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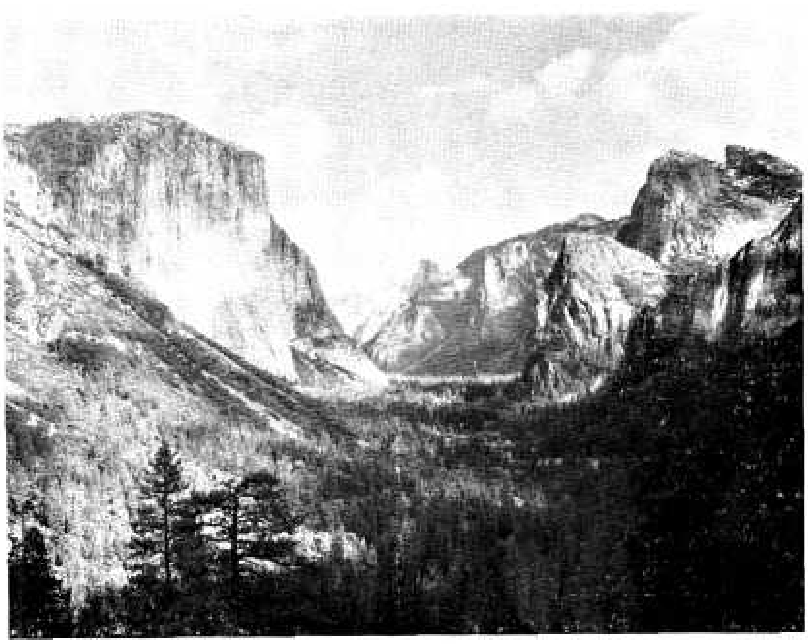

# Yosemite Nature Notes

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## FORM AND DEPTH OF THE BEDROCK TROUGH OF YOSEMITE VALLEY

**By John P. Buwalda**

**Foreword**

Dr. John P. Buwalda is Professor of Geology at the California Institute of Technology, Pasadena, California, and also serves as a member of the Yosemite National Park Advisory Board. In response to a request for advance information on the results of seismic studies carried on by his institution, he has prepared this article. The complete scientific report of these studies is expected to be published within the coming year.

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Until a few years ago it was generally believed that the alluvial fill in Yosemite Valley is not of great depth—perhaps 200 or 300 feet. If true, this would mean that we see nearly the entire bedrock trough excavated by the ice. Apparently this idea was founded on the belief that most or all Sierran glaciated valleys are box-like in cross profile, instead of U-shaped; in the box-like valleys the steep sides flatten suddenly. The further conviction apparently was that the bottoms of most or all Sierran valleys slope continuously downstream or nearly so, and that hence no very deep bedrock basins were formed by ice excavation.

Dr. Eliot Blackwelder of Stanford University apparently doubted this view for Yosemite Valley, and at least considered the possibility that the fill in the valley might be quite deep. The nearly vertical slope with which the glaciated walls pass beneath the alluvium here and there along the valley sides certainly suggested that the fill might be thick. Dr. Blackwelder urged Dr. Buwalda and Dr. Gutenberg of the California Institute of Technology to determine the depth of the fill by means of geophysical methods. The California Institute possessed seismic reflection equipment and had been carrying on experimental studies of geophysical methods. Accordingly, with funds made available by the Geological Society of America and the California Institute, the investigation was undertaken, the field work being carried out during several weeks before and after the tourist seasons of 1934 and 1935. A total of $2,000 was expended on the study. The extensive work of calculations, done intermittently during following years, was completed by Dr. Gutenberg some time ago, and the results are now being cast in shape for publication.

## METHOD USED

The seismic reflection method depends upon the fact that when a compressional wave, produced by a small dynamite explosion in the ground, strikes a surface at depth which separates two materials in which the wave travels at considerably different velocities, part of the wave is reflected or echoes back. The time interval between the instant of the explosion and the return of the reflected wave can be measured to the nearest thousandth of a second. Also, the velocity of the wave in each kind of material can be determined, in another experiment, by measuring accurately the time it takes a wave to travel a distance of say several thousand feet. Knowing then the speed of the wave and the number of thousandths of a second it requires to go from the shot point down to the reflecting surface and back to the instruments, situated near the shot point, it is possible to calculate the depth from the shot point and instruments down to the reflecting surface. The principle is simple, but the procedure requires considerable equipment: a crew of ten or a dozen men, of whom at least three must be highly trained and familiar with the technique and mathematics of the method, and considerable dynamite, photographic paper and other consumable goods. Minimum equipment consists of: recording truck to which are attached at least five portable seismographs or seismometers, portable telephone equipment, and large wire-winding spools, and in which are fitted the recording oscillograph and camera, portable darkroom for immediate developing and fixing of records, and timing device; portable drilling outfit consisting of a take-down derrick on a truck; dynamite and water truck or car; and other cars for constant messenger service. The method is expensive, but highly satisfactory so far as reliability of results is concerned.

## PROCEDURE IN YOSEMITE VALLEY

It was desired to determine the thickness of the fill at many points in Yosemite Valley, for from these data the form of the bedrock trough could be immediately discerned. In addition we desired to know whether the fill consisted of one formation—all the same kind of material—or whether more than one formation lay beneath the valley floor.

The conditions for the work were quite ideal. The difference between the soft fill and the hard smooth surface of the bedrock trough resulted in very strong reflections, accentuated no doubt by its concave form.

The depth of the alluvium was measured at about 85 points ranging in geographic position from east of Mirror Lake to west of El Portal. While it was often necessary in other parts of the country to drill holes 50 to 100 feet deep in which to fire the charges, little drilling was required in the valley. Nearly everywhere holes a few feet deep, dug with a post hole augur, sufficed. It was usually necessary to shoot no more than 1/16 pound of dynamite in a hole, and often a cap was sufficient. Perhaps 1/2 ton of dynamite was used in all.

In addition to measuring the depth of the valley fill at about 85 points the velocity of the dynamite wave at different depths in the fill was determined by shooting successive charges at a point and moving the instruments farther and farther away. Since the wave always travels along a path quite concave upward, spacing the shotpoint and instruments farther and farther apart means the wave passes through deeper and deeper parts of the fill. Comparison of the velocities at the different depths shows whether more than one formation is present to constitute the fill, for different formations invariably transmit the waves at different velocities.

## FORM OF THE BEDROCK TROUGH OF YOSEMITE VALLEY

The results of the geophysical work indicate with no doubt whatever that the depth of the glacial bedrock trough is much greater than was previously supposed. Between the Government Administration Building and Camp Curry the fill is nearly or quite 2,000 feet deep. Downstream the bottom of the trough rises 1,000 feet in the three miles to El Capitan, where the depth of fill is only about 1,000 feet. Farther downstream it becomes still less, so that it is only about 200 feet below the dam, but it is again some hundreds of feet at Cascades, and continues with depths of this order to the fartherest west point occupied, west of El Portal. Upstream from Camp Curry the depth of the fill decreases gradually toward the upper end of the valley. From the upper end of the valley the bedrock floor steps up rather suddenly both upstream on the Merced from Happy Isles and upstream on Tenaya Creek at the point where it enters the valley proper. On both of these streams the bedrock appears in the creek bottom within a mile or two upstream from the point where the stream enters the upper end of the main valley.

It thus appears that the valley is actually U-shaped in cross profile, as might have been expected. The steep walls continue downward a maximum of 2,000 feet with gentle concave curvature instead of flattening suddenly to give a box-like valley.

While this finding was expectable rather than surprising, the rapid rise of the bedrock floor at the upper end of the valley, and the 1,000 foot rise of the floor **downstream** in the 3 miles from Camp Curry to El Capitan may seem at first a bit odd. But not so if we compare Yosemite with other glaciated valleys. Commonly in such U-shaped troughs there is sudden, often great, deepening just downstream from the point where an important tributary ice stream joined the main glacier, or just below the point where two ice streams of nearly equal size formed a junction. The reason for this is well understood. Rivers do the same thing on a small scale. The increased amount of ice below the junction requires a larger cross section of the trough, and since the upper surface of the ice continues to slope downstream, the dimensions of the trough cannot be increased upward. The trough is therefore deepened and widened, and this is what happened in Yosemite Valley.

The rise of the floor downstream to El Capitan seems more unusual, but it is not unique in glacial troughs. The great glacial troughs on the coast of Norway, the lower ends of which are now often filled with sea water and form fiords, show the same feature. Often they are hundreds, even thousands, of feet deep at a distance of some miles from the seaward mouth of the fiord, while at the mouth, the depth of the sea water may be very much less, sometimes so little as to make entrance into the fiord by sea-going vessels difficult. This has been ascribed in part to dumping of rock debris by icebergs where they left the end of the glacier, but it is well known that the floor of the fiord rises from its greatest depth some distance from the sea, toward its mouth. The glacial trough in which Lake Chelan lies, on the east slope of the Cascade Mountains in central Washington, exhibits exactly the same features.

The reason for this rise in the bedrock bottom of the trough in the downstream direction is, of course, that the ice cut less and less effectively as the glacier became thinner toward its snout, through melting. The weight or pressure of the ice on the underlying rock became progressively less downstream, and also less ice passed over each square foot of the rock surface. It is possible also that in Yosemite Valley the rock at El Capitan was more resistant than at points farther upstream, and that it served somewhat as an ice weir or sill, retarding both downward and lateral ice erosion.

It may seem strange that the bottom ice of the glacier should move uphill 1,000 feet in the three miles below Camp Curry. But the bottom water in a deep pool experiences no difficulty in rising along the bottom of a river toward the next riffle downstream, even when the bottom rises at a rather rapid rate and the surface of the water in the pool slopes downstream only very gently. Ice in a glacier behaves essentially as a fluid; one may, if he prefers, think of it as a viscous solid.

The results of the geophysical work on the thickness of the fill indubitably demonstrate that Yosemite Valley is considerably more than half again (65% or 70%) as deep as it appears to be in the Camp Curry region. The trough is about 5,000 feet deep below Glacier Point rather than about 3,000 feet. That part of Yosemite Valley is about as deep as the Grand Canyon. Of course that deep basin in Yosemite Valley was never dry land; it either held a lake when the ice retreated, or if the ice receded slowly enough it may have been filled with gravel and sand as rapidly as the ice withdrew from it.

Another fact of interest is that the fill consists of three formations. We know this because the dynamite waves are transmitted at greatly different velocities through the deeper materials. The top unit or formation is presumably river gravel and sand, like that seen on the floor of the valley today. We are not yet certain what the nature and origin of the two lower formations are. It may be possible to ascertain this by further study of the velocities and comparison of the velocities with those known in such types of material as could reasonably be expected in a glacial trough. These three types of material have not been found in the canyon below Yosemite Valley or in the tributary canyons above the head of the main valley.

The geophysical work demonstrates that Yosemite Valley is an even grander natural feature, through its much greater depth, than is evident in the views enjoyed by the average visitor.

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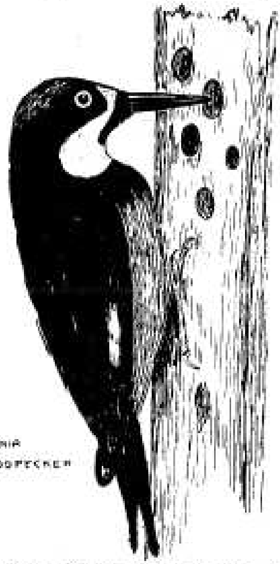
## OUTSIDE THE CABIN DOOR

**By Ranger-Naturalist Enid Michael**

Day breaks in the Yosemite with a chorus of song—the robins are in full voice. The trees sleep on for the winds are not yet awake, and no whisper of gossip is rumored through the sleeping foliage. The sun comes up behind Half Dome, and long fingers of light feel their way into the valley. It is a smooth, warm morning in late June, and as the trees sleep on, the heavens become alive with great, puffy clouds, which commence to wander aimlessly across the blue sky.

My cabin door looks out on the world. Beyond the highway the winding, green river slides serenely along. I lift my eyes, and there floats Yosemite Fall — leisurely drifts the filmy mist like white smoke going the wrong way. But, there is hurry on the highway: cars whiz along, and fallen leaves whisper in little voices as they scamper away on the breeze of passing cars. Robins and blackbirds wing from the highway at the last panic-stricken moment.

A black-backed woodpecker with a blazing red cap hugs close to the trunk of the great oak, and eyes the




feeding tray. Now she drops to the tray, and facing head on, I know it is she, for she wears the black band across her forehead, which is the badge of her sex. This lady woodpecker has three husbands; she lives not far away, and yet she is the only one of the family that comes to the feeding tray.

Now it is the chickaree's turn, and it is really the boss of the tray. It is a big eater, but a slow one, and so the birds impatiently wait. On broad wings, swinging like a pendulum over the tray, the jay tries to bluff the chickaree; but it is "no go." The chickaree sits with its tail curled over its curved back, and goes on munching its biscuit. It holds the biscuit in its forepaws, and munches away. For a glutton the chickaree is a dainty feeder—leisurely it dines; there is no hurry. A long time the birds wait, and then a Brewer's Blackbird comes swooping in; strikes chickaree on the back, and drops to the ground. The chickaree stops eating, leans out over the tray, and looks down to see what bird is so bold. He gives the blackbird a dirty look, and goes on eating.

The chickaree sits on its haunches in the middle of the feeding tray, his round stomach growing rounder as time goes on, and still it pokes food into its face. The birds sit around and wait their turn. I take pity on the birds and toss food on the ground. The chickaree is very much interested, and leans out over the tray to gaze down at the feeding birds. It leans far out with its fat tummy resting on the edge of the tray. I can read its thoughts. It is wondering if the birds are getting something choice. It decides to investigate, and leaps to the trunk of the oak. Down it comes headfirst, hanging to the bark by its hind toes. Hesitating, it hangs loosely like a wet dishrag. For a full minute it is frozen in silent contemplation. Hanging limp, it loses much of its plump appearance, and the black markings along its sides stretch into a straight line. Its tail does not now hug its back, but waves loosely about. Now it ventures onto the ground, with reluctant hind claws clinging one last moment to security, it bounces out, grabs a crust of bread, and bounces back to the tree trunk. Instinct warns against feeding in the open, and it sits with its back to the tree. It finishes the crust, and now in poised calmness, with wide contemplative eyes, there seems no current of haste in its system.

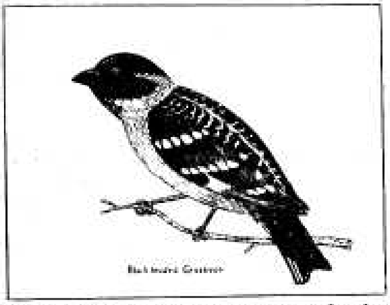
The chickaree's alertness and instinctive caution appear not to be centered in its brain, but in those muscular legs and springy toes—legs that are set on a hair trigger, ready to go off with the speed of a steel trap in case of danger.

The wide eye-ring of the chickaree gives it a round-eyed innocent look, but this pious expression belies its true character, for really it is a little fiend; it likes its birdlings raw, and it sucks eggs.

## BLACK-HEADED GROSBEAK FEEDS FROM HAND AT HAPPY ISLES

**By Ranger-Naturalist Lloyd P. Parratt**

During the summer season of 1941, two male Black-headed Grosbeaks were fed from the hand at the Happy Isles refreshment stand by attendants James Roberts and Frank Herkebrath. Bill Crowley, also an attendant at the same stand, began feeding one of these grosbeaks in early June.



These birds were apparently feeding young as they carried food away on the average of every fifteen minutes. They were more active in the early morning hours when few visitors were about, and would hop around the stand for several minutes at a time. One was particularly bold, and the boys often found it perched on the cash register, waiting for shop to open, having come in through the canvas from the back of the tent. If not already inside, the grosbeak would flutter in as soon as the front tent flap was pulled up.

It was found that the grosbeaks preferred peanuts above all other foods at hand, and they became so tame as to feed on a peanut held between the attendant's teeth. This made a good human interest picture for the museum slide collection on birds, showing that they will respond to kindness in the most unexpected manner. Fluttering their wings vigorously, the grosbeaks would tug at the peanut until the attendant released it from his teeth.

In late June, there were two male and one female grosbeaks feeding at the stand. By this time the birds were so tame that visitors could share in the pleasure of feeding them from the hand. Along with the feeding of these grosbeaks a Western Tanager, several Blue-fronted Jays, California Ground Squirrels, chipmunks, and a Sierra Chickaree came to the refreshment stand to join in the feast, and afforded a splendid show of wildlife activity for the enjoyment of many visitors.

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## NATURE NOTELET

From the top of Sierra Point on the morning of May 26, 1941, our hiking party had the good fortune of seeing the mating flight of the White-throated Swift. The two birds were observed flying back and forth over the canyon below. Suddenly they came close together, and from our viewpoint appeared as one, except for the four wings extended and held motionless. As the mating act proceeded, the swifts were falling continuously, spinning around slowly as they descended. After dropping in this manner for several hundred feet, they separated and continued their rapid flight to and fro.

—Willis A. Evans

## SNOWBOUND MAY LAKE IN LATE JUNE

**By Ranger-Naturalist Lloyd P. Parratt**

Having a Sunday off, Ranger-Naturalist Tex Bryant, my brother, a visitor, and I decided to explore the May Lake—Mt. Hoffmann area. So early in the morning of June 22, 1941, we drove over the Tioga Road, and parked our car where the May Lake Trail joins the road.

We had anticipated some snow, since the snowfall of the past winter had been 15 to 20 per cent more than average, but found the trail covered in most places with a hard pack 4 to 5 feet in depth. It was fortunate that the snow had a hard outer crust, making it rather easy for hiking.

May Lake was a beautiful sight—almost completely covered with ice and snow, except for some small patches of blue water showing through. This was indeed an unusual situation for late June, so we photographed the lake in Kodachrome for reference. Some skiers were playing around the edge of the lake, which added to the wintry atmosphere.

Then we began the ascent of Mt. Hoffmann (elevation 10,921 feet), climbing through snow the entire way. Just before starting up the slope, we spotted a Belding Ground Squirrel running over the snow. Tex commented that this was unusual, because under such weather conditions this mammal would be expected to be in the sound sleep of hibernation. A California Gull soared over May Lake—a lovely sight against the blue sky, but a hopeless search for open water from the gull's standpoint.

Brilliant patches of orange and lemon-green lichens were growing abundantly on the chimney rocks in striking color contrast with the whiteness of the snow. Large masses of Ladybird Beetles, which seem to be everywhere in Yosemite National Park during June, were apparently breeding in ice and snow.

After seeing some cheery Rosy Finches feeding along the snowbanks near the crest, we took out the Sierra Club register, and found that we were the first to sign up for the year of 1941. The wind was blowing strong and cold, so we ate our lunch on the lee side of some rocks.

The descent of the mountain brought back the joys of childhood, as we slid most of the way down on our feet and the seat of our pants. Coming down on the north side of the lake, we spotted a Slender-billed Nuthatch with a bill full of pitch, which would indicate nesting activity. However, the bird observed us also, and kept playing hide and seek by putting the pitch in various likely places, but never in the real nest.

The exhilaration of this trip was not mentally dampened by wet feet as we made our way back to our car through the snow. So tired, but happy, we drove down to the valley with memories of May Lake in late June that never will be forgotten.