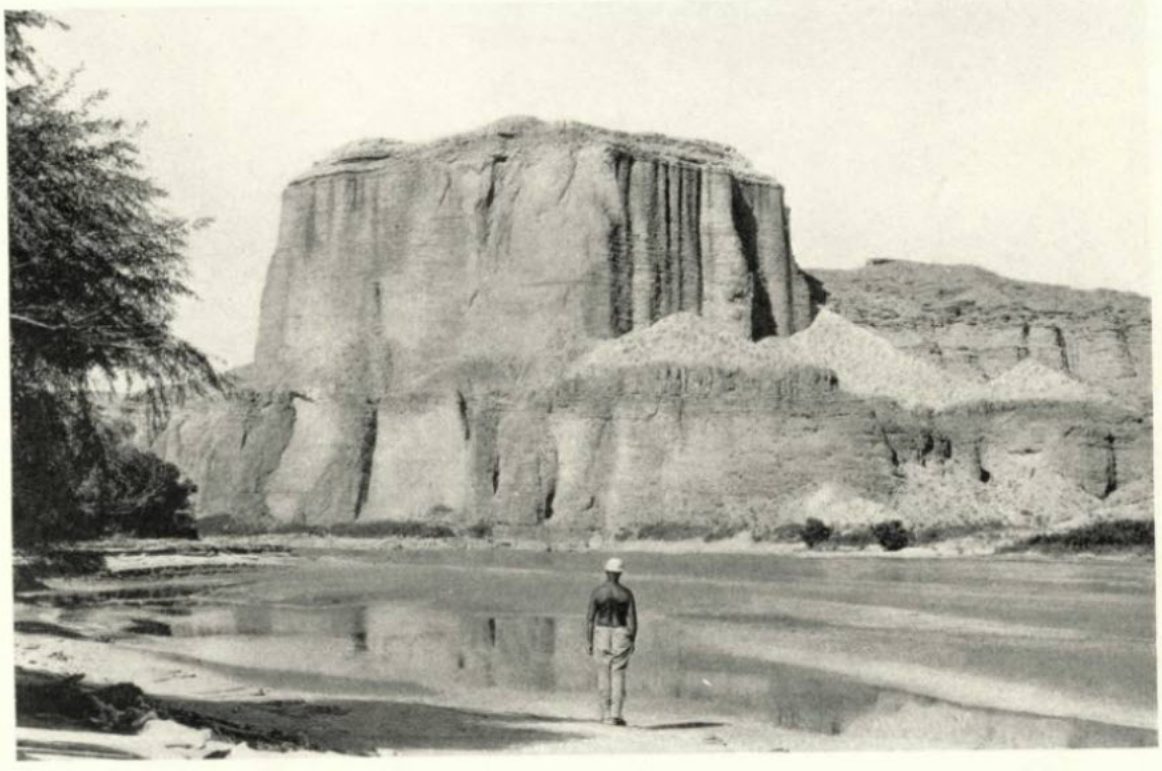
AN EERIE NIGHT RIDE

A distinctly unpleasant odor from the water suggested that the flood was coming from the Little Colorado (see text, page 475). Mingled with this was a humid, almost tropical, smell—rank vegetation and a suggestion of the perfume of flowers.

It was a weird and eerily stirring rather than a wildly exciting ride. Once or twice we were caught by the powerful downrush of the rapid, but a stroke or two brought the boat back to the half-water on the verge of the eddy.

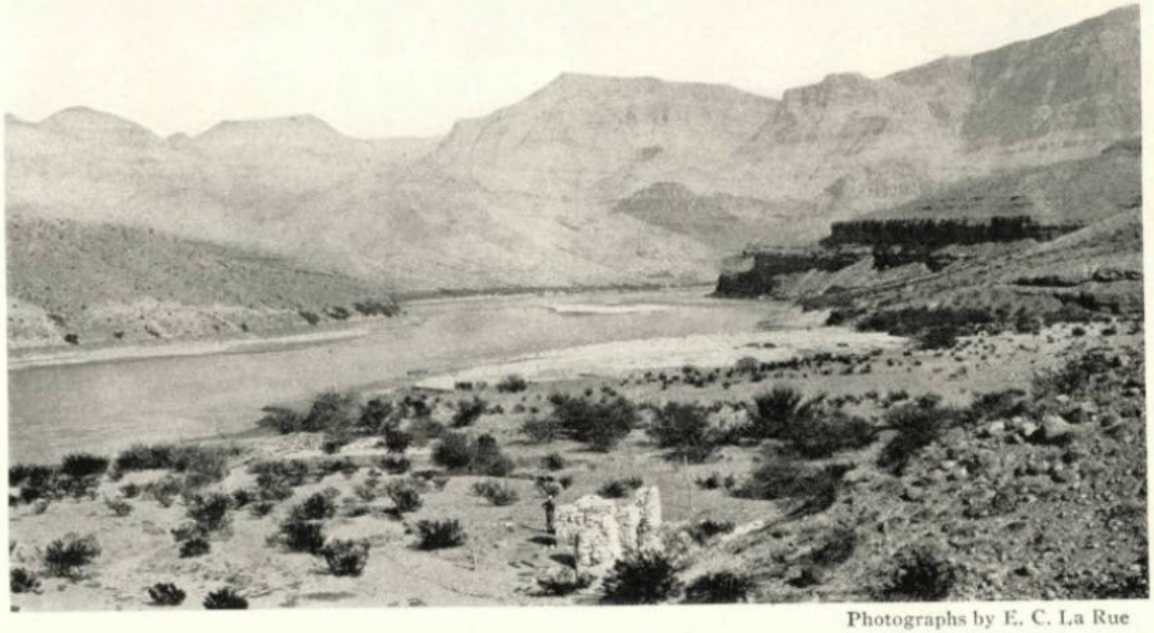
As we doubled cautiously round a jutting point, a new roar from down-river cut into the heavier boom of Lava Falls. Evidently we were nearing a second rapid not far below where the gleam of the tail of the first was quenched in the shadow of a moon-blotting cliff. Then a bay opened up to our left and I pulled into quieter water and beached the *Grand* beside the *Boulder,* on a sloping shelf of travertine.

As there had been no chance to get my bed in the rush of pushing off, I took a lantern and started back to camp as soon as the boats were secured. It was vile work pushing across the slushy, crumbling springs formation, with a tangle of rotting vegetation underfoot and huge thistle and saw-edged grasses growing higher than my head. These pricklers and cutters were particularly unpleasant, since my sole protection against them was half a pair of knickers and one tennis shoe.



THE "TEMPLE," A BUTTE OF CONGLOMERATE ABOVE THE MOUTH OF VIRGIN RIVER

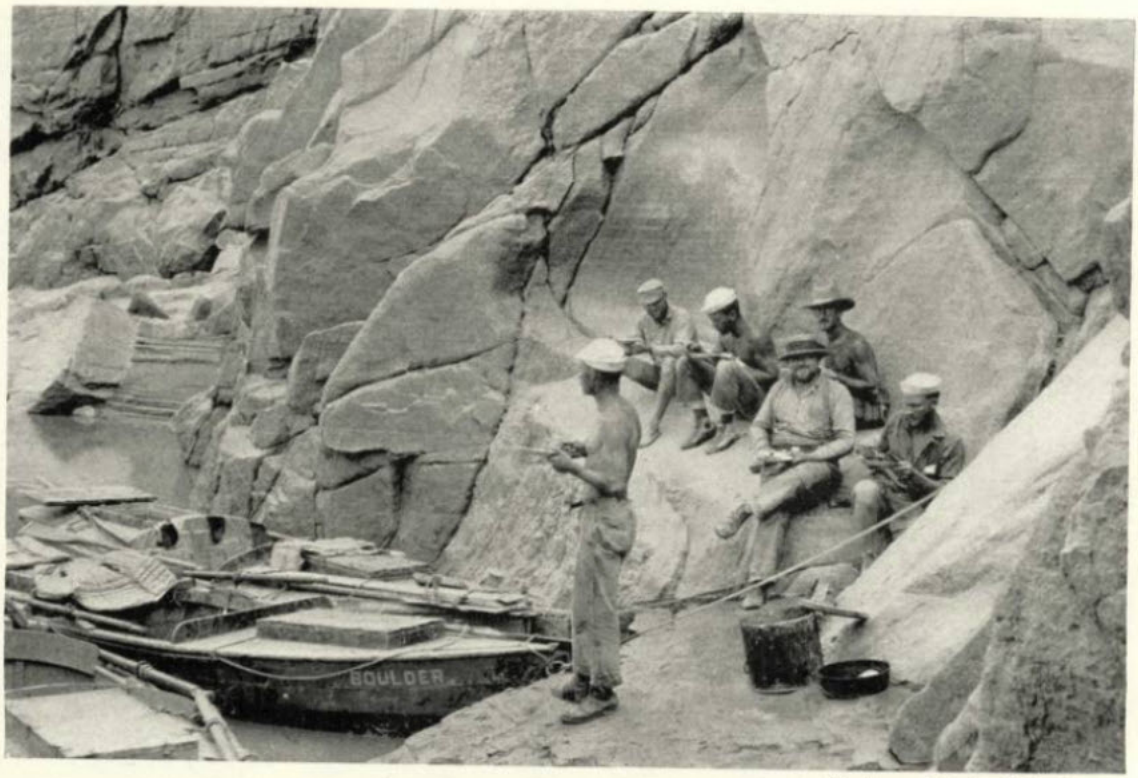
Virgin River enters the Colorado just above the point where the major stream makes its final sharp right-angle turn, flowing due south (see the Map of North America supplement).



Photographs by E. C. La Rue

LOOKING UPSTREAM TOWARD THE WEST PORTAL OF GRAND CANYON

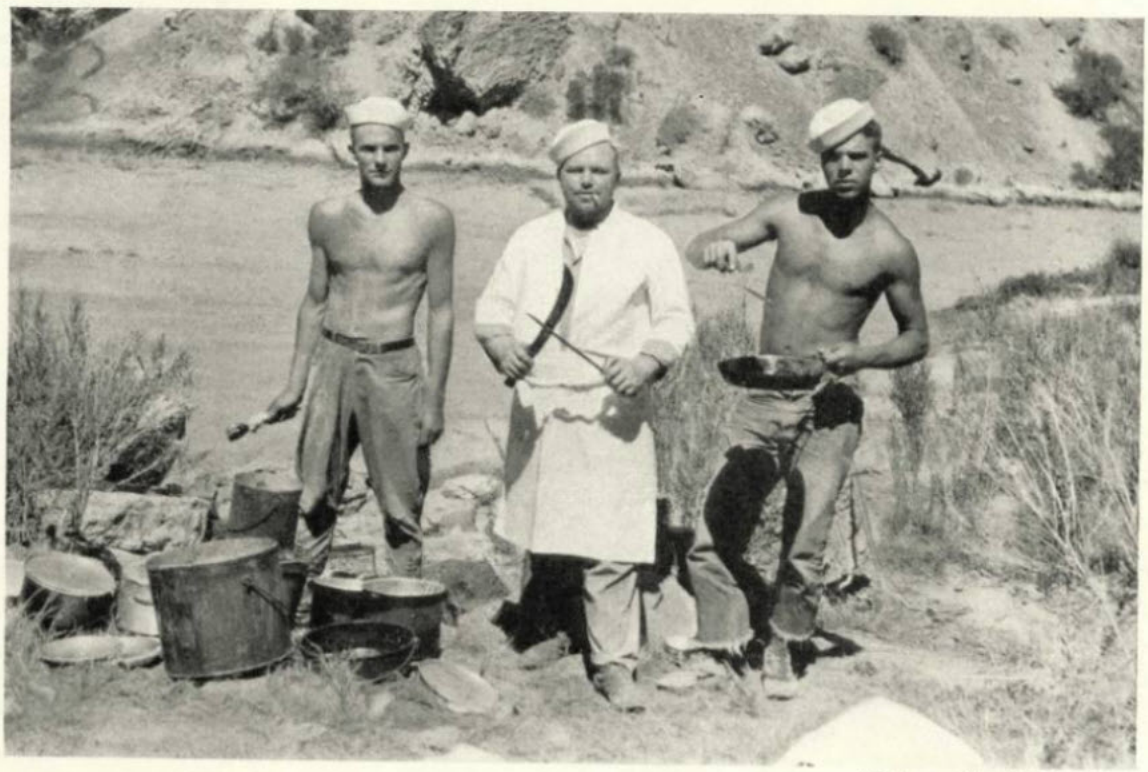
Note the ruins of the old stone house in the foreground. This was once one of the buildings at Pierce Ferry, where a wagon trail from Kingman to Moapa crossed the river.



Photograph by E. C. La Rue

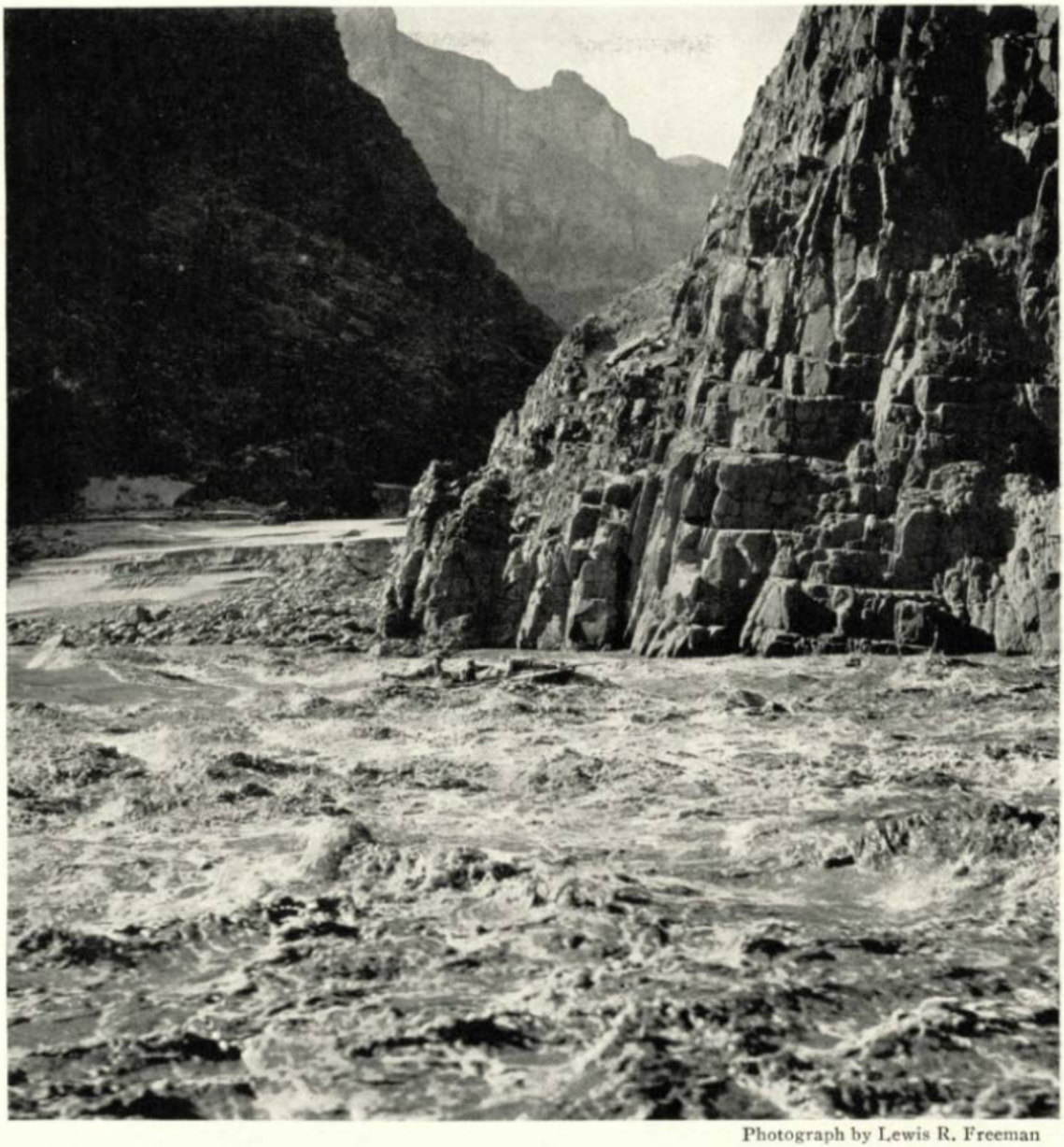
TIME OUT FOR LUNCH

On a narrow ledge 26 miles below the mouth of Diamond Creek.



Photograph by E. C. Kolb

FELIX, THE COOK, AND HIS ASSISTANTS, BLAKE (LEFT) AND LINT (RIGHT), AT DIAMOND CREEK



Photograph by Lewis R. Freeman

THE "MARBLE" IN A RAPID NINE MILES BELOW DIAMOND CREEK

Note the two men clinging to the overdecked bow and stern, while the oarsman in the cockpit pilots the craft.

After fording three or four warm streams, I finally broke through to more open going, but even here there were many cacti. The last 100 yards was along the cliff and over boulders, among which the rising flood was already beginning to swirl.

There were zest and exhilaration in the blind ride in the half moonlight down the edge of the booming rapid, but the tortuous tramp back through the swamp of the hot springs was sodden grief all the way.

In my absence the *Marble* had been dragged several feet above the water, but the spray was already beginning to dash over her again, as the mounting waves banged higher and higher against the wall. I found every one in camp engaged in moving back from the encroaching flood.

RESCUING THE COOK'S BED

We had hardly turned in before it was necessary to scramble back over the boulders and give the *Marble* another hoist. Then we had a rest until an am-

bitious wave came up and surrounded the bed of Felix, the cook. The surprised sleeper awoke in such consternation that he fled, leaving bed and clothing behind in the water. Birdseye and Dodge salvaged the sleeping-bag, and Felix was put to bed again on a higher level.

By morning the water was up to our feet, where we had rolled in after our final move to the last bit of beach under the mesquite. The rapid had unbelievably altered in character overnight. The head of the dam of boulders, where the previous day there had been a series of abrupt falls, was now completely submerged. Over it rushed a broad, solid chute of wildly running water which did not begin to break into waves until halfway down what had formerly been the rapid.

From there on the combers were tremendous—the largest we had seen. They culminated in an enormous uptossed mass of churning, surging water just above where the boats were moored—a point where yesterday there was only a swift but comparatively smooth stretch of current.

This wave was a great boil or fountain, which at times measured all of from 15 to 20 feet from trough to crest. It appeared to be caused by conflicting currents rather than by a rock, and rarely assumed the same form twice in succession.

At times, in breaking back, it cupped down a large quantity of air, which, when compressed, threw out jets of spume like that from a cavernous blowhole on the ocean shore.

A continuous procession of drift logs of great size was moving down the river, some of the largest trees being up-ended and sucked down in whirlpools or, again, almost tossed out of the water. It looked barely possible that a boat might survive a run through the rapid, but only in the event that it could be kept away from several of the largest waves.

A RISE OF 21 FEET IN 24 HOURS

The river had risen 13 feet during the night, to which 8 feet more were added by evening of the second day. The hydraulic engineers of the party estimated the flow at from 75,000 to 100,000 second-feet. We learned subsequently that it had been more than 112,000—slightly greater than that of the last spring rise.

The *Marble* had finally to be hoisted up an almost sheer wall by block and tackle to keep it clear of the climbing waves. The other boats, after unloading, were more easily handled (see page 519).

After a three-days' halt to allow the flood to recede, we pushed off again on the morning of September 22. The increased weight of the water was evident the moment we were well into the current, and when it began to slop aboard in running the riffle under the cliff below it proved to be a veritable liquid mud. A splash of it left a white coating on the skin as it dried, while the effect on the eyes was almost blinding.

Although we had most favorable boating conditions, we were four days behind schedule in arriving at the mouth of Diamond Creek. This fact and the reported sighting of an overturned boat marked U. S. G. S. below the canyon were responsible for the sensational dispatches reporting that the expedition had met with disaster.

SEPARATION RAPID, WHERE POWELL'S PARTY SPLIT

Navigation became more arduous below Diamond Creek. Three days of rough boating in a river with an average fall of more than 15 feet to the mile brought us to the head of historic Separation Rapid, which, with its large canyons coming in opposite each other, was unmistakable from the descriptions of Powell and Stanton.

Here, according to Powell's story, three members of his 1869 party, believing the river expedition was doomed to disaster, deserted and climbed out to the plateau by the canyon from the north. After seeking in vain for a practicable portage along the sheer cliffs, Powell put into the rapid with two of his boats and went through without trouble. The three men who left were killed a few days later by the Indians, though their fate was not learned for many months.

We had no more success than our predecessors in finding a way by which those not needed in the boats could climb round the rapid. Even Dodge, the rodman, who was all but fly-footed when it came to cliff-work, gave up after a persistent attempt to get by. The left wall

proved to be sheer, though only about five hundred feet in height, rather than the thousand estimated by Stanton. The right wall was more broken and not as high as the other, but still offered no chance to climb.

The *Glen* was the first boat to navigate Separation Rapids and had a heavy tossing in the big waves where the second section beat against the left-hand cliff. Solid water appeared to roll right over the head of Dodge, who was holding on to the stern. The heavy set of current against the jutting right-hand cliff was evidently hard to pull against, but Blake kept clear by a comfortable margin. The third section, with a broad submerged rock in the middle, offered no difficulties.

As I went back to the head of the rapids to take pictures of the two canyons and other features described by Powell, the *Glen* was the only boat I saw run. Kolb went through next, and then Lint. On being told that Kolb had carried dangerously near to the right-hand cliff, I decided to take a chance at putting into the heavy water at the head of the second rapid.

The head of the second or main section of Separation Rapids is the place of which Stanton wrote: "As I looked down into that pit of fury, I wondered if it were possible for our boats to go through it and come out whole, and right side up." A few seconds after that impression was registered, Stanton was in the water and his overturned boat had a hole in it.

THE UNCAPSIZABLE "GRAND" CAPSIZES

Somehow the rapid had not looked as bad as that to me, which was unfortunate. Had I been less confident of the ability of the *Grand* to ride any waves not fanged by rocks, it would have been easy to pull to the right of the heavily running combers and fight it out with the current setting against the right-hand cliff, as the others had done. Instead, I tried only to keep the stern well on to the main line of waves on my left, and so allowed the boat to be caught quartering by a sneaking lump of a comber on the other side. An easy, effortless uplift, the flip of a foam-flecked crest at just the right instant, and the thing was done. The supposedly uncapsizable *Grand* was bottom-up.

My only mental picture of the incident has to do with La Rue's thin legs spidering against the sky as he spilled off the stern hatch, all but falling into the cockpit. Then darkness and much rolling and tumbling of water.

To keep from being cupped under the cockpit, as Kolb had been in his upset above Havasu, I let go my oars and tried to dive. In this I was materially assisted by the swirls. The several succeeding seconds were as active as unpleasant. I pawed water and gulped water, but didn't seem quite able to bring the surface down where I could use it.

Finally a violent swirl carried me to the top, but only to suck back my protesting anatomy so quickly that the breath of air I tried to get ended in a bite of water. This time the submergence was brief, and as my head came up again I managed to gulp a lungful of mixed air and spray.

The downward pull was still strong, though intermittent, and my head continued to duck under now and then, as I lunged off after the boat, drifting 10 or 15 feet below me. I had the feeling that my saturated life-preserver jacket was giving very little support, but this may have been due to the drag of the current on my very heavy hobnailed shoes.

Moore, minus cap and glasses, was riding contentedly by one of the side ropes. La Rue was not in sight. The spectacle of the right-hand cliff seemingly about to topple over on us, as the boat was carried under it, was a bit disturbing, as one could have no illusions as to which would get the worst of it in case of a collision. The disappearance of the ominously looming wall and a throaty croak from the other side of the boat announcing that La Rue was still a passenger disposed of the chief worries of the moment.

A splash and a quickening of motion signaled the entrance to the third riffle. From above, squarely in the middle of this, the current had appeared to break in a broad, low wave over what must have been a large flat rock, fairly well submerged at the present stage. It hardly looked capable of precipitating a violent smash at the worst, yet I was glad to see our derelict giving it a wide berth to the left.

The boat danced at a merry pace on

Photograph by Lewis R. Freeman

RIGGING SAIL ON THE "GRAND" 50 MILES ABOVE NEEDLES, THE END OF THE VOYAGE

through the rest of the riffle, but not in a way to make it hard to hold on.

THE "GLEN" IS UNDAMAGED

Moore and I climbed up on the bottom of the boat as soon as it floated into quieter water, but as La Rue appeared somewhat dazed it was not practicable to attempt to right her in midstream. This was accomplished as soon as Blake and Dodge, on the *Glen,* had worked her in to an eddy against the left wall.

Baling hastily, I replaced a lost oar and pulled across to a beach on the opposite side to dry out. The little water that had entered the holds had done no harm, even to an unprotected sack of sugar. The only losses of moment were Moore's colored glasses and several irreplaceable geological specimens, loose in the cockpit at the moment of upset. My missing oar was picked up a few miles below and restored to the mate with which it had worked all the way from Lees Ferry.

Lava Cliff, the rapid considered by Stone as the worst in the whole Colorado Canyon series, was passed by intricate and laborious lining on October 11 and 12.

Burchard, the topographic engineer, who was handling the instrument in running the river line, was the victim of two bad falls the day we left Diamond Creek. In the first, when he was precipitated upon a barrel cactus with fishhook spines, he was saved from injury through the fortunate circumstance of having used the leg of a discarded boot to patch the seat of his trousers.

In the second fall he landed upon the corner of his instrument box and fractured a rib. Although in much pain at times, he stuck gamely to his work, and on October 13 was rewarded by picking up with his instrument a little pyramid of white stones on a jutting point ahead. It was the monument marking the highest point reached by his up-river survey of 1920. When the two surveys were tied in, their elevations were found to check within four feet.

There were many splashy rapids remaining below us, but none which required a preliminary reconnaissance. With the survey completed, progress was speedy. We ran out of the canyon on the first day, and on the fourth day from the Grand Wash our boats were tied up at Needles. More than 50 miles a day had been averaged where the broad, shallow river wound down through open valleys.

The party disbanded at Needles on October 20, just over three months from the date of departure from Flagstaff. The *Glen, Boulder,* and *Marble* were returned to the Southern California Edison Company; the *Grand* was shipped to Washington to be put on permanent exhibition at the Smithsonian Institution.