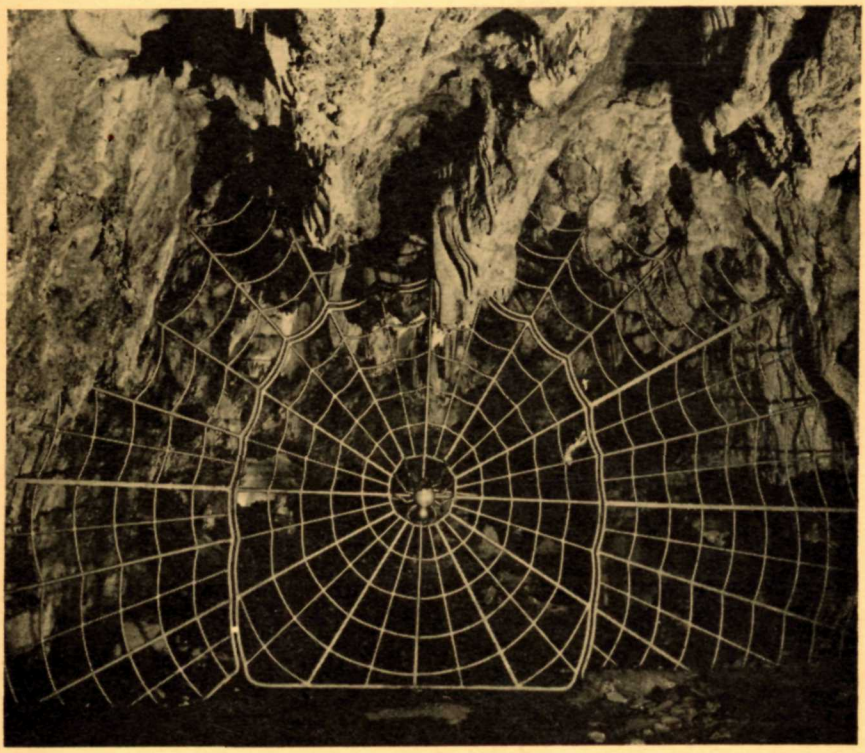
CRYSTAL CAVE

IN

Sequoia National Park



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CRYSTAL CAVE

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SEQUOIA NATIONAL PARK

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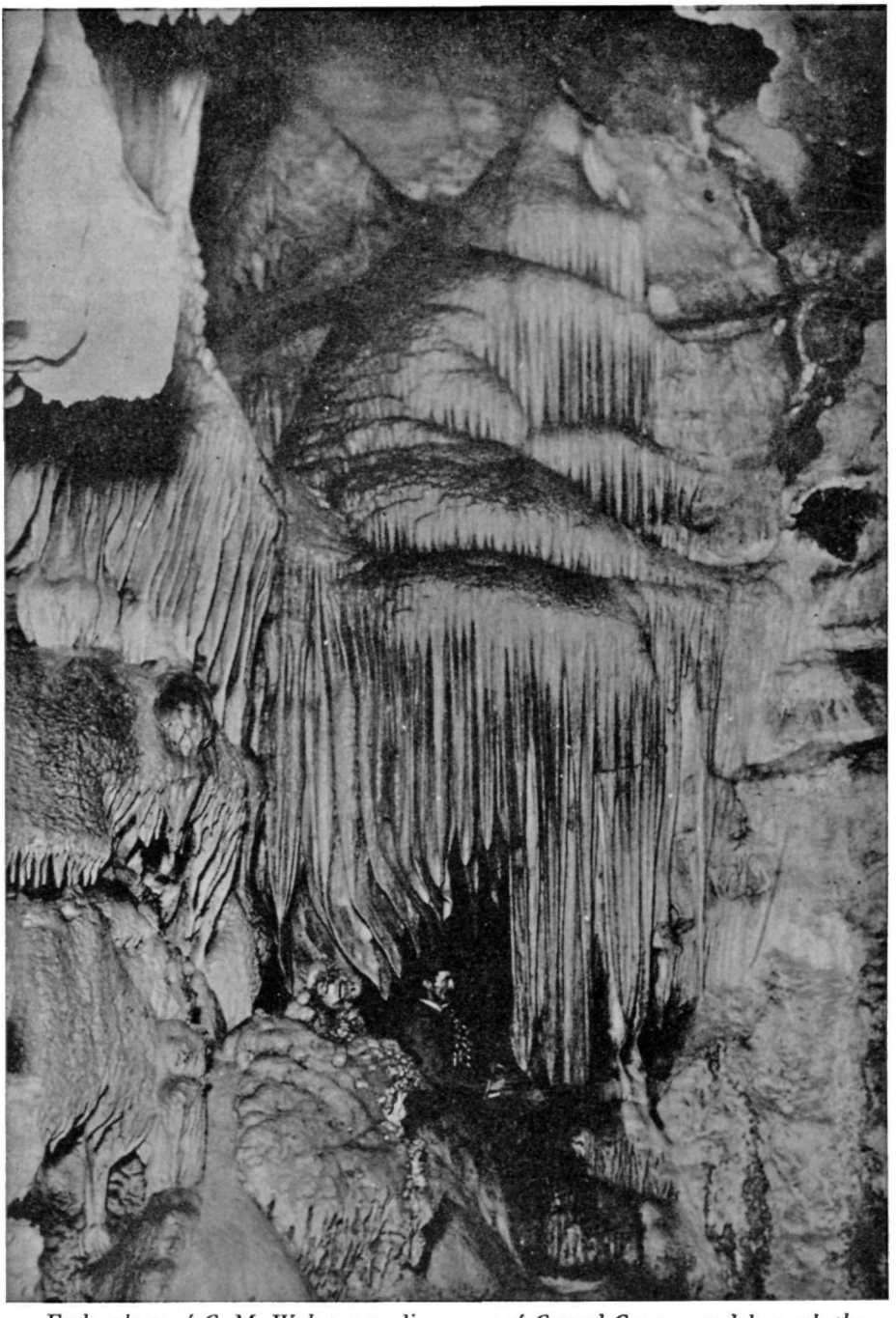
INTRODUCTION

Extending across the western part of Sequoia National Park from northwest to southeast, there are numerous outcroppings of white crystalline marble, many of which are known to be cavernous to some extent. Caves have been partially explored in eleven different localities, but Crystal Cave is the only one that has been developed for public use. While the other caves are interesting, chiefly from a scientific viewpoint, they are not easily accessible nor do they compare favorably with Crystal Cave in extent or beauty.

Crystal Cave was discovered April 28, 1918, by C. M. Webster and A. L. Medley, National Park Service employees, while on a fishing trip along Cascade Creek a short distance above its junction with Cave Creek. It is situated in a vertical bed of marble 200 feet thick, which extends through the ridge between these two creeks. It was named by the then Superintendent, Walter Fry, who took immediate steps to protect it, by having a log barricade built across the entrance, until funds became available for development. (12). The cave was opened to visitors on May 29, 1940. The cave is open only during the summer months, when Park Rangers conduct scheduled trips through it daily. In addition to protecting the cave against vandalism, the Rangers explain its many features and suggest how it may have originated. There are many unsolved problems connected with the origin of the the cave, and some of the questions that arise may never be answered correctly.

Most parts of Crystal Cave that are accessible, as well as several other caves in the park ranging in altitude from 2,000 feet to 6,300 feet, have been explored. Some of the caves have their entrances near the level of surface streams in the bottoms of deep canyons, as at Crystal Cave, while others are situated near the tops of mountain ridges high above the level of present day streams. At least four of the lower caves have streams, and some now dry contain deposits of gravel which indicate the former existence of streams in them. Perhaps a complete geological survey might reveal a common origin for most of them, with minor variations induced



Early photo of C. M. Webster, co-discoverer of Crystal Cave, seated beneath the Cave Organ.

by changes in drainage resulting from the series of uplifts which gave birth to the Sierra Nevada.

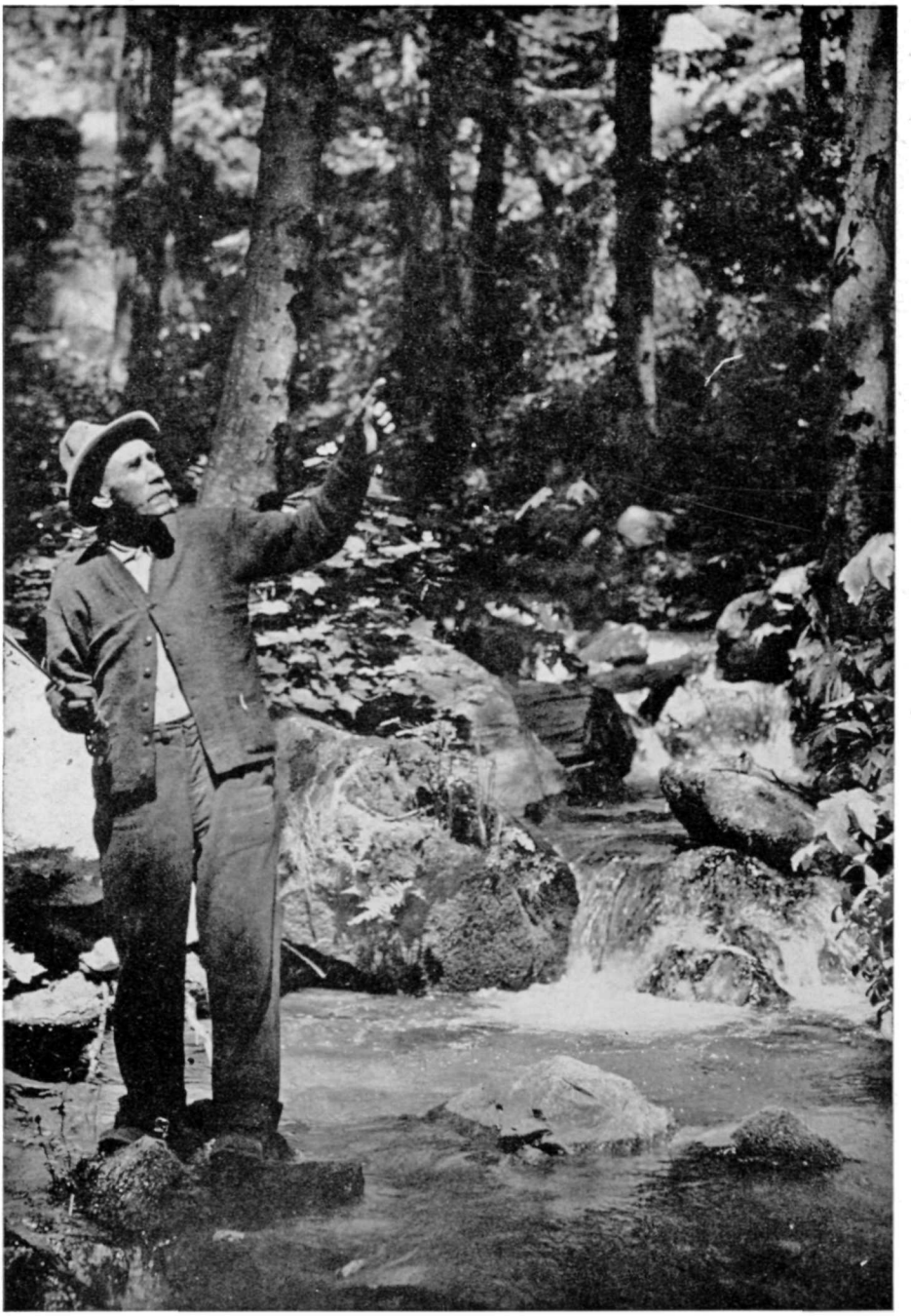
The Approach to Crystal Cave

The side trip to Crystal Cave from Giant Forest is one of the high lights of a visit to the park. The approach road completed in 1941, branches off from the main highway in the lower part of Giant Forest at an elevation of 5,500 feet, and follows a winding course across the beautiful Marble Fork Canyon through virgin forests of mixed stands of pines, firs, incense cedar, black oak, dogwood, and numerous low-growing species of flowering plants. In moist places, profuse growths of beautiful tiger lilies may be seen blooming along the roadside in the early part of the season. Through the lower part of this Transition Zone forest, the road finally descends to the cave parking area nine miles from Giant Forest, at an elevation of 4,860 feet. This is a meeting place of the higher Transition Zone and the Upper Sonoran Zone. The latter is so named because the vegetation here resembles that of the Northern Sonora District of Mexico. It is characterized by several species of brush or chapparral, certain species of trees such as interior live oak, blue oak and western sycamore. The beautiful Mariposa lily and stately Yucca also are representatives of this zone, together with dozens of low annual and perennial flowering plants which reach their climax in color and beauty in this section of the park.

From the parking area a half mile of hard surfaced trail descends on an easy grade to the cave entrance in the bottom of the canyon of Cascade Creek. The altitude at the cave entrance is 4,540 feet, or 320 feet lower than the parking area. This delightful nature trail is a fitting prelude to a trip through the cave. It affords excellent views of the marble outcrops and associated rocks. Fingers of vegetation representing the Upper Sonoran Zone extend upward along sunny slopes, while similar extensions from the Transition Zone cross the trail and descend into the canyon in more sheltered places, resulting in an interesting variety of plant and animal life. The trail crosses Cascade Creek over a rustic oak bridge. Above and below it is a beautiful series of waterfalls visible from the lower switchbacks on the trail. One of the interesting trees along the trail is the rare California nutmeg (Torreya californica). This tree is an evergreen with sharply pointed needles. It grows to a height of about 75 feet in cool canyons of the Upper Sonoran Zone, and its interesting seeds resemble nutmegs. The entrance to the cave is situated near the base of the lower waterfalls where a pleasant resting place has been provided in the shade of the alders. There are many caves that surpass Crystal Cave in size and beauty, but none of them has a more interesting and scenic approach.

A Trip Through the Cave

The entrance to the cave is a beautiful natural arch 30 feet wide and 16 feet high. A good trail 1600 feet long provides access to the most scenic parts of



Recent photo of A. L. Medley, of Exeter, Calif., demonstrating how he discovered the cave while fishing on Cascade Creek with the late C. M. Webster in 1918.

the cavern. Since the first 500 feet are retraced on the return trip the total distance traveled underground is nearly one-half mile. In side rooms adjoining the entrance, a light generator and rest rooms have been installed. Thirty feet inside the entrance, an appropriate wrought iron gate resembling a huge spider web forms an effective barricade. The cave is illuminated with indirect white light, and the wires and fixtures are so well concealed that they are not noticeable from the trail. There is good ventilation throughout, and the temperature never varies more than two degrees from the normal of fifty degrees.

The entrance leads directly into a large room some twenty feet in width and one hundred sixty feet long, with average height of about nine feet. A flat ledge about four feet high projects from the east wall almost ten feet into the room, and beneath it there is a shelf two feet high. The cave floor beneath this shelf is visible through small, natural windows dissolved in the marble, and is seen to slope down toward the east wall where the cave stream is concealed in a deep marble trench. The ceiling is irregular in pattern with grotesque solution remnants of marble and massive deposits of dripstone pointing downward. There also are several small, vertical shafts in the ceiling, commonly used as nesting sites by canyon wrens.

Cave Decorations

The scenic features of the cave result from fantastic patterns and remnants of undissolved marble extending from ceilings, walls, and floors, and from the beautiful deposits formed by dripping water as it evaporates and loses carbon dioxide upon entering the cave. These formations collectively are termed dripstone. They include the following:

Stalactites. Icicle-like formations suspended from the ceilings and ledges, commonly having a small tube in the center.

Stalagmites. Frequently built up from the floor by dripping water. They resemble stalactites but are usually thicker and blunt at the ends.

Columns. Formed when the above-named features join.

Helictites. Irregular branching growths extending in various directions in defiance of gravity.

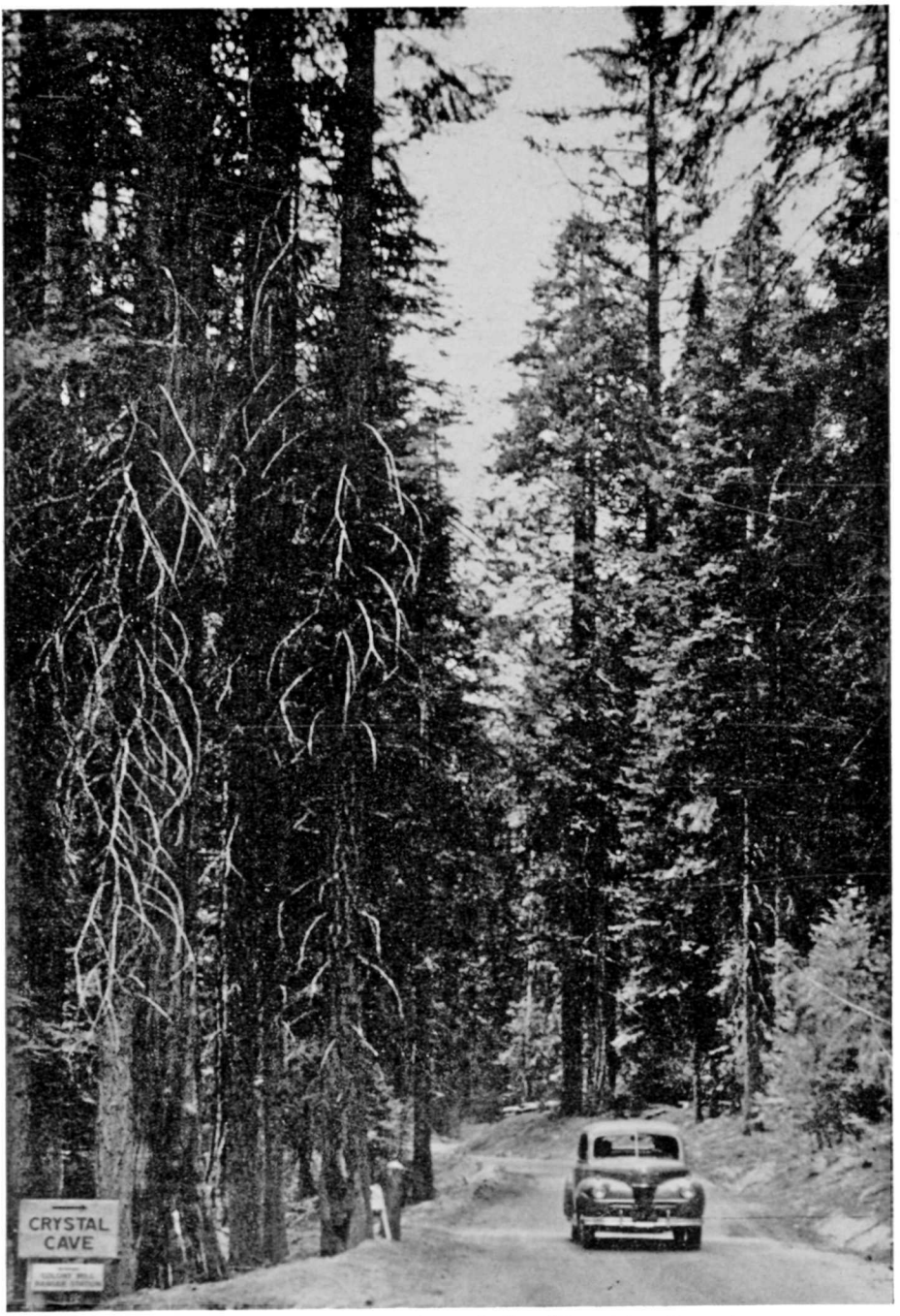
Curtains or draperies. Thin, blade-like deposits extending from walls, or cascading in folds from ledges as curved double-edged stalactites, terminating in single, sharp points.

Flowstone. Coating or sheet-like deposits of dripstone.

Rimstone. Coral-like dams of ruffled dripstone enclosing basins arranged in a cascading series. Formed by evaporation of water around margins of pools.

Pisolites or cave pearls. Limestone concretions about the size of peas formed in flowstone basins around particles of sand by dripping water.

In addition to the above, there are many slopes in the cave adorned with glit-



The road to the cave passes through fine Transition Zone forests.

tering deposits of crystals resembling frost. Most of these features are pointed out in the first room.

Unexplored Grotto

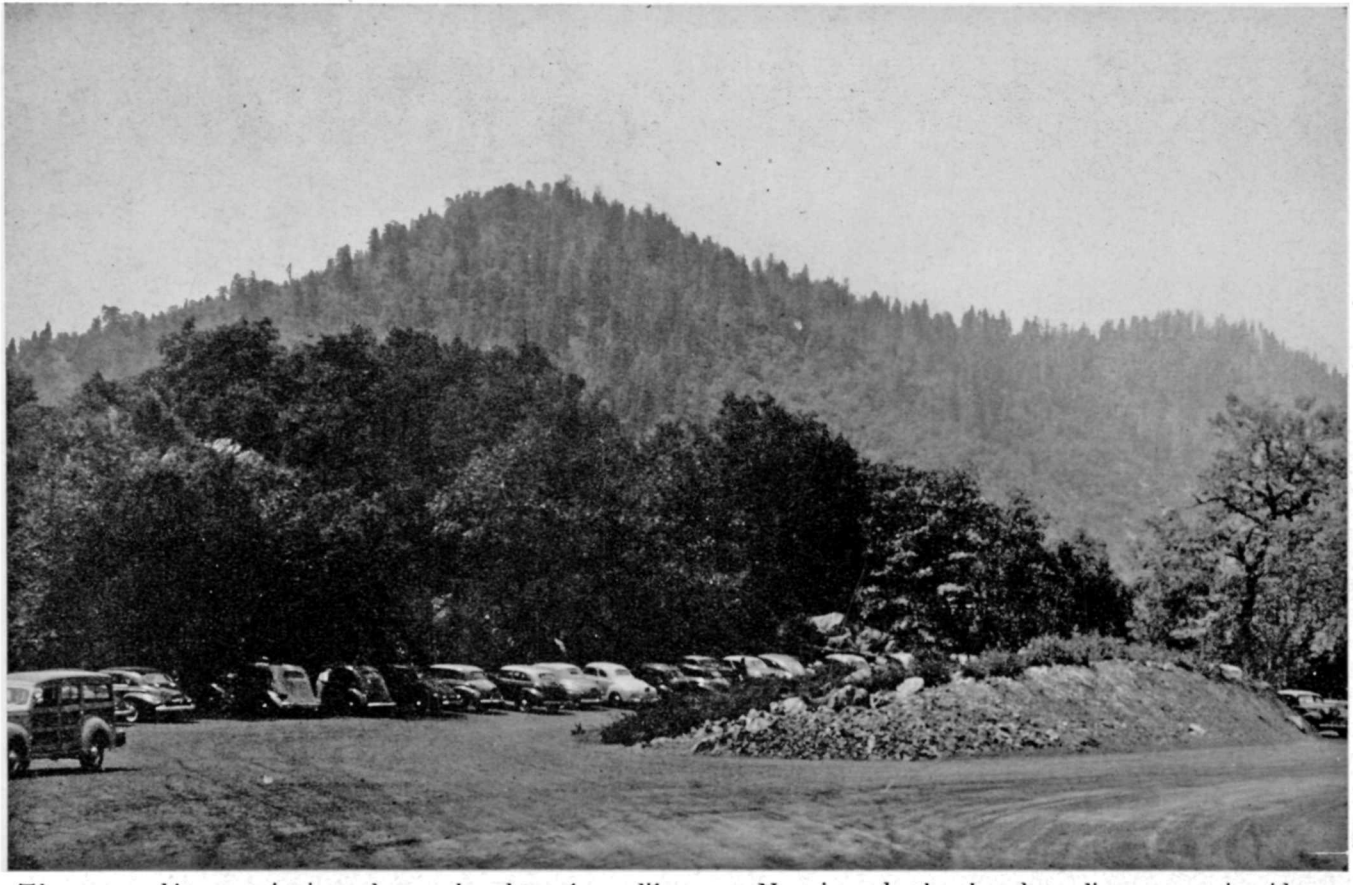
Ninety feet from the entrance, an interesting side chamber branches off to the west. This passage is about three feet wide and filled with quiet water from an unknown depth to within three feet of the ceiling. It is blocked from the main entrance room by a mound of clay covered with flowstone, and indicates that a different type of circulation formerly existed within the cave. The passage has never been explored, but as far as it is possible to see into it by flashlight there is a maze of weird marble projections both above and below water, and myriads of beautiful stalactites directly above the water. This illustrates the fact that a cave does not necessarily have to be drained of water before stalactites can form, as some authorities maintain.

The trail from the entrance room follows beside the stream through a high, narrow passageway beautifully adorned with a variety of stalactities. Here, also are good examples of coral-like growths in the rimstone basins and stone nests containing calcite eggs, or pisolites. This passage narrows to a small opening about three feet wide and ten feet high near the *Junction Room*. There is usually a breeze through this opening which moves outward in summer and inward during the winter, depending upon differences in pressure between the cave atmosphere and that of the outside.

The Junction Room, named because it is the junction of three trails, is about thirty feet wide, seventy-five feet long, and twelve feet high above the stream. It has an excellent display of cave decorations, containing many solution pits. Overhead there is a tortuous, winding passage incised through the marble. This passage connects with an interesting elevated chamber of complex design. In addition to many other interesting features, there is a series of many rimstone dams about eighteen inches high, enclosing basins up to five feet in diameter. These basins long ago lost the water which built them up. Also in the Junction Room, a great keystone pillar rises from floor to ceiling, and the remnants of undissolved marble hanging downward from the ceiling assume profiles that remind one of various animals and persons.

The Circle Trip

From the Junction Room a counter clockwise course is followed, past many side and overhead openings, to the *Curtain Room*. Here delicately folded flowstone descends from the ceiling in the form of draperies. A few feet farther along, the narrow, sinuous trail opens into a sizeable chamber called the *Organ Room*. In this room a huge cascade of flowstone twenty feet high terminates in a magnificient bank of curving, double-edged stalactites which resemble a giant pipe organ. Leading from this chamber there are several alcoves, partly separated by



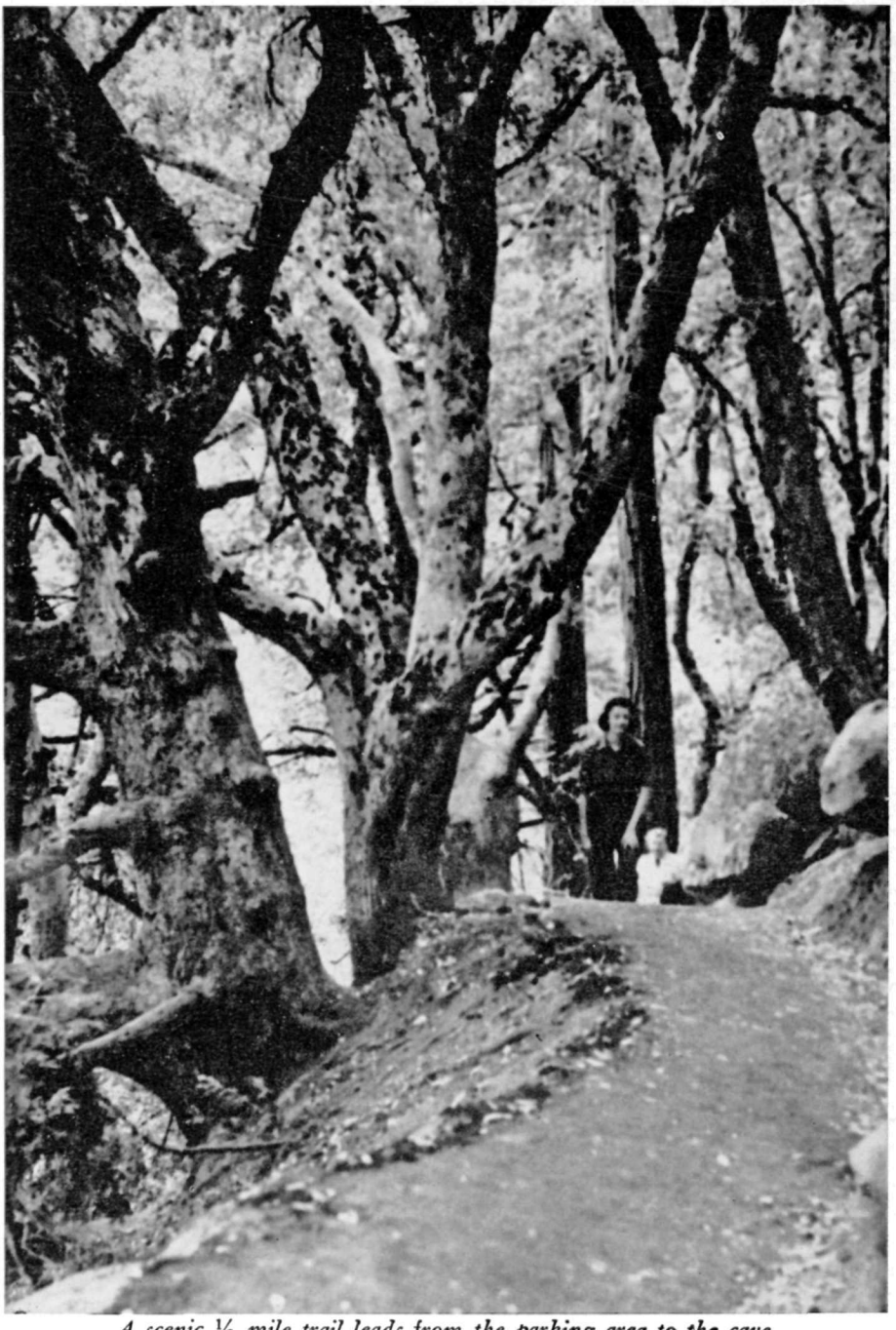
The cave parking area is situated near the edges of two life zones. Note irregular brush and tree line on opposite ridge.

thin, window-rock partitions. The alcoves are partly filled with clay and gravel; remnants of which are common in the main passage. Narrow, fissure-like openings and tubular passages radiate out in various directions from this section, some of which make complete loops. Huge blocks of fallen marble occupy much floor space in this and succeeding rooms.

A series of blade-like window rocks separates the Organ Room from the *Dome Room.* The dome is a huge block of fallen marble capped by a thick layer of flowstone which resembles frosting poured over a mammoth cake. In general, the entire formation is shaped like a shoe, near the toe of which there are several miniature lakes with delicately beaded shores. Here are some of the most fragile and attractive stalactites in the cave. On the instep of the Dome, there are several stalagmites resembling totem poles. The Dome is situated directly under a major crack in the marble from which water is constantly dripping to form a thin film of water over the Dome, on the inner side of which thin strips of draperies resembling huge slices of bacon are forming beside curved, double-edge stalactites. The dripstone throughout the cave is a cream-white or ivory color of various shades. The ceiling in this room has a weird assortment of marble remnants and an intricate pattern of small, rounded channels incised upward into the marble. Some of these are filled tightly with stream-deposited sand and gravel. A delicate slope of glittering, frost-like, white crystals is a major attraction in this room. The deep, inverted potholes in the ceiling are of special interest.

The trail from the Dome Room leads upward through a narrow passage called *Fat Man's Misery,* and finally descends into the largest room in the cave known as *Marble Hall.* There is a maze of connecting passages along this route, some of which are complete circles, and practically all of them connect with Marble Hall. This big room roughly is 54 feet wide, 43 feet high, and 141 feet long. The high point on the trail near this room is about 60 feet higher than the entrance. Huge blocks of collapsed marble partially fill this large room. From high ledges massive banks of flowstone are terminated in a weird assortment of stalactites and draperies. Some of the ledges have broken off and lie inverted with the broken stalactites pointing upward. Other large blocks have slumped, as indicated by stalagmites pointing obliquely upward. There are huge remnants of marble suspended from the ceiling by narrow necks or extending out from high alcoves and side chambers, that contribute to the gnome-like atmosphere. Here the lights usually are turned off to demonstrate the natural darkness of the cave. There are excellent deposits of bedded clays in the alcoves adjoining this room, and many remnants of the gravel on high levels, to suggest how completely the cave was filled in times past.

After traversing Marble Hall, the trail leads through a short, artificial tunnel to connect with a narrow fissure along a fault zone where the marble formation



A scenic ½ mile trail leads from the parking area to the cave.

has parted and slumped along a steeply inclined plane to the right. One can see upward over this inclined slope more than one hundred feet.

Near the lower end of the winding trail, a large overhead balcony of extreme beauty is viewed from a landing. The walls of this balcony are almost completely covered with a thick coating of cascading flowstone. This probably is the most scenic alcove in the cave. From this point it is about one hundred feet to the junction, from which point the trail is retraced to the entrance.

It is impossible to describe more than a few features of the cave. The pattern is so complex and there are so many thousands of features that one can see only a few of the more outstanding ones in a single trip.

Living Things In Crystal Cave

Certain forms of living things have adjusted themselves to a dark existence in caves, and have become modified by re-arrangement of normal sense organs. Sightless fish and insects are not uncommon in some of our larger, well known caves. In Crystal Cave, a large, brownish-black spider has been identified tentatively by experts as a new species in the genus *Pimoa,* family *Linyphiidae.* (28) This spider spins its web in various parts of the cave and around lights where small flying insects, and occasionally large cave crickets, become entangled frequently enough to furnish food for the spiders.

The cave crickets have been discovered only recently, and entomologists report that they are a new species in the very rare genus *tropidischia.* These crickets are colored like the spiders, and have antennae three inches long upon which they seem to rely in moving about, rather than upon eyesight. "This genus is practically unkown to science." (28).

There also are millepeds, sometimes called thousand-legged worms, in various parts of the cave. They are quite harmless and roll themselves into a spiral when handled. Mice and wood-rats find their way into the darkest recesses of the cave, and caches of acorns and other seeds are common. These animals are the same species seen above the ground and inhabit the cave only sporadically. Their droppings are abundantly distributed over the surfaces of clay banks in the alcoves adjoining the Organ and Dome Rooms. Bats are seen in the cave only occasionally. One specimen, a Lump Nosed or Big Eared Bat (*Corynorhinus sp.*), taken from a remote recess in December 1945 proved to be a new species for the park. Bears have been reported to den up in some of the outer openings of the cave during cold weather, and the skeletal remains of a raccoon were found in one of the openings. Bones of deer and other animals have been found at great depths, some of which are partially encased in flowstone. In the Fall of the year, deer commonly enter the cave as far as the spider web portal.

Caves have been used by man as dwellings and burial grounds since the earliest times, and they furnish important information concerning ancient cultures of

A guide party assembled at the mouth of the cave.

The first large room behind the entrance. Note honeycombed marble.

primitive people in the form of artifacts, paintings, and skeletal remains, as well as information concerning the plant and animal life upon which they subsisted. Some of the most common superstitions and legends in Roman mythology center around caves. Present day curiosity and interest in caves seem to be instinctive. (9 and 10). There is no evidence of human use at Crystal Cave.

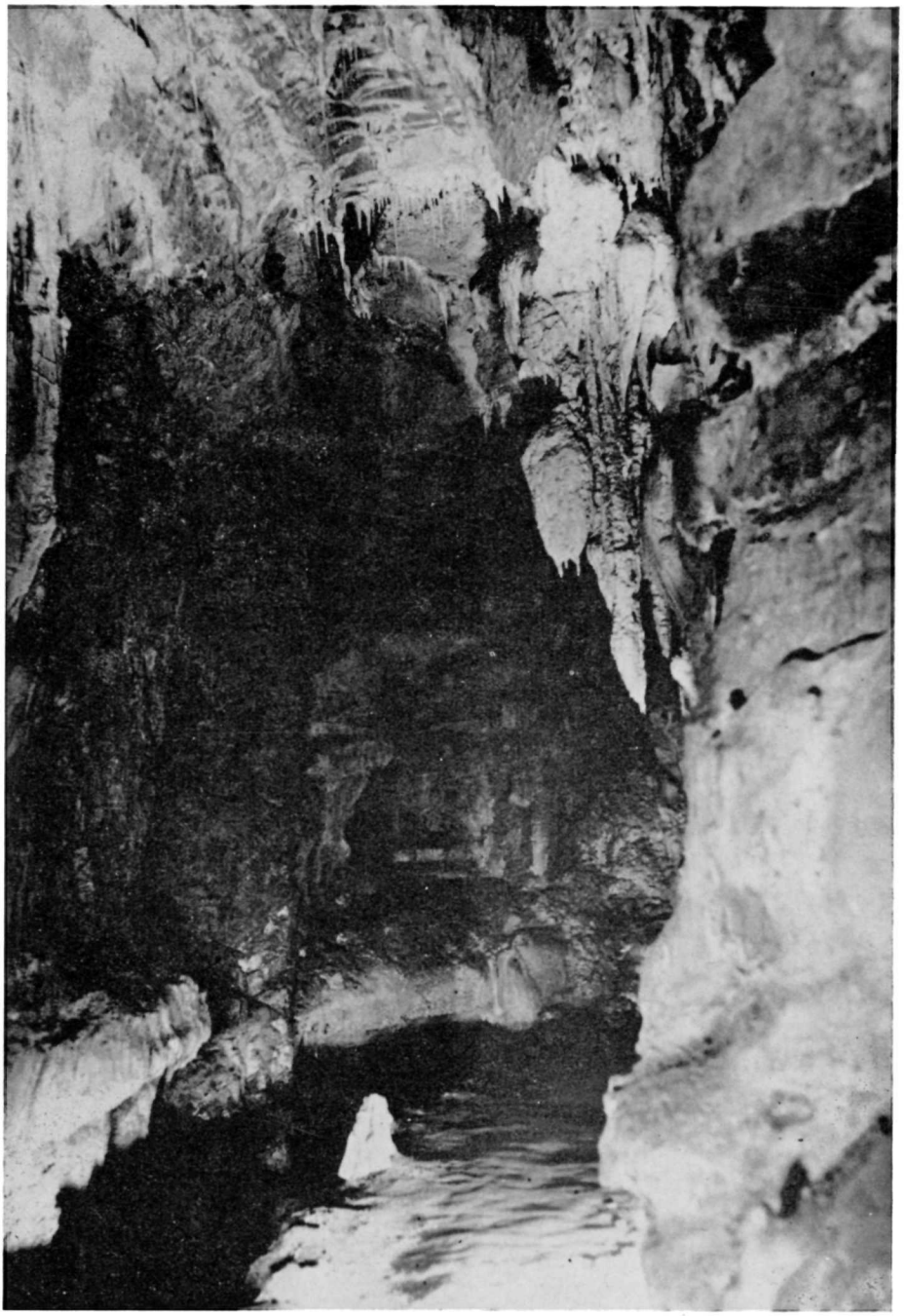
The Cave Marble

The marble represents an old limestone changed to a beautiful crystalline form by the intense heat and pressure it experienced during mountain making movements in the earth's crust many millions of years ago. The limestone had its origin in the limy ooze deposited on the bottom of an ancient sea that covered this area in still more remote times. Since no fossils have been found in the marble, its geologic age is unknown. Deposits of sand and finer materials were interbedded with the lime until the aggregate thickness amounted to several miles. The resultant sandstones and shales also were metamorphosed, or changed, as the limestone was, to their crystalline forms we see today as quartzite and schist at Amphitheater Point or Deer Ridge overlooks. These beds were compressed into a system of mountain folds beneath which a vast reservoir of molten rock material was forced. This molten rock cooled deep beneath the surface as granite. It baked and further compressed the rocks which were intruded by it. Subsequently, but long before the rise of the Sierra Nevada, this once lofty mountain system was worn down to a monotonous plain with low hills in which the granite core was exposed. Only the roots of this folded mountain system are preserved in the granite which surrounds them. They often are referred to as "roof pendants." (17).

Marble is composed of calcite, one of the most soluble of common minerals. It can be dissolved to a slight extent by water. If the water is somewhat acid, as ground water usually is through contact with organic materials in soils and because it usually contains carbon dioxide, its ability to dissolve is greatly increased. Consequently, all the marble outcrops contain cavities, some of which are sizeable cave systems.

Origin of Limestone Caverns

Water from rain and melting snow is disposed of in three ways. Part of it sinks into the ground, where it remains for an indefinite time before re-appearing at the surface as springs. Some of it runs off to join surface streams and lakes, and the third part is returned to the atmosphere by evaporation and plant transpiration. The amount that is absorbed into the ground depends upon soil depth and texture, steepness, type and quantity of vegetation, rate of downfall, cracks and fissures in the rocks, and several other factors. The character of the soil and plant cover in the drainage basin above Crystal Cave favors the retention of water in the soil despite steep slopes, consequently there is a steady source of underground water to feed clear mountain streams throughout the long, dry summers.



The passage beyond the entrance room follows a major joint in the marble.

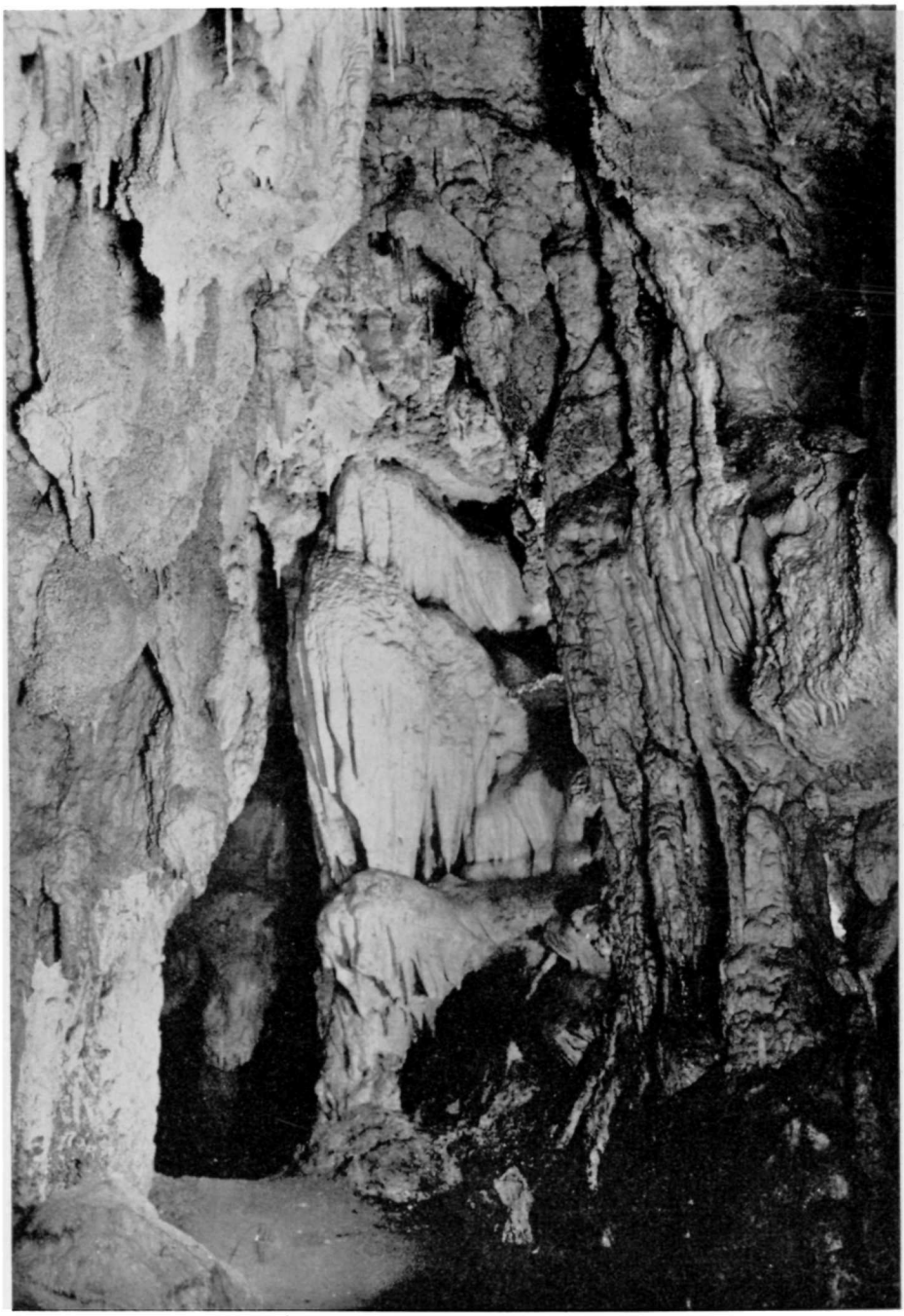
The absence of grazing and logging in National Parks encourages delayed runoff and the conservation of water.

Ground water descends slowly under the influence of gravity until it reappears at the surface as springs or reaches a level below which all spaces are filled with water. This level is called the water table. Springs appear on valley sides at this level and deep wells become filled to a height even with the water table. The water table conforms roughly to the surface of the land, although it is much deeper beneath divides and comes closer to the surface in valleys to join streams and lakes. It rises following wet periods and drops after droughts, and as valleys are deepened it descends to successively lower levels. The movement of ground water is said to be principally downward until it joins the water table, when lateral movement is reported to be dominant. There is also abundant evidence that considerable movement occurs below the water table in sub-water table streams where passages have been dissolved out. Water is forced through such passages by hydrostatic pressure. (2) Lateral movement is encouraged by the existence of caves which have openings and suitable grades near the level of surface streams. Such streams sometimes are called water table streams (8), and they are considered by some authorities to be the principal agents which excavate caves. (26 and 27) Some geologists explain the origin of caves by simply stating that openings gradually are dissolved large enough to permit free flowing water, thus adding abrasion, or mechanical wear, to the work accomplished by solution (6), while others have contended that such caverns as the Mammoth Cave of Kentucky were entirely "worn out" by running water. (15)

Until recent years, it had been generally assumed that practicaliy all solution by ground water occurred above the water table, sometimes called the zone of solution, (20) and that as the descending water joined the reservoir below the level of permanent ground water it had become so burdened with dissolved minerals that it could no longer change and dissolve limestone. Recent investigations have disproved this theory, as will be shown later.

The term "vadose" is applied to ground water above the level of the water table, while "phreatic," which in Greek means a well, applies to that below the water table.

After an exhaustive review of the literature on caves, William Morris Davis in 1930 wrote a masterly thesis on the "Origin of Limestone Caverns," (8) which had the effect of stimulating a renewed interest in caves, some geologists supporting and some opposing his theory that caves are first formed below the surface by phreatic water, and that due to uplift with a resultant lowering of the water table the caves were drained and air admitted for the first time, thus permitting the growth of stalactites and other deposits which decorate most limestone caves. His deductions are supported by the evidence found in the caves of Sequoia



In the most constricted portion of the trail there is a thick coating of beaded flowstone.

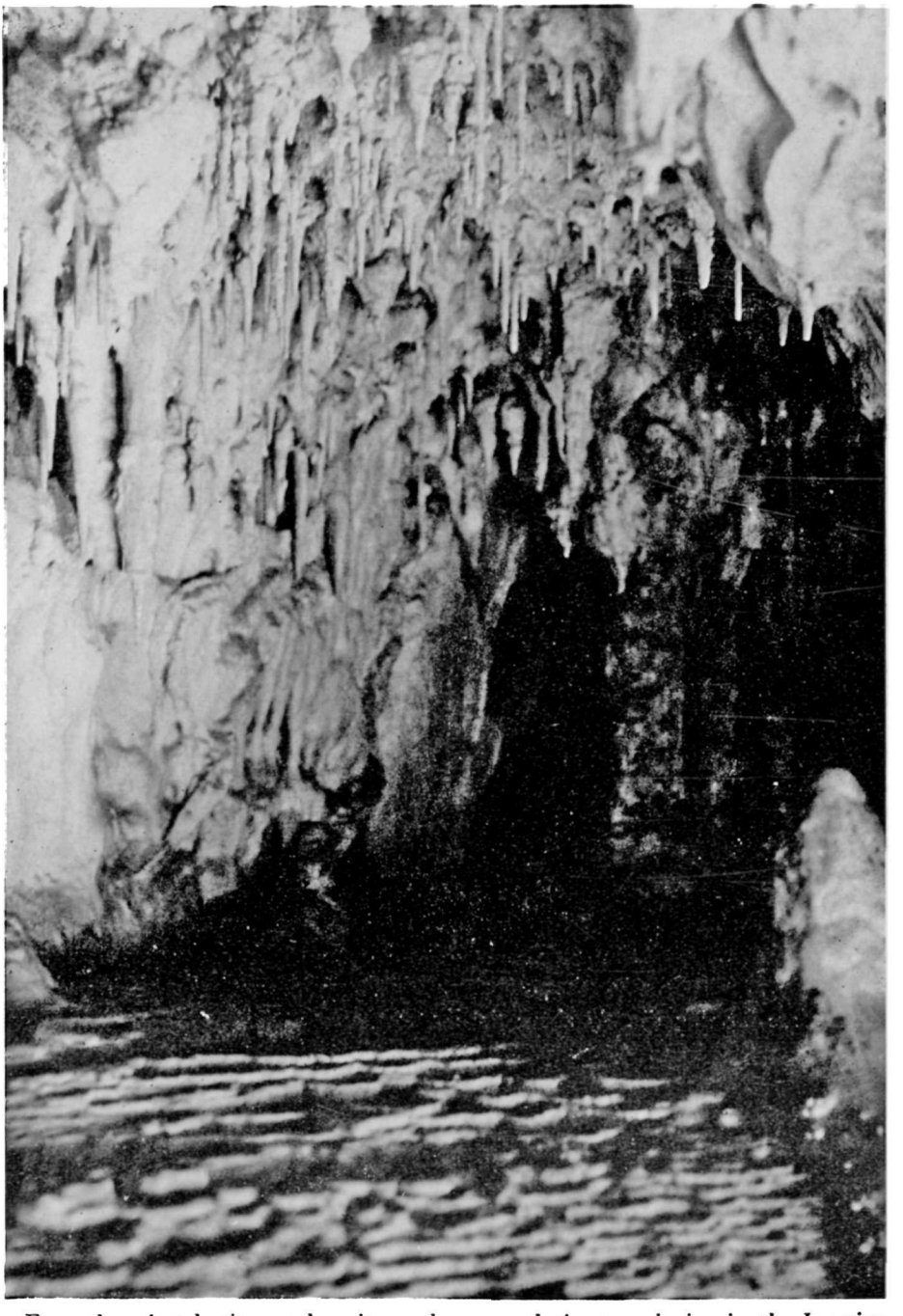
National Park. The outstanding field investigations and conclusions of J. Harland Bretz in 1942 largely confirmed the ideas of Davis. He concluded that most of the caverns he had seen were largely of phreatic origin, and that of 107 caves he studied only three simple ones were entirely vadose in origin. (2) Many of the features he describes are applicable to Crystal Cave.

That sub-water table caverns may exist is suggested by huge, deep-seated springs or rivers that rise upward to the surface of valley bottoms in many parts of the country, as well as from the ocean floor off the coast of Florida. (2 and 8) These streams must traverse large water-filled caverns. The Mammoth Hot Springs Terraces in Yellowstone National Park suggest another method of cave origin by solution at considerable depth. There the hot, rising water heavily charged with carbon dioxide has deposited a mountain of travertine about two miles long and one-half mile wide on the surface. This material was dissolved from a formation of limestone which has a thickness of about 1,600 feet. It is possible that caverns filled with hot water exist in this limestone in such proportions as to dwarf some of our best known caves. In 1941, Berlin C. Moneymaker described drilling operations and deep cut excavation in various parts of the Tennessee Valley which revealed the presence of hundreds of cavities at depths exceeding 100 feet below the water table, some of which had the dimensions of large caverns. (19) Similar drillings in other localities indicate such caverns are common geologic features. (2)

The Cave Stream And Its Work

Just inside the cave the stream is concealed under a ledge in a clean "U" shaped marble trench about six and a half feet deep and two feet wide, which gradually grades up to the level of the floor 160 feet from the entrance where it first comes into view at the foot bridge. Here it makes two almost right angle turns in adjusting itself from the west to the east side of the cave and follows beside the trail for an additional 75 feet, where it recrosses to the east side of the cave beneath another bridge. A short distance above this point, the stream disappears under a ledge and flows slowly over a light gravel fill through a low chamber about two and a half feet high and twelve feet wide. Here again a beautiful profusion of stalactites are forming directly above the sluggish stream, partly impounded on the level floor. The stream reappears in the Junction Room five hundred feet from the entrance and finally disappears beneath the stone floor of the second level of the cave about 100 feet beyond the Junction Room.

The cave stream has special significance. Some think that it has been the principal agent in the excavation of the cave, while others contend that it is secondary and that it has only modified and enlarged selected parts of pre-existing chambers and passageways that are of suitable grade, which the stream could follow most easily.



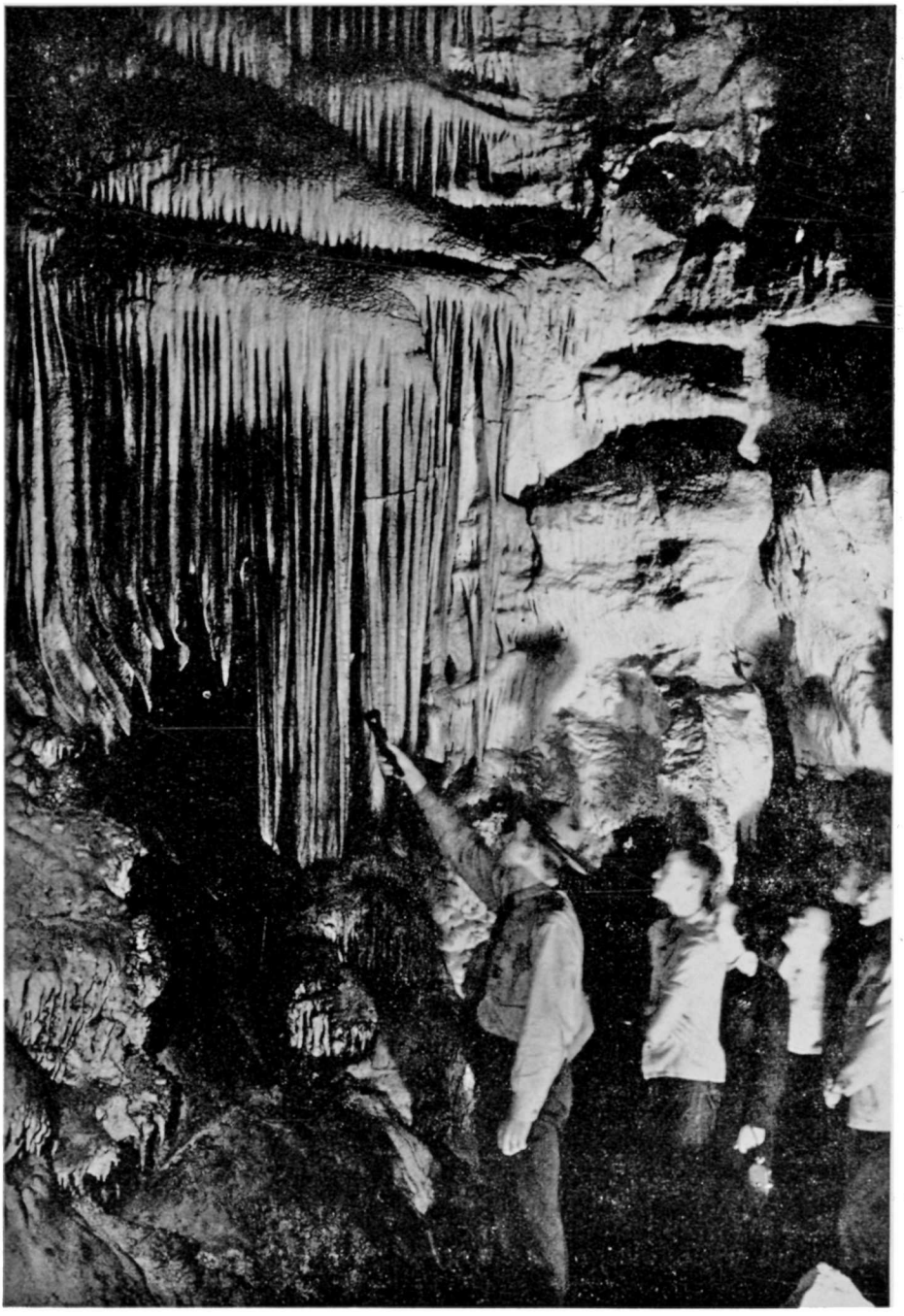
Examples of stalactites, stalagmites, columns and rimstone basins in the Junction Room.

The stream today is enlarging and modifying the cave in two ways. Near the entrance it is eating its way deeper into the marble trench in its attempt to maintain grade with the parent Cascade Creek on the outside. The trench is slowly migrating headward into the cave as the base-leveling process continues. A short distance above the trench where the stream flows sluggishly on grade over the almost level, gravel-covered floor, it cannot deepen its channel but is slowly dissolving the marble laterally. After many thousands of years, the stream will be rejuvenated in this section of the cave as the trench is extended upstream, thus increasing its velocity and cutting power.

It has been noted that the cave became substantially filled with clay, sand and gravel by a larger depositing stream after the major galleries had been mostly dissolved out, and that subsequently this fill has been removed largely as the stream load was reduced and its transporting power increased. Armed with particles of sand and gravel, the stream was able by abrasion to enlarge and modify those parts of the cave through which it flows, as well as by dissolving the marble. Evidence of stream work is preserved on the walls and ceilings in many parts of the main passageways. After most of the fill had been removed, the stream appears to have lost much of its volume and transporting power, until reduced to its present state in which its dissolving power is dominant over abrasion. Even in the rather steep marble trench where the stream flows rapidly, the principal process seems to be that of dissolving the marble rather than wearing it mechanically, as there are thin, blade-like dikes of insoluble material extending across the channel. Some of these are almost knife-edge sharp and could not have resisted much mechanical wear. They stand out from the marble because they are less soluble.

In no part of its known course is the present stream accomplishing work that could conceivably result in duplicating the major complex features of Crystal Cave. It appears to be following a pre-determined course which it is modifying as noted previously, in the base-leveling process.

In addition to the difficulty of explaining the origin of many solution features in the cave and the amazing complexity of its intricate ground plan on the basis of stream wear, it seems reasonable to expect that the largest rooms would occur near the entrance where the volume of water would be greatest, and that the openings would become progressively smaller away from the entrance as the stream branched out, if the system had been excavated in this manner. Such is not the case, for the cave narrows down to three feet in width by ten feet high, with a communicating low chamber two and one-half feet high and twelve feet wide 400 feet inside. The largest room in the cave is most distant from the entrance and is known to have had a height of at least 75 feet before the collapse of marble occurred. Its average width of more than 50 feet, and a length of about 140 feet, dwarfs the dimensions of the entrance room which is separated from the major



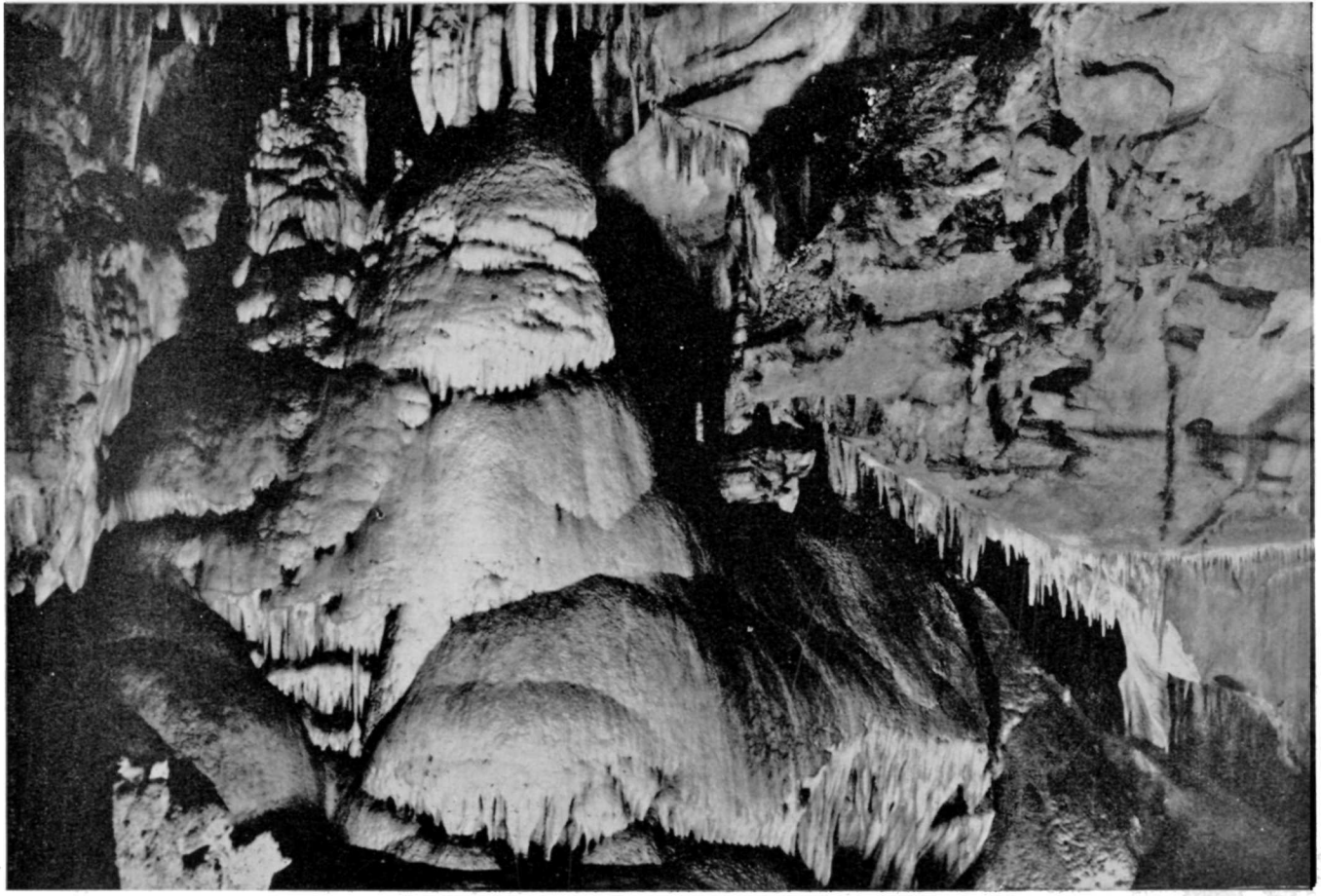
A scene in the Organ Room. Note curved, double-edged stalactites.

large rooms by the restricted portion of the main passage mentioned previously. This discrepancy in size can scarcely be explained on the basis of variable resistance in the rock structure.

Perhaps there are other caverns dissolved in marble beneath Crystal Cave waiting for surface streams to cut to their horizon and drain them, thus duplicating the higher features of the underground landscape, which in time will hasten the lowering of the land as Crystal Cave ridge is gradually reduced in the general base-leveling process.

The Origin of Crystal Cave

The small stream issuing from Crystal Cave as a spring, about ten feet below and fifteen feet east of the main entrance, joins Cascade Creek almost on grade a short distance below. A similar stream issues from the opposite side of the creek a short distance upstream on approximately the same level. This latter stream evidently is draining a cave system which probably was continuous with Crystal Cave in times past. However, due to slumps and collapse of the marble, it is not open to inspection. It is suggested that the major portions of this once continuous cave system were dissolved out and carried away before Cascade Creek valley was lowered to this level, thus bisecting the cave system and giving rise to these water-table streams flowing from opposite directions. After the cave galleries were dissolved out, there is evidence that most of them became filled with clay, sand and gravel. (2) Most of this fill subsequently was washed out, but some of the side chambers still retain a compact, reddish clay reaching almost to the ceiling in some cases. Deposits of gravel contain stream worn boulders up to ten inches in diameter. There are remnants of the fill on the highest shelves in the largest room in the cave, and some of the narrow passages are still tightly filled to unknown depths. These stream gravels are not in accord with the volume or plan of the present stream, and indicate that the larger depositing stream which the cave at one time contained mainly followed two passages to the lower gallery through which the cave is entered. It is interesting to note that similar deposits were reported in sub-water table caverns in the Tennessee Valley. (19) Most of the network of side chambers and passages were not filled with gravel, and their bedded clays indicate that relatively quiet water filled them when the clay was deposited. Some of the clay deposits are capped by a thick layer of flowstone. Perhaps a tight clay fill prevented the latter aggrading stream from entering these recesses to leave coarser materials. There are gravel deposits in the cave which are separated by at least three layers of flowstone, indicating that the stream which laid them down fluctuated considerably from time to time, since flowstone forms slowly, depending upon evaporation. The gravel was exposed successively for a considerable length of time before the stream returned repeatedly with new loads. In the Dome Room and other parts of the cave, there are intricate patterns on the otherwise flat ceilings. Remnants



Scene in the Dome Room. Note the intricate pattern of ceiling with gravel deposits in upper right half of picture. The Dome is shaped like a shoe.

of marble hang down in great profusion and an interesting network of channels, many of which are filled tightly with stream-deposited wastes, have been incised upward into the ceiling. These have been interpreted as having been dissolved by water flowing against the ceiling on a rising fill. (2)

Directly upon entering the Dome Room from the Organ Room, there are some interesting inverted potholes or cone shaped extensions in the ceiling. It is difficult to explain these features except on the assumption that water completely filled all spaces when they were formed, otherwise the presence of air would seem to have prevented their upward growth. (2) Some of them are over seven feet deep.

Streams normally are characterized by a branchwork of tributaries feeding into main channels, but the principal maze of network constituting Crystal Cave is so variable in grade and plan that it must have had a phreatic origin. It seems improbable that a stream could have produced this pattern. (8) There are so many inter-connecting passageways and loops with grades so inconsistent that no free flowing stream could follow them. Some channels resemble syphons and could have supported a stream only under pressure. In many parts of the cave there are patterns on the walls and ceilings which resemble ripple marks in sand. In 1925, Judge Walter Fry noted that the roof in Marble Cave was "heavily grooved and fluted." (12) It has been shown that these flutes record the direction of stream flow, and that they are elongated in the direction of flow. (18) Since they commonly occur on ceilings, they probably were dissolved out by moving water. Some of them have an upgrade both on walls and ceilings, consequently sub-water table streams moving under hydrostatic pressure appear to be the best explanation for them. (2) The same argument may be applied in the Junction Room and other places in Crystal Cave where the flutes change from a downward to an upward trend. A normal free flowing stream could not have made them.

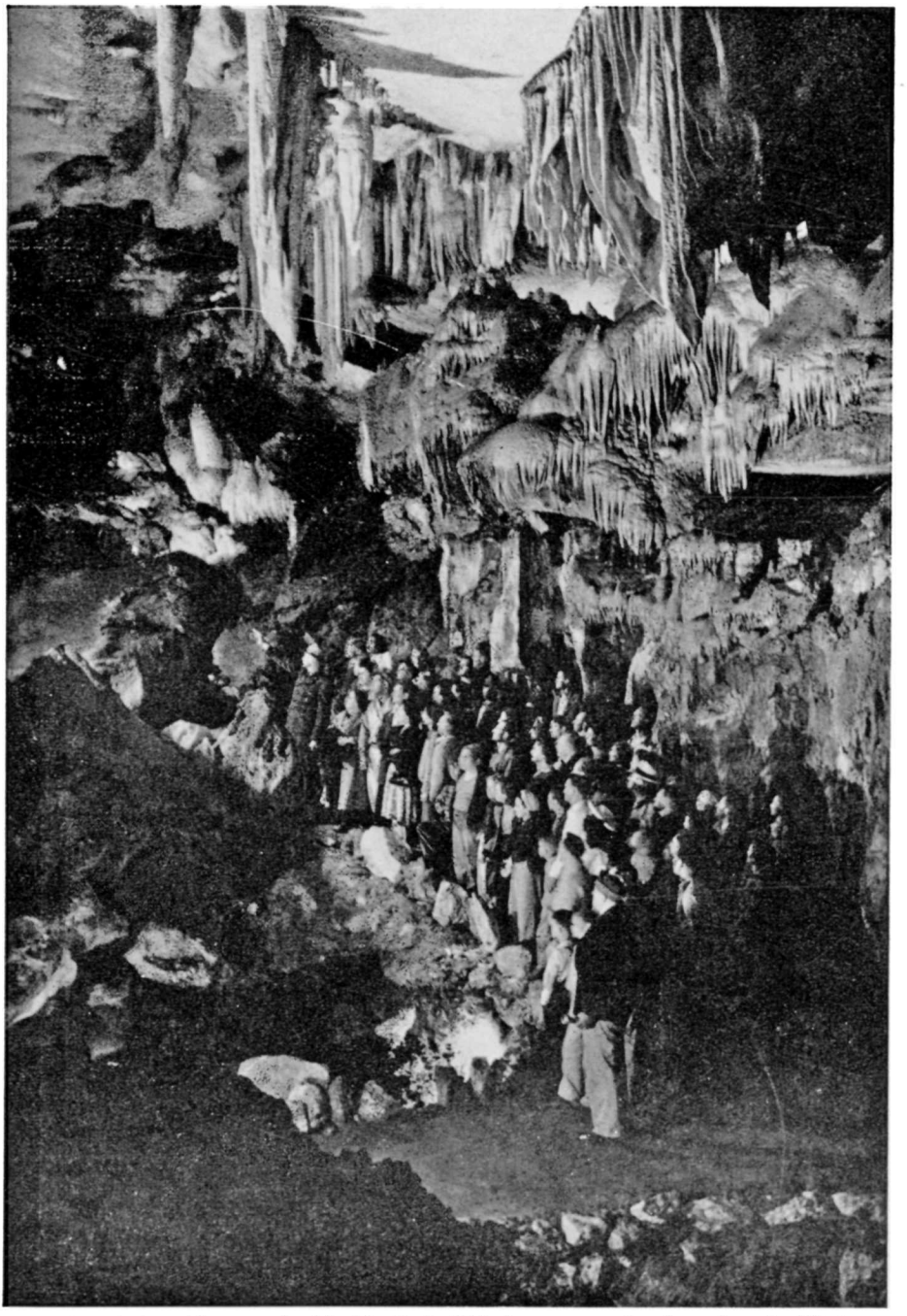
In the Dome Room, as well as in several inter-connecting passageways behind it, there are partitions and thin bladed extensions of marble such as the Elephant Head. Many of these have jagged holes dissolved through them. In several places multi-legged pedestals with sharp, jagged edges rise from the marble floors. There are some passageways that terminate in blind ends. Natural bridges of rough marble across high, narrow passages are not uncommon. The marble literally is honey-combed in places which could not be explained on the basis of stream wear. They appear to have been eaten out when all spaces were completely filled with water.

There are many tubes in the cave, most of which are roughly circular. They extend from horizontal to vertical. One tube about three and a half feet in diameter terminates on the ceiling of Marble Hall, extending upward at a steep angle. On the outside of the cave, about 100 feet above and east of the main entrance, there is a small opening in slumped marble. Behind the slump this becomes a rudely cir-

Drum-head or disk-like faces of flowstone supported on dripstone legs behind the Dome.

cular tube six feet wide and five feet ten inches high above a partial filling of soil. The tube descends into the mountain at an angle of about six degrees, and at twenty-eight feet from the entrance it turns sharply to the left and narrows to four feet eleven inches in diameter, and forty-two inches high above the fill. From this point on the fill rises almost to the ceiling. Flutes on walls and ceilings indicate a downward or in-leading current of water formerly flowed through it. There is no possible way this tube could have originated under present conditions, terminating on the Valley side and pointing upward about one hundred feet above Cascade Creek. Like many other parts of the cave, it is much older than the valley of Cascade Creek and was exposed by the downward cutting of the stream. It has never drained into Cascade Creek. On the Cave Creek side of the ridge at about the same altitude, there is a jagged shaft descending straight down for a distance of fifteen to twenty feet. There is no evidence that it ever supported a stream, although it communicates with the main cave system. It, too, is a pre-existing part of the cave.

Much additional evidence exists to support the supposition that Crystal Cave is largely phreatic in origin, and that it has been modified and enlarged by a variable stream. As additional studies are made, it is hoped that a more precise and complete interpretation can be made which will include the history of all the known caves in the park.



A typical guide party in Marble Hall. This large room has been largely filled by collapse.

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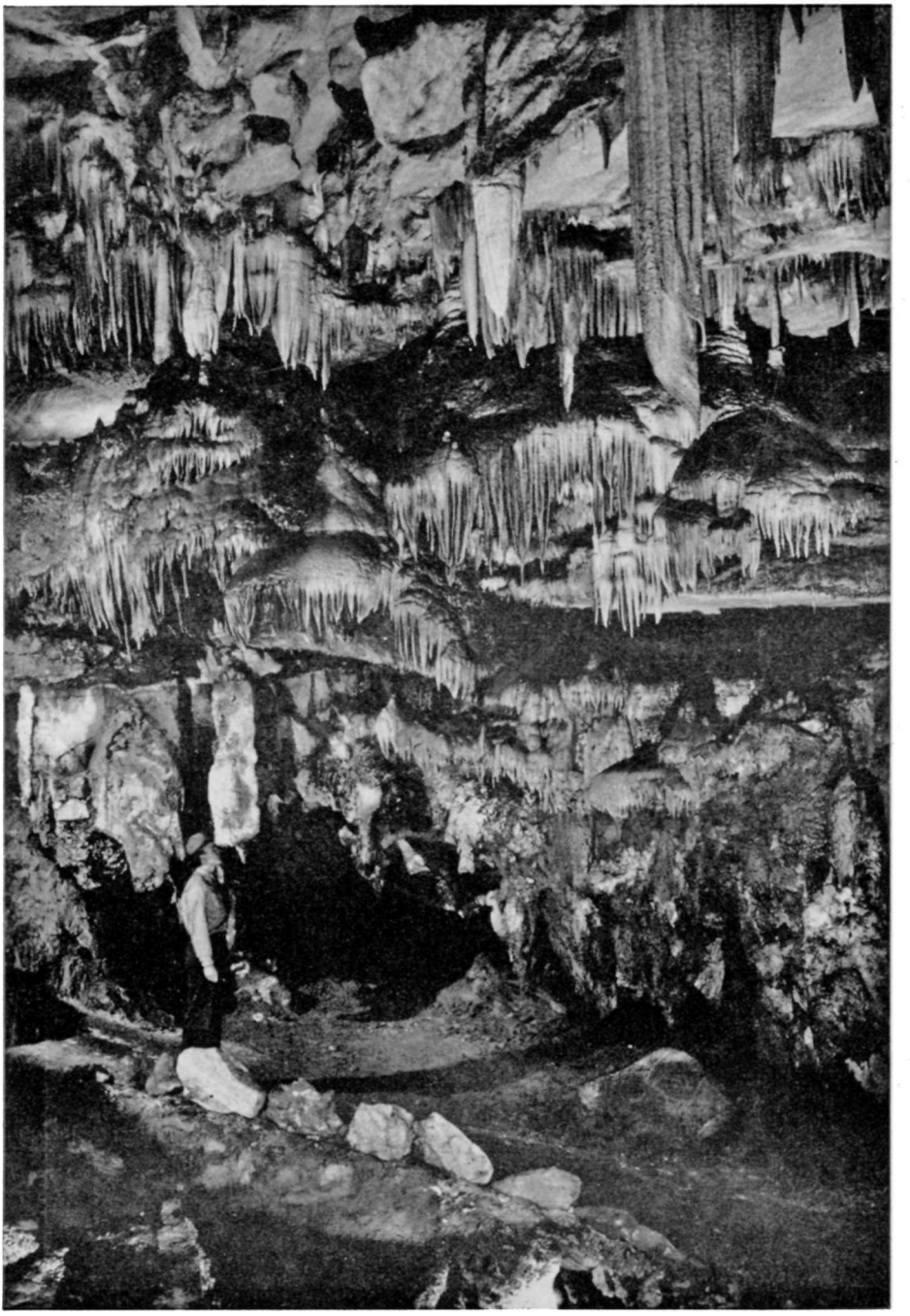

Another scene in Marble Hall, illustrating bedded clay banks in alcove facing ranger and relics of the gravel fill on ledges. Note channels incised in ceiling and many solution remnants of marble.

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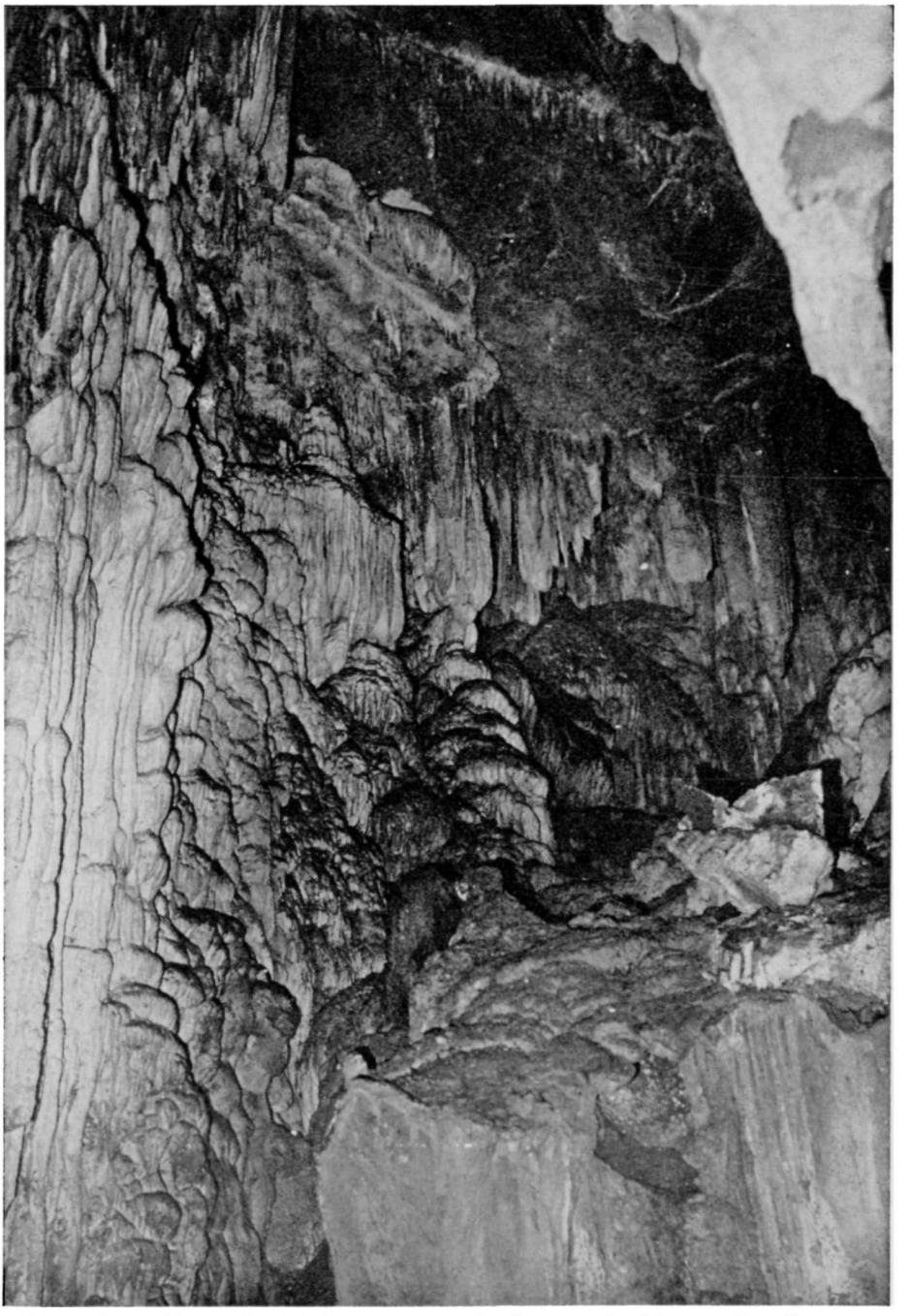
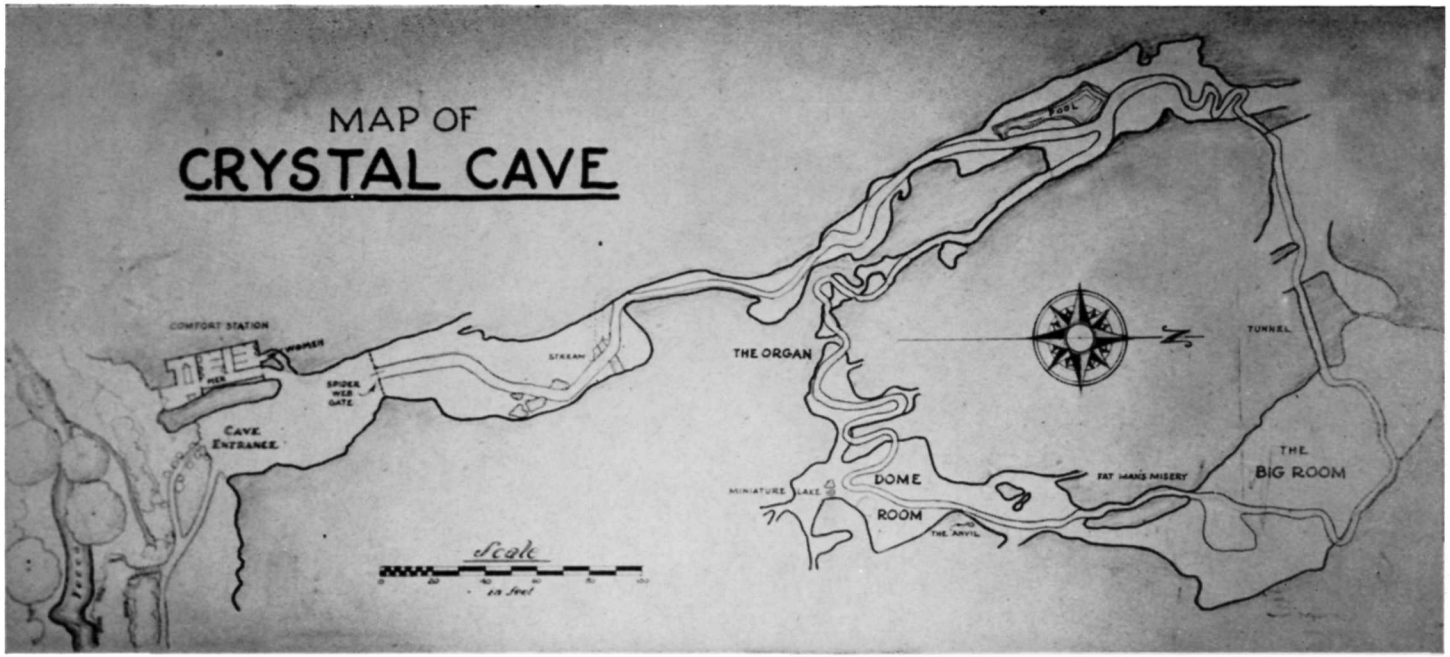
28. *Note: Cave Spiders and Crickets tentatively identified through the courtesy of Dr. W. Dwight Pierce of the Los Angeles County Museum at Los Angeles, Calif.*

Photographs by Wm. J. McCallum and F. R. Oberhansley



The walls of this overhead balcony are completely covered with cascading flowstone.



Map of route through Crystal Cave.

THE SEQUOIA NATURAL HISTORY ASSOCIATION

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