Zion-Bryce Nature Notes

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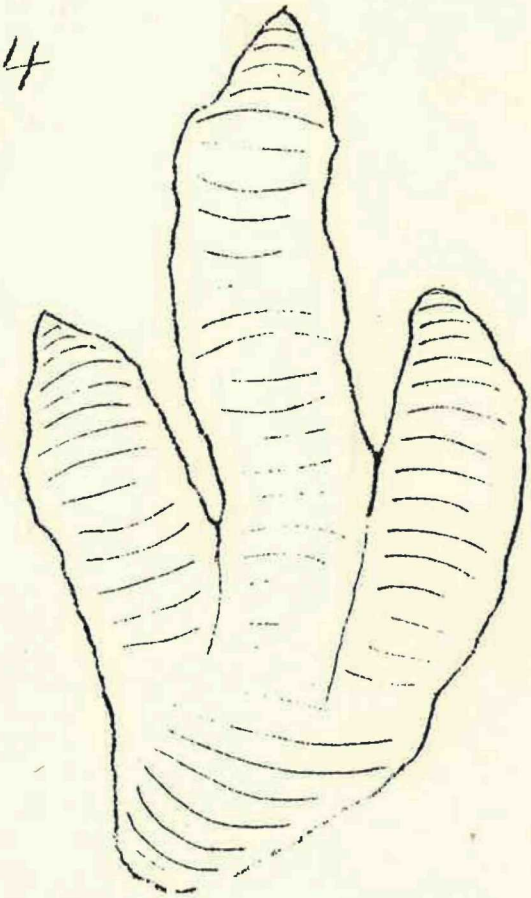
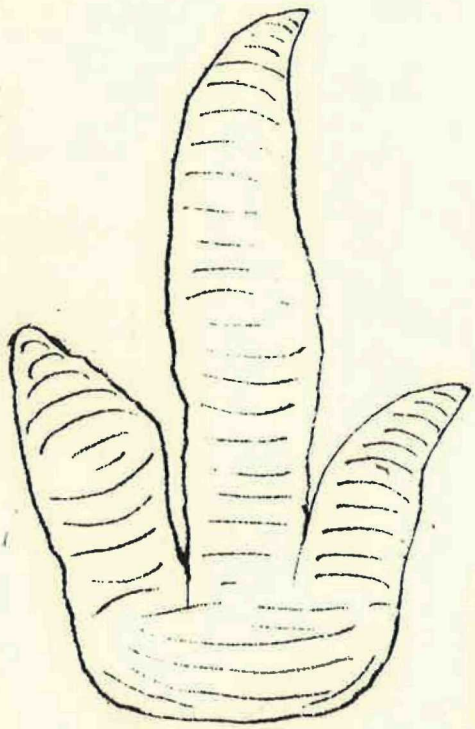
Erosion Number





DINOSAUR TRACKS,
in flagstones
at Kanab, Utah.

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U. S. DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
ZION AND BRYCE CANYON NATIONAL PARKS, UTAH

ZION-BRYCE NATURE NOTES

September, 1931 Vol. III, No. 4

This series of bulletins is issued from time to time during the summer for the information of those interested in the educational opportunities, the natural history, the scientific features, or the scenic beauties of this region. Publications using these Notes SHOULD GIVE CREDIT TO THE ZION-BRYCE NATURE NOTES AND AUTHOR.

Thomas J. Allen, Jr., Superintendent.

A. M. Woodbury, Park Naturalist.

EROSION NUMBER

Zion and Bryce Canyons represent unique phases of erosion, the former a vertical-walled U-shaped canyon of great majesty and beauty, cut primarily by a river; the latter a bowl or amphitheatre full of pinnacles or monuments of such infinite variety and pattern as to be almost unbelievable, cut and carved primarily by the myriad trickles of water that flow after infrequent rainstorms and melting snows.

It is the scenic features of these two canyons that attracts most attention, but the chief message which each has to offer is one that appeals not only to the aesthetic senses, but also to the understanding. Perhaps the highest enjoyment comes to one viewing these unique handiworks of nature when the story of their creations is understood. This story is primarily one of erosion, hence we have asked each naturalist to tell the story, each one from a different point of view. We hope that each article will add something to the understanding of these natural wonders.

THE CARVING OF ZION CANYON

By A. M. Woodbury, Park Naturalist

Zion Canyon was first cut by a fork of the Virgin River as a deep, narrow gorge, just wide enough to accommodate the stream, undoubtedly leaving potholes (made by eddies in the edge of the current) perched up in the side of the cliff where they were cut as the stream entrenched itself in the solid rock.

The cutting power of the stream was given to it by land elevation, which gave it more fall as the land gradually rose toward its present position. The increasing gradient allowed the river to cut deeper and farther headward toward the mountains, thus producing younger gorge upstream. The river heading in the high plateaus having plenty of fall so that it could cut, and flowing through a semiarid region, was thus able to entrench itself by digging downward faster than the other forces of erosion were able to tear off the side walls.

The river cut the initial gorge, but wearing away of the side walls is largely due to other factors, although the river is still the chief transportation agent which moves the sediment downstream toward sea level.

The physical agencies of erosion undoubtedly play the principal role in reducing the walls of the canyon, but of course, living organisms modify these physical agencies, either in the direction of accelerating erosion by disintegration or breaking of rocks as by plant roots, and by exposing bare soil, as by trampling of animals, or in the direction of retarding erosion such as by binding or holding the soil by plant roots or by protection of the surface by a layer of plant litter.

The principal physical agent is rain water, acting either directly upon the surface as run-off, or indirectly as ground water, percolating through the rock. In either case, the apparent effect is upon the surface. The run-off water works largely by solution - taking out the cement from the rock and grinding with loosened sand grains.

The ground water may operate in several ways. Emerging near the foot of the cliffs as seeps or springs, or merely as evaporating water, it undermines the cliffs, preparing the way for great rock fall, either as arches or as large masses.

Run-off water works largely from above, carrying great quantities of sediment from the top of the cliffs, down into the canyon. The ground water works largely from below, undermining the cliffs and maintaining vertical walls as they are thus pushed farther apart. Both processes tend to widen and to fill the canyon, since more material comes into it than the stream can transport. As the walls are pushed back and the floor filled up, this leveling process will eventually obliterate the canyon, so be sure to enjoy it before that time arrives.

EROSIONAL AGENTS OF BRYCE CANYON

By K. E. Weight, Ranger-Naturalist

The main Bryce Canyon is really a great amphitheater composed of several small canyons leading down from the rim, collecting together in the bottom. It has no permanent stream of water flowing through it. It is a canyon of intermittent or ephemeral streams. These streams vary in size and depend entirely upon the water from infrequent rainstorms and melting snows.

Rain water is the principal agent of erosion, assisted by wind, frost, plants and animals to a minor degree. Upon looking over the rim of the canyon, one sees a steep hillside. This steep slope has thousands of ravines, ranging in size from those just visible to several feet in depth. The smaller ones near the top gradually coalesce into one large one near the bottom. They have been formed by the rain water on its way to the bottom of the canyon. During a heavy rainstorm thousands of trickles of water flow from the slope down these ravines, collecting together to form a large stream at the mouth of the canyon.

Pure water has very little cutting power as it passes over rocks, but when armed with small particles of clay, sand and silt, it functions like a file or rasp, cutting the limestone rock away at a rapid rate. These thousands of rivulets remove the soft clay soil that is in its path and soon the bare hard rock is exposed. The grinding of the heavily loaded water carves deeper and deeper into the pink limestone cliffs, until finally deep canyons are formed. Wall Street, through which the Navajo Trail passes, is one of the best examples.

The vertical walls of the individual canyons, sometimes five or six hundred feet in height, are gradually cut crosswise into separate parts by similar processes. Monuments or pinnacles of various shapes finally result. Some have a heavy capping at the top which resists erosion more than the softer layers underneath. This produces undermining around the sides of the pinnacles, and they eventually become so thin at the softer layers that the larger mass above topples over.

The various monuments are being washed more slender and graceful each year. Continued action of the agents of erosion finally cause the monuments to disappear entirely. When this stage is reached the landscape will be that of smooth rolling ridges, separated by small ravines.

The monuments and walls of Bryce Canyon when viewed from a distance appear to be very soft. This impression is due to the clay deposit that is found on the surface. Rain water falling on the monuments above picks up the fine clay particles from the various layers and as the water continues down the wall, leaves part of its load as a "kalsomine" deposit on the sides of the walls or pinnacles, thus often hiding the real color of rock underneath. The kalsomine deposit is sometimes several inches thick.

The rate of erosion is comparatively rapid at the heads of the various canyons. Conifers growing on the rim have been undermined by the action of rain water and wind. Roots exposed for several feet on the canyon side are evidence that the canyon is eating gradually into the forest on the plateau above. This rate of recession is estimated to be about one-half or three-quarters inches per year. The monuments erode away much slower, estimated to be about the thickness of a thin piece of paper per year.

Ground water, functioning as a solvent as it passes through the underground rocks, plays its part in the chemical decomposition of the rocks, especially where it emerges from the surface at the foot of walls. Iron oxides are dissolved out, weakening the rock which soon crumbles to pieces. The freezing of water in crevices produces a great pressure, resulting in the flaking and chipping of the rock surface. The continued wetting and drying and the changing daily temperature play a part in the physical and chemical decomposition of the rock. The many small caves found in the perpendicular white formation just under the rim are probably due to the above agents. Wind, also, may aid in this undermining, but rain water, the chief agent of erosion, would be excluded from the undermining activity.

To summarize, a myriad trickles of water which flow following infrequent heavy rains or melting snows, dig deep channels, leaving vertical-walled ridges between them. These, in turn, are cut crosswise in a similar manner, leaving pinnacles or monuments. The monuments wear down in two ways, principally by undermining of softer layers underneath by the agency of ground water, frost, drying, etc., preparing the way for them to fall over, but also by rain water falling on the top of the pinnacles and running down the sides. As new ridges and monuments appear at the head, older ones disappear near the bottom, so that the net result is a gradual movement headward into the plateau, leaving a lengthening canyon behind.

PLANTS AND EROSION

By J. W. Thornton, Ranger-Naturalist

Roots are playing their part in tearing down the walls of Zion Canyon. Anywhere you look on the walls and on top of the rocky peaks, you will find plants growing. In many of these places there is no soil at all. The plants come out of solid rock and the surprising thing is that their growth is normal. The fact that they come from a solid rock foundation does not seem to interfere with their development into a normal sized tree or shrub.

Near the beginning of the Narrows Trail there is a large sandstone boulder that has fallen from the wall. The texture, structure, hardness and general formation of this rock is no different from any other rock that might fall from any of the Navajo sandstone cliffs. On this rock is growing a splendid specimen of our Western Oak (Quercus gambeli) and a yucca plant. Each plant is as healthy as any found in the soft soil of the canyon. The rock affords minerals and moisture sufficient to produce a splendid growth. When nature plants its seeds in solid rock, it provides them with the weapons that enable them to drill into the rock and establish themselves. From the rock the roots get the things required to carry on a natural and normal growth. By exuding an acid from the root tips, decomposition occurs in the rock and the root succeeds in sinking itself farther into the boulder. As this lengthening process goes on, there is also a corresponding thickening of the root. This increase of the diameter causes great pressure to be exerted by the root on the walls and frequently the walls are cracked because of this force, and the rocks fall into the canyon. Often times the root is left practically bare and the plant frequently dies. On the side wall of the Temple of Sinawava there is a young White Fir sending its roots into the wall. Year after year it is loosening the slab of rock on the outside, which will some day fall out. In this way it will repeat the thing done by a small Boxelder tree in the Narrows where the rock has already fallen and the little tree has died because of lack of support from the rock that once fed it. Many such examples of the erosion activity of plants may be seen in the canyon.

In places where the rock of the wall is being worn and cracked by other agencies of erosion, you will find the plants establishing themselves. The presence of these plants increases the erosive action. The roots sink more easily into the rock through the crevices and fractures begun by other means. This sinking of the roots into the rock and the added pressure incident to the enlargement caused by the laying down of cells under the bark, makes more rapid the erosive process.

Plant roots often open up channels through which water can run deeper into the rock, and upon the decay of the roots, the acid that comes through the decomposition of the organic matter actively attacks the rocks and hastens their decomposition. Other plant organisms found on the walls such as lichens, mosses and flowering plants, also contribute to their disintegration. The lichen is the first plant organism to appear on the rocks. It forms a bed of organic matter that later becomes the home of the mosses, which in turn are followed by plants of a more complex nature. In this succession, plants are established upon the rocks which aid in tearing them down both by mechanical and chemical action.

ANIMALS AND EROSION

By S. D. Durrant, Ranger-Naturalist

A great many animals have a very definite effect on the erosion in the park. Yes, I mean that they are hand in hand with many other factors in tearing down these majestic walls and pushing them farther apart. Little do we realize, as we look at the stern, rugged cliffs, that anything living could very much influence their existence. Yet even mountains are subject to the eternal change that takes place all through nature. They are formed, raised up and then torn down. Animals play their part in this scheme of things.

A great many animals play an important role, but here I wish to point out only the most common and the ones whose work is the most obvious.

Deer and Mountain Sheep

The mule deer (Odocoileus heminus macrotis) and mountain sheep, (Ovis canadensis subsp?) have several means ofhelping or causing material to be carried off and thus altering the landscape. When deer and sheep walk over the ground, their sharp cloven hoofs cut through the leaf mould and expose the soil. When it rains this foot print may be filled up, and hence a few grains of sand have been shifted. Naturally, this is only on a small scale, but when this action is repeated over the same route enough times we have a trail being established.

In the Narrows, many a deer path can be found leading off from the steep slopes down to the river bed. Deer have the characteristic of following beaten trails. They start a trail down through the brush. Then by constant use, all the vegetation is worn off or killed along the trail. When rain water falls violently, as it does in desert country, these trails have no vegetation to withhold the runoff. As a result, small rivulets are formed. These rivulets may keep recurring until a small gully is formed, and many tons of material will ultimately be carried away to the stream. In steep places the deer also carry down considerable loose material simply by plunging and sliding down steep slopes. With specific regard to mountain sheep, however, they naturally inhabit a very rocky area, hence the action is not as pronounced, although the procedure is similar.

If these trails are followed, they will ultimately lead to the bedding ground. These wily animals bed down under the ledges in secluded spots, as I have found close up against the foot of the Great Red Arch Mountain. Here again can be seen the action of erosion. By constantly bedding down and trampling over the same area, it is reduced in many cases to dust beds. These dust beds offer no resistance to runoff of rain and snow water, and as a result much material is removed and carried away.

In places where succulent food is found, over-grazing sometimes occurs, thus damaging or reducing the plant cover, hence exposing the underlying soil, which is then subject to removal.

The summary of the action of deer and mountain sheep on erosion then consists of beating or wearing of trails and bedding grounds, and grazing upon the plant cover, all of which expose bare soil by removal of the cover, making runoff easy.

Rodents

Among the rodents that have the most noticeable affect on erosion are the rock squirrel (Otospermophilus grammurus grammurus) and the valley pocket gopher (Thomomys perpallidus aureus.)

The most prevalent action caused by these animals is due to their burrows. One striking example of the work of the ground squirrel can be seen near the government horse corral on the river. Here the squirrels have their burrows in the bank. When the river rises in flood the water flows into the burrows, with the result that the river finds ready access to undermine the banks.

Squirrels also throw up dirt in front of their burrows and make trails between the various openings. When rain comes, it pounds down this dirt and the trails make run-off possible.

Gophers work toward aiding erosion in several ways. The gopher is a subterranean form and spends ninety-five percent of his life under ground in his burrows. As it digs its way along with its front feet and strong jaws, it pushes the dirt along ahead of it. This dirt is thrown up at the openings of the burrows. During the rainy season these mounds are pounded down and form bare areas which in turn make it easy for run-off water to carry it away.

Some work might also be accomplished by the food habits of the gopher. The gopher eats the roots of plants. This constitutes the bulk of his food. As a result plants may be killed and hence remove the cover, and thus expose bare soil to the action of running water.

MAN'S PART IN EROSION

By H. L. Reid, Ranger-Naturalist

Man, by pasturing his sheep and cattle within and upon the hills surrounding Zion and Bryce Canyons, has been a factor in erosion. Although, when compared with the total, his part has been very small, yet considering the very short time that he has been associated with the canyons, his part has not been so inconsiderable.

During the ages before man entered the region the water-sheds were in a natural primitive condition. The landscape, according to the testimony of the early settlers, was covered with a reasonably good growth of vegetation, except upon the bare rock areas which are exposed in such deep canyons. Along the bed of the Mukuntuweap River, both within and below Zion Canyon, there was growing a luxuriant growth of willows, shrubs and trees. The river was small and well confined within its accustomed banks.

As the pioneer settlers entered the region, during the early sixties and seventies, they turned their stock loose to forage. During the early years there was sufficient pasturage for the stock, but as the years passed the numbers increased, and soon there were vast herds of cattle, sheep and horses feeding upon the range. As the herds increased the vegetation decreased. As the cattle and sheep trailed over the hills and valleys in search of food, they cut paths and trails into the landscape.

Zion Canyon with its high protecting walls became the winter range for hundreds of cattle. According to the estimate of early cattlemen, there were pastured within Zion Canyon each winter, for the forty years between 1875 and 1916, about 300 to 350 head of cattle. During these years the canyon, along the flood plain, became almost barren of vegetation, and even the larger shrubs that were able to resist the attack were stripped of all the foliage on the lower branches.

With the watershed practically de-vegetated and furrowed into paths and trails, and with the river flood-plain beaten into a bed ground, the conditions were ripe for a very rapid erosion. In time of storm, (and it often rains violently in this region) the water would collect in the trails, and instead of being held by a vegetative cover, would form small rivulets, thus allowing a quicker run-off of a larger percentage of the rain water. As these rivulets rushed down the open trails, they cut into the soil, making gullies or washes.

EROSION UNCOVERS TRACKS OF THE PAST

By A. M. Woodbury, Park Naturalist

Small dinosaur tracks were discovered two or three years ago in the flagstones of the path in front of the Union Pacific Lodge in Kanab. More recently larger tracks were found by Bernell McAllister of Kanab. These were examined not long ago by Dr. H. E. Gregory and myself, as a result of which, several tracks and casts have been brought into the museum at Zion National Park. Some of the tracks measure as much as fourteen inches in length. They are all three-toed and apparently were made by a form of dinosaur that walked upright on its hind legs.

These tracks were found in the upper chinle shales just under the wingate sandstone where they had been uncovered by erosion. A harder limey member of the shales, more resistant to erosion than the layers above, was exposed as a shelf around the side hill. The removal of the softer material above left many of the tracks plainly exposed. At one point, we found the trails of three different animals which had crossed each other's tracks - a cross-roads, as it were, at Dinosaur Junction.

If one should let the imagination play, we might draw a picture something like this. Back in Triassic time, when dinosaurs were developing toward a climax of world-wide domination, some of the forms having an upright posture were disporting themselves upon a muddy beach, leaving their tracks where they stepped in the mud.

When the next flood of water came down, bringing sediment, these tracks were covered, being filled with the new material of different texture, thus preserving their form. As time passed, they were covered by more sediment, until they were buried to a depth of perhaps 8,000 feet. It then became the task of erosion to uncover the tracks, by cutting down through 8,000 feet of rock and removing the upper layers, thus exposing them to the gaze of wondering humans after the lapse of an immense period of time, revealing something of the life that existed so long ago.