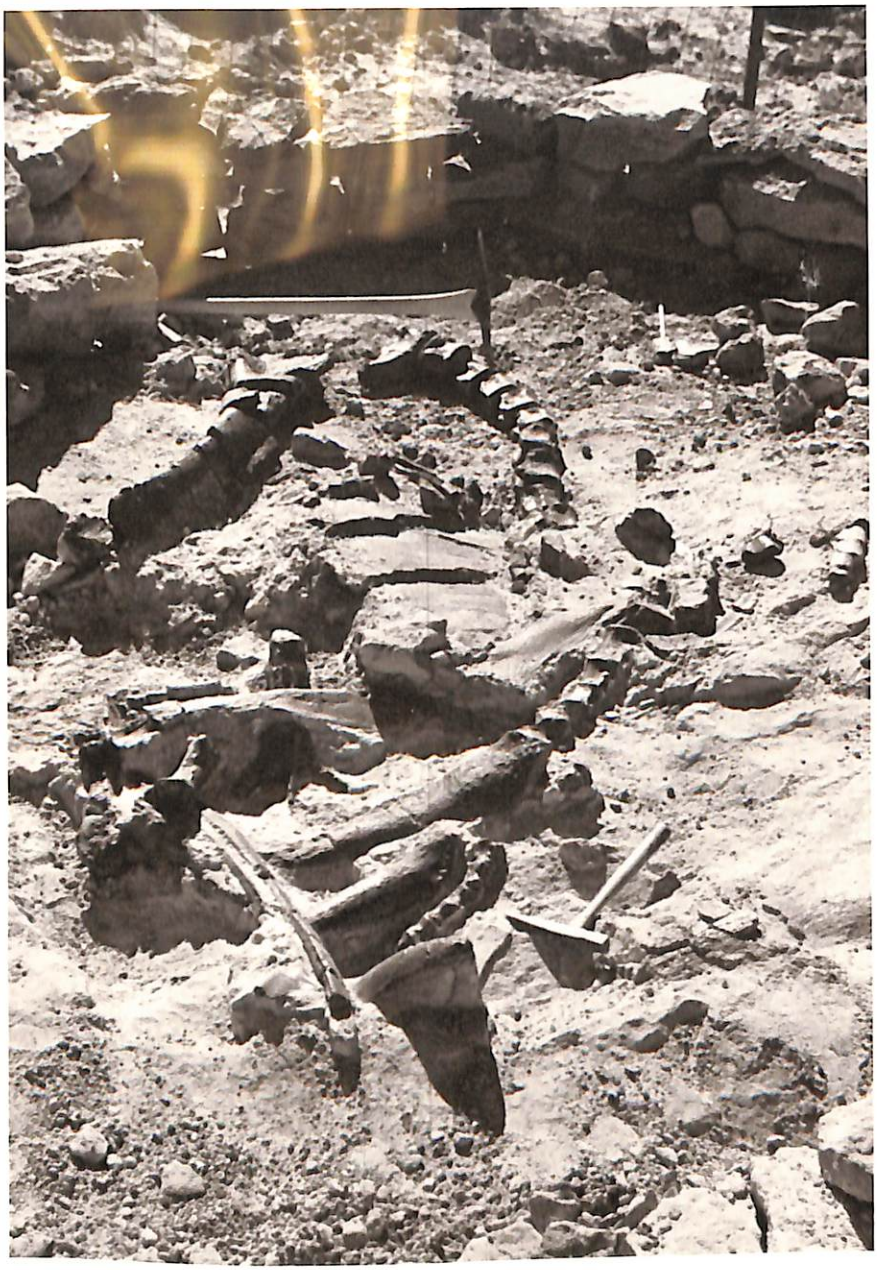
Geological Report on Colorado National Monument

Chad N. Gould



Skeleton of Stagosaurus.
Just to the left of the hammer can be seen the long tail spikes and some ribs. The tip of the tail vertebrae (just to the left of the hammer) are about one inch in diameter. Then they increase in size up to about four inches in diameter near the hind quarters of the animal- near the pick that is sticking in the ground.

The flat dermal plates that covered the back of the animal can be seen in the middle of the picture- and the hind leg - just to the left of the big pick.

Skeleton of Brachiosaurus - largest land animal of all time. Picture shows 25 vertebrae of the tail (about 15 feet long) and the tibia or lower leg - in the upper right hand corner of the picture. The lower leg is 6 and a half feet long.

Skeleton of Stegosaurus.

This shows 29 vertebrae of the tail-
from the hips down to the tip end of the tail.
Altogether about 13 feet of tail.
At the end of the tail can be seen four
spikes which extended vertically up from
the tail in the living animal. These are
about two feet long and can be seen just to
the left of the whisk broom. Two dermal
plates(triangular in shape and about two
feet long are lying next to the tail vertebrae.
One just to the right of the whisk broom and
the other flat one where I am pointing.
Near the pick can be seen one of the bones
(the hind leg).

Another view of Stegosaurus.

View of Allosaurus Skeleton.

This shows the partial skeleton of the great carnivorous dinosaur. About twenty vertebrae of the tail can be seen near the whisk broom. Two forelegs can be seen to the right of and above the broom. At the top of the picture can be seen a shoulder blade(near the hammer. And just to the right of the hammer is a foot bone sticking up in the air. Numerous ribs can also be seen. Besides these bones I found one claw (seven inches long). The claw is not in the picture, but I will donate it.

GEOLOGICAL REPORT ON COLORADO NATIONAL MONUMENT

COLORADO

BY

REGIONAL GEOLOGIST CHAS. H. GOULD

REGION III

Report No. 178

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GEOLOGICAL REPORT ON COLORADO NATIONAL MONUMENT COLORADO

BY: CHAS. N. GOULD

INTRODUCTION

Colorado National Monument is located in Mesa County, western Colorado. Its western limit approaches within fifteen miles of the Utah state line. It lies about six miles west of Grand Junction, the largest town in this part of the state. The monument, which contains 17,359 acres, was established in 1911. A general map of the monument is appended hereto as Plate I.

At the time of my inspection, I was accompanied by Dr. H. C. Bryant, of the Washington Office, Dr. W. B. McDougall, of the regional office, and by Paul N. Franke, Assistant Superintendent of the Mesa Verde National Park. Ranger James Luther showed us over the monument.

Colorado National Monument occupies a range of high hills and cliffs paralleling the Colorado River for approximately ten miles. A general view of the Colorado River is shown in figure 1 and a near view in figure 2. The cliffs rise abruptly above the bottom land at a distance of two to four miles from the river. The river at this place is at an elevation of about 4500 feet above sea level. The highest point on the monument, near its west line, is 7,000 feet. Thus the relief is about 2500 feet.

TOPOGRAPHY

The surface of the monument is extremely rough and broken. The upland has been cut by a series of steep-sided canyons which rise near the highest point of the monument and flow northeast toward Colorado River. Starting on the south the largest of these canyons are named: No Thoroughfare, Red, Ute, Monument, Lizard, and Fruita (see map). As a general rule these canyons have been cut to a depth of 500 to 800 feet in the once flat or sloping upland. The greater number of these canyons end in "boxes" or "dead ends," 100 to 800 feet deep, bounded by precipitous cliffs, one of which is shown in figure 3. It is rarely possible to climb out of these deep canyons. Advantage has been taken of this fact to locate the buffalo and elk pastures in the deep canyons along the northeast side of the monument. A fence along the boundary below the cliffs suffices in holding these animals. A herd of buffalo is shown in figure 4.

GEOLOGY

The geology of Colorado National Monument is not complex. Four formations, or groups of formations, are present, namely, in ascending order: granite; red shales and sandstones of the Triassic and older Jurassic; the Morrison, or younger Jurassic; and the Dakota. These formations will be described in the order given:

Granite, the oldest rock on the monument, consists for the most part of fine-grained, black granite with many dikes and veins of lighter-colored igneous rock. It contains many joints and fractures, and weathers into boulders of various sizes. This granite is probably part of the "basal complex," which goes downward to the center of the earth.

Somewhat similar granite occurs chiefly in the mountain ranges in many other parts of Colorado, Utah, and surrounding states. In Colorado the granite is found in the San Juan Mountains, the Uncompagre Plateau, the Pikes Peak Region, and thence north along the front range of the Rockies, and in the Wasatch Range. This granite is exposed near the mouths of the various canyons, near the place where they break out, and on the bottom land along the Colorado River. For a distance of 10 miles along the front of the mesa the granite is exposed along the lower part of the cliff. At this place a fault extends parallel to the front of the mesa and of the Colorado River. The upthrow of this fault has raised the granite so that for the distance of ten miles this black granite may beseen along the foot of the cliff, the upper part of which is composed of red sandstone and shale. On a clear morning, in bright sunlight, the effect is very striking. Figure 5 shows the line of contact between the granite and sandstone. To the northwest, near the Fruita entrance to the park and also near the Serpent Trail or Grand Junction entrance at the southeast end of the monument, this fault dies out,

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and ties into or merges with a steep anticline fold, which will be described later in this report.

Above the granite there is a great unconformity which occupies a hiatus of many millions of years.

Next in succession above the granite is a series of red sandstones and shales belonging to the Mesozoic era. These rocks are of Triassic and Jurassic age, and are approximately 1,000 feet thick.

The lowest formation of Mesozoic age here exposed is a red shale usually 20 to 30 feet thick, known as the Chinle. The age is upper Triassic. In northeastern Arizona, where it is typically exposed, the Chinle consists of vari-colored shales, making up what is popularly known as the Painted Desert. On Colorado National Monument the Chinle is brick red. It lies immediately above the granite, and in many instances fills pockets in the unevenly-eroded surface of the granite.

Above the Chinle lies the Jurassic. Farther west and south the Jurassic formations have been classified as follows:

	Morrison formation
San Rafael Group	(Summerville formation (Entrada Sandstone (Carmel formation
Glen Canyon Group	(Navajo Sandstone (Kayenta formation (Wingate Sandstone

With the exception of the Morrison, which will be described later, the prevailing color of all these formations is red, buff,

or gray. They reach their greatest development in the region of the Colorado River in northern Arizona and southern Utah. Toward the east, in west-central Colorado, these formations seem to coalesce, and some of them appear to lose their identity, so that in this part of the State it is often very difficult, if not impossible, to identify the various formations.

At the time of this writing I shall not attempt to subdivide the red Jurassic in the Colorado National Monument. My present judgment is that when the data have all been sifted the greater part of the rock will be identified as the Wingate, at the bottom, possibly Kayenta in the middle, and Entrada above. The Navajo is probably not present.

Lying above the red Jurassic sandstone on Colorado National Monument is the Morrison. This formation, about 300 feet thick at this place, consists chiefly of alternating layers of red, gray, and a purplish shale, and light-gray and buff sandstone. There are also one or two beds of hard, quartzitic sandstone, which on weathering roll down hill and form prominent boulders on the slopes below.

The Morrison formation is widely exposed in Colorado, New Mexico, and Utah. It is sandwiched in between the red Jurassic sandstones below and the brown or gray Dakota sandstone above. In many places the Morrison contains bones of dinosaurs. Some of the largest and best-preserved skeletons of these gigantic fossils

lizards obtained in North America come from the Morrison in these states.

In the vicinity of Colorado National Monument the Morrison formation is exposed under two conditions: First; the formation occupies considerable areas in the higher parts of the monument, being exposed on the plateau above the heads of the canyon, and above the roadway which traverses the monument. Second: the Morrison is exposed along the foot of the bluffs and in the river bottom between the bluff and the Colorado River.

The highest, or youngest, formation exposed in Colorado National Monument, is the Dakota. This formation consists chiefly of hard, gray or brown sandstone usually occurring in heavy ledges or beds, separated by shales.

On the monument the Dakota crops out on the highest point of the area, west of the road, chiefly, on East Black Ridge in sections 24, 25, and 36, township 11 South, range 102 West. West of the monument the Dakota forms the crest of the high mesa which extends for several miles beyond the monument boundaries. The thickness as exposed on the monument probably does not exceed 50 feet.

The Dakota is one of the most widely-spread sheets of sandstone in North America. It is found in every state from Arizona and New Mexico northward to the Canadian line, and also occurs in the Prairie Provinces of Canada.

STRUCTURE

The structure of the monument is rather striking. As previously stated, a fault, with several hundred feet displacement, having the upthrow to the southwest, extends for approximately ten miles along the foot of the cliff which parallels the Colorado River. At both ends this fault dies out, merges into a sharp monocline fold, as shown in figures 6 and 7. The result is that the formations which occur on top the cliff also occur in the valley, dipping sharply away from the cliff toward the Colorado.

The Dakota sandstone, which occupies the highest part of the mesa, also occurs along the Colorado River, the beds dipping under the river. The Morrison formation, which underlies the Dakota, is exposed high on the mesa and also in the valley between the foot of the cliffs and the river. The Triassic and Jurassic red beds which occur under the Morrison and exposed near the top of the cliffs, giving a red color to the landscape, also dip northeast. The oldest rock, the granite, is found near the base of the cliffs, along the line of the ten mile fault, as shown in figure 5. Also in the lower part of the valley in the area northwest of Lizard canyon at the Fruita entrance, as shown in figures 8 and 9.

EROSION FORMS

Erosion forms of great beauty and scenic interest occur in this monument. The steep-sided canyons have been mentioned. Fantastic and unusual figures occur, such as monoliths, towers, spires,

and turrets. Some of them have received distinctive names; for instance, Independence Monument, shown in figure 10, The Coke Ovens, seen in figure 11, Pipe Organs, Praying Hands, Squaw Fingers, Kissing Couple, and Liberty Cap.

These figures are all erosion remnants, left after the surrounding rocks have been eroded away. The greater number of these figures are in the massive red Jurassic sandstone.

FOSSILS

No fossils, of course, are found in the granite, and practically none in the Triassic and red Jurassic rocks. On the other hand, the Morrison formation contains many large and spectacular fossils. These are chiefly gigantic lizards, known as dinosaurs. Five species of dinosaurs have been found in the Morrison formation as the same is exposed in the valley south of Colorado River and between that stream and the monument.

Many years ago, Dr. E. S. Riggs of Field Museum at Chicago discovered and excavated a skeleton of Brontosaurus, near Fruita, at the location shown in figure 12, and a Brachiosaurus at a locality since known as Riggs Hill, about halfway between Fruita and Grand Junction.

Mr. Ed Holt, a teacher at Grand Junction High School, has exposed on Riggs Hill the skeletons of Allosaurus, a carnivorous reptile, a Stegosaurus with big plates along the back, and Brachiosaurus, one of the largest reptiles that ever lived. A view of some

of these bones in place is shown in figure 15. Diplodocus, the 70-foot-long lizard, has also been found near the same place.

It has been proposed to include Riggs Hillas part of the Colorado National Monument. From the standpoint of paleontologic interest I consider this very much worth while. The specimens already uncovered by Mr. Holt are of great scientific value. Doubtless other fossils will be discovered. If the land can be secured, and if matters of administration do not prevent, the inclusion of this land as part of the Colorado National Monument would seem desirable.

It should be remembered that the same Morrison formation in which the bones have been found in the valley also crops out on the monument high on the mesa. Fragments of dinosaur bones have been reported from within the monument boundaries, but, so far as I have been able to learn, no specimens worthy of preservation have come to light. There is no reason why good skeletons might not be found in the monument.

GEOLOGICAL HISTORY

The geological story of Colorado National Monument has great interest. The oldest rock, the granite, is probably of Archean age, and may be classed among the oldest rocks on the North American Continent. It forms part of the basal complex or "earth stuff" which goes all the way down to the center of the earth.

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No one knows just how much of this rock there is, but we do know that it underlies all other rock. That is, if one should drill anywhere in western Colorado, or eastern Utah, he would, after passing through all the sandstones, limestones and shales, finally come to this granite or other similar rock. In only a few places is it exposed on the surface.

Very probably this granite once formed great mountain masses, possibly as high as the main ranges of the Rocky Mountains today. It was subject to weathering and erosion, and, throughout a long period of years, many millions in all, the surface was finally worn down to almost level plane. This process is known as peneplanation.

Later the surface was lowered and submerged beneath the ocean. Sand, silt, and mud washed in from adjoining lands, forming the sandstone and shales which we today see in the red Triassic and Jurassic rocks. The red color is due to the presence of large amounts of iron. Some of the Jurassic rocks have the appearance of sand dunes, and it may be that at times the land stood out of the water and the sand was blown by the wind. All the deposits bear evidence of having been deposited, not in deep seas but in shallow water along prehistoric ocean benches.

The Morrison was also a beach or shallow water deposit. Probably the sea was not deep. Mud washed into shallow bays, hardened to form the gray and maroon shales of the present. The soft sandstones of the Morrison were most likely sand flats along the coast.

In these shallow flats and deltas roamed the strange gigantic beasts we know as dinosaurs, whose bones we find today preserved in the rocks.

As time went on the rocks of the Dakota were next deposited, and under conditions somewhat similar to those which prevailed during Morrison time beds of sandstone formed along the sand flats, and muds washed into shallow water formed shale.

The most common fossils in the Dakota are petrified leaves. Many genera and species of trees living in this country today are found embedded in the Dakota sandstone. A little careful search should reveal these fossils on the monument.

After the deposition of the Dakota, there occurred a long period of time when muds and silts were being washed into a shallow ocean. This material, when hardened into rock, formed the Mancos shale, which occupies the flats of Grand Valley north of Colorado River and the lower slopes of Book Cliffs to the north. The Mancos contains beds of coal which represent the forests which grew in marshes and swamps of Cretaceous times.

The next rock to be deposited was the Mesa Verde sandstone, which may be seen on top of the Book Cliffs. The Mesa Verde is very similar to the Dakota in that it consists of alternating beds of sandstone and shale.

Still higher formations make up the Roan Cliffs and Roan Plateau north of Book Cliffs.

After these various formations of shale and sandstone had been laid down, one above another, during a long period of millions of years, there occurred one of the great times of geologic revolution. The land was raised out of the water in the form of a great uplifted dome, probably many thousands of feet above its present level. This is known as the Laramide Revolution. Then began the process of erosion. Water, wind, frost, gravity, chemical agents, and others of nature's tools started working on the rocks and leveling them down. This process is still going on. Every rain washes shale and mud into the streams, and it is being carried seaward by the Colorado River. Frost and percolating undermines the surface, and great masses of sandstone break loose and roll down the hillsides. Wind works on the surface of the rocks, and chemical agencies dissolves out the cementing materials so that the rocks disintegrate. Slowly, without haste, but without rest, these processes have been going on for millions of years, and are still in action.

The mountain of which Colorado National Monument forms a part, is but a "butte of erosion." It is the remnant left stand after the higher rocks have been removed. The Mancos shales, the Mesa Verde sandstone, and the higher formation which make up Roan Cliff and Roan Plateau are all gone. The Dakota now caps the mesa, succeeded below by the Morrison, the red Jurassic, the Chinlee, and finally by the granite.

Given time these rocks too will be gone. Every rain storm,

every frost, every wind loosens and carries away a small part of the mountains. Time only is needed.

CONCLUSION

Colorado National Monument has a most attractive setting. However, the construction of the road to the summit, especially at the Fruita entrance, does not measure up to National Park standards. It would seem that the primary object must have been to maintain an even grade with no thought of the landscape effect. The result is that a number of most unsightly scars have been created, which will not be healed for many years. It is probably too late to remedy this evil without unwarranted cost, but great care should be exercised that it does not occur again.

Respectfully submitted

Chas. H. Gould

CHAS. H. GOULD
REGIONAL GEOLOGIST

MWH

Figure 12. Site of discovery of Brontosaurus in Riggs in Morrison shales, near Fruita.

Figure 13. Bones of dinosaurs in place on Riggs Hill, and Mr. Holt, the discoverer.

R. E. TOPE,
SUPT. OF SCHOOLS

J. F. BEATTIE,
PRINCIPAL

RECEIVED
JAN 13 1938
NATIONAL PARK SERVICE
III REGION

Grand Junction High School

Office of the Principal
Grand Junction, Colorado

H. J. WUBBEN,
VICE PRINCIPAL

MARIAN HINDS,
JUNIOR HIGH SCHOOL

ROUTING

Finney

Colo
732

632 Hill Ave,
Jan,11, 1938

United States Dept Of Interior,
National Park Service,
Santa Fe, N.M.

Dear Mr. McColm;

I returned from my Christmas vacation to find your letter of Dec,21 waiting, and in return I am sending you the photographs of the dinosaurs found by me near the Colorado National Monument.

I talked with Mr. Nusbaum on his last trip to Grand Junction and urged him to do all he could to have the fossil locality included in the National Monument. They are only about three quarters of a mile north of the boundry. When I discovered them in August I started to excavate the skeletons to bring them to my museum in Grand Junction, but came to the conclusion that they were so close to the Monument and right next to the main road - that they should be preserved in the rock as excavated and left there for the education of future generations.

The excavations were carried on through the local Chamber of Commerce and help from nearby C.C.C. camps. The three skeletons are now fully uncovered, and will make very spectacular exhibits. They have now been covered up for the winter.

We had the exhibit open for three weeks in November to the public , and on three successive Sundays we registered a thousand visitors a day. A goodly portion were out of state tourists.

I sincerely hope the Park Service willl take steps to preserve this exhibit- as the Local Chamber Of Commerce are low on funds and it would be a shame to see the skeletons destroyed and stolen by tourist erosion. Action should be undertaken immediately to see that the exhibit will be protected before the coming summer season.

The inclosed photos have been described. The cost of same will be sent to you as soon as the photographer gives me the bill.

I want you to feel free to call upon me in the future for any help that I might be in seeing that the bones are properly preserved. I donated my time - and worked all fall in the supervision of the digging and feel that this will be one of the best exhibits of its kind in the west.

Finney X
encumbered 1.00
from Photographer
Grand Junction

very truly yours,

Edward L. Holt

Edward L. Holt

Instructor In Geology - Mesa College.

P.S. The three skeletons are all close together and could be included in an inclosure 65 feet by 20. Scientifically the brachiosaurus skeleton is the most important. This is a rare find. Dr. Riggs of the Field Museum has asked my permission to come out to Grand Junction in the Spring to describe it in a Paleontological way. So the bone deposit is important in a national way.