OREGON CAVES NATIONAL MONUMENT

A Manual for Cave Guides

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I. INTRODUCTION

This manual has been prepared to give a broader understanding of Oregon Caves National Monument, its history, purpose, place in the national scene, administration and natural features. It is believed that this will enable all concerned with the operation of the monument, whatever their affiliation, to do a better job through being more fully informed.

In the preparation of the material presented, the rangers and guides have been especially kept in mind, because protection hinges on understanding, and a conducted cave trip can be no better than the interpretation furnished by the guide. However, every person working at the monument is basically there for one purpose - to serve the public.

Only the most salient features of the story of Oregon Caves appear here, partly because much still remains to be learned about this cave. **This is a provisional manual and, therefore, should be considered quite tentative. It may be changed in some respects due to more extensive information having been uncovered.** The story is not static. There can be no final word. It is our duty to keep abreast of changes brought to light by fuller knowledge. Suggestions and questions are very much in order and should be submitted in writing to the Park Superintendent.

Thanks are due members of the staffs of the Departments of Biology, Geography and Geology, University of Oregon; Departments of Geography, Geology and Natural Resources, Oregon State College; Dr. William R. Halliday, Director, Western Speleological Society, who has twice carefully reviewed the text, for encouragement, advice, and suggestions; and to the State Library, together with that at Oregon State College, for valuable aid with references and the loan of books. Several persons with experience at Oregon Caves as ranger or guide, or both, have been most helpful, as has the management of the Oregon Caves Co., especially Mr. Richard L. Sabin and "Old Dick" Rowley. However, none of these persons or institutions is responsible for any errors which may appear in the material presented here.

II. HISTORY AND POLICY

The Oregon Caves have been known since a day, in 1874 (Watson, 1909), when Elijah J. Davidson, then living in the Williams Valley, went hunting in the Siskiyou Mountains (Davidson, 1922). The story goes that, after killing a deer, he followed his dog to a large hole in the mountain. Here he heard sounds of fighting coming from within. Being undecided as to what to do, he stood waiting—until his dog gave vent to a weird howl, as if in great pain. Hesitating no longer, Davidson rushed into the opening. He soon found the chase difficult to pursue without a light, whereupon he resorted to a few matches that he had in his shot-pouch. Striking match after match, he expected that he would soon be at the scene of the struggle. Before arriving there, however, his supply of matches gave out, leaving him in the dark. Davidson finally found his way back to a running stream of water and, following it, came to the mouth of the cave. Soon after, the dog came splashing down the creek and, but for a few scratches, was unhurt. As it was then well on in the evening, Davidson decided to go back to camp and return the next day. Before leaving, however, he placed near the entrance to the cave the buck that he had recently killed. He anticipated that a bear would come out for food, eat all he could, and then lie down by the remaining part. Returning to the scene early the next morning, Davidson found a monstrous black bear lying near the carcass of the deer.

Davidson told others of his discovery, and the cave soon became an attraction for the adventurous, portions of it being explored and opened. Explorations by three different parties are reported for 1877. One of these included Davidson, his brother, Carter Davidson, and James Nail (Fidler, 1922). Another consisted of nine persons, among these being three women and Davidson (Fidler, 1922). The third was composed of John H. Kincaid, Frank M. Nickerson, John M. Chapman, and Davidson (Watson, 1909).

In 1880, Homer and Ernest Harkness, brothers, took a squatter's claim at the lower entrance (Watson, 1909). They were unable to acquire title because the land was unsurveyed. During the next two years they spent about a thousand dollars in enlarging passages between the known chambers. They also built the first trail into the area. However, too few visitors could be attracted from the sparsely settled surrounding country and from the nearest railroad some 200 miles away, so the enterprise became a financial failure. This discouraging situation led the brothers to abandon their claim.

In 1887, Frank M. Nickerson and A. J. Henderson took possession of the cave and incorporated a company for its further exploitation (Watson, 1909). Their work attracted the attention of one "Captain" A. J. Smith, who secured a bond from Nickerson and his partners, employed surveyors to lay out roads and trails, hired men to explore and develop the cavern further, bought provisions and supplies, erected cabins, and put gates at the entrances. Much work was accomplished within the cave during succeeding months, especially by John H. Kincaid and Frank M. Nickerson. At the same time, the liabilities assumed by the "Captain" grew to an amount of several thousand dollars—whereupon he one day suddenly and permanently disappeared. Kincaid and Nickerson continued to be associated with the cave for many years, acting as guides.

In April, 1903, a large area in this part of Oregon and California—including the cave—was withdrawn from the entry as the Siskiyou National Forest.

In August, 1907, two years before the establishment of Oregon Caves National Monument, the cave was visited by a party that including Joaquin Miller, the Poet of the Sierra: C. B. Watson, author of *Prehistoric Siskiyou Island;* and the Honorable Jefferson Myers of Portland. Their guides were John Kincaid and Frank Nickerson. These visitors were deeply impressed, and Miller did much to attract public attention to the area by his reference to the cave as "The Marble Halls of Oregon."

President William H. Taft, on July 12, 1909, proclaimed the Oregon Caves, including a tract of approximately 480 acres, as a National Monument, stating that "the public interests will be promoted by preserving these caves . . ." Because there was no National Park Service at the time, the monument was administered by the United States Forest Service. In 1933, it was turned over to the National Park Service, and administration was delegated to the Superintendent of Crater Lake National Park.

"Old Dick" Rowley was a close personal friend of discoverer Davidson, having lived as a neighbor to him in the Williams Valley for years. He made his first trip through the cave in 1908 with Davidson. He was intensely interested and made several trips later by himself. The place could still be reached only by trail at that time.

In 1910, Dick accepted the job as ranger-in-charge for the Forest Service, acting as fire guard, forest ranger, and guide until 1923. During this period, he did all the development in the cave. With the formation of the present concession company in 1923, Dick

was retained as chief guide until his retirement in 1954. Until a few years before his death on March 8, 1964, at the age of 94, he continued to help orient new guides at the beginning of each season.

In 1923, the Forest Service granted a concession to the Oregon Caves Company, which built the old Chalet and took over the guide service that same year. In 1934, the Chateau was opened to the public.

In the years following 1934, the National Park Service made a number of physical improvements in the facilities within the monument. Oregon Caves National Monument is one of about 300 National Parks, Monuments, and areas comprising a system that originally was unique in the annals of civilization—wherein a national government sets aside priceless parts of its national heritage to be conserved for all the people for all time.

Our National Park System, the world's first, got its start in 1872 when a group of Americans voluntarily relinquished their legal and moral rights to profit through private ownership of what is now Yellowstone National Park. They decided to work for the preservation of the area as a park for all the people.

The law requires that National Parks and Monuments be administered to provide for public enjoyment "in such manner and by such means as will leave them unimpared for the enjoyment of future generations." They are, thus, great outdoor museums, and this is why it is against the law to molest wildlife, plant life, cave formations, and similar natural features that they contain.

It is the responsibility of the Secretary of the Interior, the Director of the National Park Service, and the administrative officers of the various areas to preserve, develop, and regulate the use of these areas. The Park Superintendent is the General Superintendent's representative at Oregon Caves National Monument and, as such, is in immediate charge of this area.

With as many as 200,000 visitors a year coming to the monument, certain services and accomodations are needed for public convenience. The Oregon Caves Co. operates under a contract with the Secretary of the Interior to serve the needs of these people. This company provides a hotel (Chateau, cabins, souvenir and refreshment store (Chalet), food, and nursery service (for children under 6, who are not permitted in the cave).

In addition, the company is authorized to provide competent guides for conducting visitors through the cavern. In this respect,

the contract is unique: this National Park concession being the only private organization which is authorized to provide cavern guide service within the National Park System. This service is performed by uniformed personnel of the National Park Service in other National Parks and Monuments having caves open to the public. The information and guide service performed by National Park Service employees is internationally known for its excellence and the high quality of the information given out.

It is apparent, then, that you, as guides at Oregon Caves, have a high standard to measure up to. You work in one of the units of a system which has set a pattern for nature protection and interpretation eventually followed by other countries throughout the world. It is imperative that dignity be maintained and that accurate information be given out. If you grasp the true significance of the National Park idea, your work will mean far more to you than merely being a job. You will be proud to share in the responsibility of assisting the public to appreciate the natural values in Oregon Caves and, consequently, to contribute to the preservation of the monument so as to leave it unimpaired for others to enjoy.

III. GEOLOGIC STORY IN BRIEF

The Mountains

In the heart of the Siskiyou Mountains we find the Oregon Caves (entrance 4,000 ft.). The Siskiyous lie between the Rogue and Klamath Rivers and extend west of the Cascades to the Pacific; they are part of the Klamath Mountain System.

Over a period of time, possibly 200 million years ago, or in the Triassic Period, a shallow arm of the sea covered this area, where there were accumulated masses of volcanic rock. Within the sea were small marine animals that extracted calcium carbonate from the water to form their shells. When these animals died, their shells drifted to the bottom and accumulated there, forming a layer of calcium carbonate. Rivers then poured a layer of sediments in on top of this shell layer, the pressure from which compressed the shells into limestone.

Later came a period of mountain making, involving folding and uplifting of the rocks due to stresses in the earth's crust and other forces. As a result of these processes, the limestone was changed by intense pressure and heat into marble. An example is the narrow, tilted belt running through Mt. Elijah.

Soon after being formed, the marble was profoundly fractured, and it is quite likely that this fracturing continued until a later period. Some of the more prominent fractures revealed in Oregon Caves are vertical, but in addition,there are many minor cross fractures of varying angles. Next, for a long period, the mountains were slowly worn away by erosion until this was an area of low relief, near sea level.

Then followed a period of uplifting, in various stages, giving us the Siskiyous of today. Indications are that this was mainly accomplished before the Ice Age, during which glaciers were formed locally in the higher mountains.

The Cave

The study of caves has been given the name *speleology*, and those who make such studies are known as speleologists. In recent years, devotees of cave exploration as a hobby have called themselves "spelunkers."

Caves are in general classified according to the rock in which they developed. They may be formed in limestone, sandstone, or igneous rocks, such as volcanics. Of these, limestone caves are the most important and most frequently attain great size.

In order to have a large cave or cavern it is necessary that there be a mass of limestone or other soluble rock to contain it and underground water to fashion it. Limestones are more extensive and widely distributed than other water soluble rocks and, in consequence, most caves are found in limestone regions. Gypsum and rock salt are extremely soluble materials and they, too, cover large areas but they seldom possess the inherent strength necessary to support a large underground solution system. Caves can also be formed in less soluble rocks through processes other than ground water solution; for example, by the continued flowing of molten rock from within the periphery of lava tubes with already solidified exteriors. The vast and spectacular caves, however, do have an underground origin and are the products of subsurface water sculpturing.

Oregon Caves represent a type found in limestone formations throughout the world, but is of special interest in that it has been formed in tilted strata of marble (a recrystallized limestone). There can be little question that the cavities were produced by the action of underground water dissolving the marble and carrying it away.

This solution was initiated along cracks and joints until pockets were finally formed and these in turn enlarged to what are now galleries or rooms. It would seem that the cavern at some time was completely filled with water and the level of this water would have varied with that of the adjacent surface streams. As the streams deepened their valleys, this level would have been lowered, through drainage. As the water level dropped, the galleries above were emptied.

These galleries appear to have been only slightly altered by streams flowing through them afterward. What streamwork does appear has not greatly modified the spongelike cave pattern produced by the earlier solution. Further, this general pattern of several-storied, honeycomb chambers does not conform to the branchwork that might be produced by free-running subterranean streams. Some of the points mentioned here will be referred to under "Progressive Cave Trip Comments" (Section VI).

Areas containing subsurface water can be conveniently divided into two distinct zones. The upper zone, called the zone of aeration or *vadose* zone, is characterized by rocks that are cracked or porous, the openings being filled with air most of the time. Water within this zone moves from the surface to a deeper zone of saturation by gravitational pull. The lower or *phreatic* zone also contains porous and fissured rock but, in this case, the

openings are filled with water. Ground water within the saturated zone may circulate because of gravity or as a result of hydrostatic pressures. This may be a very slow circulation, but, normally, the movement is intensified near the water table, the fluctuating and irregular horizon or division between the vadose and phreatic zones.

Recognition of this division of ground water into separate zones is important in explaining cave formation for most caves have experienced a two-phase or two-stage method of development, one phase taking place in each zone. The first phase is that of excavation, performed by ground water solution when the rocks which enclose the cave lie beneath the water table of the area. This is a deep-seated, phreatic dissolving in the zone of water saturation and is most effective, for the process of solution proceeds on all exposed surfaces. The first stage is followed by the depositional replenishment of the cave. This second stage is brought about when the water table is lowered, usually as a result of regional uplift. With the lowering of the water table, air enters the once water-filled chambers and, instead of further solution, flow of water from the surface to the water table may bring mineral matter to the rooms and galleries where it is deposited as flowstone and dripstone. During the first or phreatic stage, the cavern system is hollowed out; during the second or vadose stage, the cave is at least partially refilled or destroyed.

Marble is said to be 93% calcium carbonate ($CaCO_3$), which is but slightly soluble in plain water. However, if water picks up carbon dioxide, the carbonic acid solution thus produced makes the calcium carbonate many times easier to dissolve through a change to calcium bicarbonate. Rain water, as it percolates down through the soil, becomes charged with carbonic and other acids, derived from decaying vegetation and other sources. It finds its way along small fracture planes in the marble, altering the calcium carbonate to calcium bicarbonate and dissolving it out.

The carbonate thus removed from one place is redeposited wherever the water is subjected to evaporation or agitation. This occured in the various cavities as the underground water in them was drained away and they became air filled. Particularly, where the water dripped slowly from the ceiling of a cavern, each drop, as it clung to the rock, lost some of its CO_2 to the air, and the calcite which it carried was left as a deposit on the rock. Each successive drop added its increment to the previous one, and gradually an icicle-like *stalactite* was formed.

Where the drops of water fell to the floor and there evaporated, a pillar known as a *stalagmite* was made. In some places a stalactite and stalagmite eventually joined, forming a *column* that extends from floor to ceiling.

By alteration of the volume and path of the water, drapery-like blades and fluting were produced. On the sides, where water ran down the walls, are layered deposits, sometimes known as *travertine* or flowstone. There are many forms taken by these deposits in Oregon Caves. The process of deposition is still going on at varying rates, so that we can ascribe no time for deposition that will apply equally to all the formations.

The rate of growth of cavern deposits is subject to many variable factors, including the amount of seepage water, the availability of carbon dioxide in that water, the quality of carbonates in solution, and the rate of evaporation and degree of agitation. The often expressed thought of a cubic inch per century as the average rate of growth of cavern formations is not tenable. Measurements of still active structures show that those formed under a very slow seepage of water do so at a much faster pace; however, changes in rate of growth occur almost daily, so present rate of growth cannot be used in estimating the age of any given formation.

It should be borne in mind that marble is merely recrystallized (metamorphosed) limestone and that both marble and limestone, together with the above cave deposits, are composed primarily of a mineral known as *calcite*, which has the chemical composition, $CaCO_3$. It is also found in caves as free calcite *crystals*. However, since there are differences between all these, it is inaccurate to say that they are all the same and use the terms interchangeably. The term "lime" is best abandoned in the cave story for, while it is thus used freely by mining men, in the minds of visitors "lime" means the commercial products known by that name, which have different chemical compositions and different properties.

This geologic account should have indicated that a great many variable factors enter into the making of caves in limestone,and, therefore, specific comparisons cannot always be made between caves. This should be a guide in answering questions from visitors such as "In Blank Cave they told us the stalactites grew one cubic inch a century.Why don't these all grow at the same rate?" Or, "Why aren't Oregon Caves as large as Blank Caverns?" In reply to this second question, the limestone in Blank Caverns is perhaps more easily dissolved and/or may have been

subjected longer to solution; or it may not be severely tilted and metamorphosed; or perhaps it has a more well defined system of joints which would make it easier for the solution formation of chambers.

The *general* processes of development of solution caves, however, are becoming better understood and made more widely applicable as more and more caves are studied critically by geologists. That is why we can infer certain things about the history of Oregon Caves, because of certain recognizable signs that match those found in other caves where the story is more completely told in the rocks. The chief general principle to remember is that solution comes early in the history of a cave, while the deposits (speleothems) or "formations" come later. This may be a continuous process: while the upper ("older") chambers are receiving deposits, the process of solution is still going on at a lower level.

IV. YOU AS A GUIDE

Manners and Appearance

During your service at Oregon Caves, you will guide many hundreds of visitors. The degree to which they enjoy their tour rests directly upon your total performance. This begins with neat appearance and good manners. Obviously, you must shave daily, wear clean clothing, and keep your hair cut regularly. Sloppy appearance, uncombed hair, shirt-tails sticking out under your jacket, etc., cannot be tolerated.

Courteous, friendly manners and a sincere regard for the needs of your party do more than comfort the visitors. They help you, as a guide, maintain the respect of your audience and thus keep the party organized and attentive, resulting in an informative and enjoyable tour. There is no place inside the cave for horseplay or impertinence.

Many people visiting a cave for the first time anticipate mystery and adventure. This attitude might tempt you to exaggerate or tell "tall tales." Such exploitation of the visitors' attitude is still a practice in many privately owned caves, but is definitely not permitted by the National Park Service. The real story of Oregon Caves is impressive enough if you do a good job of guiding.

The Mission

Basically, your mission is two-fold: The first part is to help the visitors *see* the cave in safety and comfort. Secondly, you must help them understand what they see, through careful explanations.

Your duties in respect to the first objective will follow a rather set routine. All regular public tours (i.e., trips for paying visitors) will last at least one hour and fifteen minutes, and not longer than one hour and thirty minutes, from the time of starting the group at the cave entrance to the time of return to the *foot* of the return trail; the average tour will last one hour and twenty minutes. Allowing 15 minutes for the return trail, this will permit the tours to spend between one hour and one and one-quarter hours within the cave.

Without fail, you must warn every person of all the "low bridges" (asking them to pass the warning on down the line), projecting rocks and steep stairways. At the 110' exit you must always give the visitor a gracious opportunity to leave the cave, and at Paradise Lost to forego the climb *without embarrasment*.

Another important consideration often abused is your walking speed. It is easy for a guide, in his enthusiasm, to rush his party from one feature to another, causing some to get out of breath, stumble, or bump their heads in an unconscious effort to keep up. Remember you are young, strong and familiar with the cave. They are not. Watch each member of the party for signs of being rushed. Failure to do this could aggravate heart trouble, strokes and other medical problems among older persons.

The second part of your mission—explaining the features—is an even greater challenge, in many respects. Obviously, the first requirement is to learn as much as possible about the cave, and to *keep learning* as you guide. Carry a note pad so you can jot down questions as they arise, then ask a ranger about them later. Be prepared for the alert visitor who wants to know more about the cave. At the same time, be willing to say "I don't know," if that is the case. You are not expected to become a geologist in a few weeks. To mislead your audience, lie or bluff is a betrayal of trust.

Stay out of the Guiding Rut!

Once you have acquired the basic knowledge of the cave story, you are ready to concentrate on the hardest part of guiding. This is the development of a friendly, flexible approach to each party, sizing-up their level of interests through conversation, and adjusting your "talk" in a way that will make the trip most understandable to them. In this way you talk *with* them rather than *at* them. To some guides this ability comes naturally. Others fall into a rut of giving the same "canned," memorized spiel to all parties. They lose contact with the party as they stare at the floor and talk as if they are reading a book. Half the party may be confused, the other half will be yawning in boredom. Worst of all, the guide himself begins to dislike his task. When that happens he should stop guiding.

Your party has paid to be shown the cave and learn something about it. Not all of them are well educated, but they can all understand how it was formed if you explain it clearly, in terms they are familiar with. Their questions and reactions will tell you how well you are doing.

There is one tool that will do more for you and your party than anything else. This is simply an occasional question, asked not by them, but by you. An example is "Why do you think the green plants grow only near the lights?" Be careful not to embarrass them when an incorrect answer is offered; compliment their

reasoning and carefully steer them toward the proper answer. This invites group participation and injects variety into each tour you lead. It will keep you on your toes as a guide and assure the party of a stimulating tour. Caution: it consumes more time. Use it with judgment.

A touch of humor along the way is equally valuable, if not overdone. Remember not to confuse it with factual information.

Emergencies

Your primary objective in respect to emergencies is to prevent them from occurring whenever possible. Always keep good batteries in your flashlight. Caution your party whenever appropriate about low ceilings and other hazards.

Know what to do if and when emergencies do occur. If the power fails, keep your party in place until help arrives with adequate light or until the power is restored. Know the details of the cave emergency plan.

Other problems

In spite of your efforts to keep your party in a dignified mood, you may someday encounter unruly individuals who deliberately cause trouble in one form or another. Politely warn them that they can be fined for disorderly conduct, disturbing natural features, etc. If a problem is anticipated, proceed to a telephone and request the Supt., a ranger, or a naturalist. Any damage to the cave formations should also be reported immediately.

Of less serious nature, visitors who have previously toured the cave may say, "that's a different story than they told last time." It is futile and impolite to question their memory, or cast reflections on earlier guides. Simply explain that the information you are required to give is sometimes changed from year to year to keep abreast of the latest information we have available. If they remember certain items no longer included in the tour (such as Petrified Forest or Dante's Inferno), simply explain that alterations have been made in the tour to avoid congestion from increasing numbers of visitors.

If a visitor is dissatisfied with any part of the tour, or anything else encountered in the National Monument, encourage him to contact the Supt.

GENERAL RULES & REGULATIONS

The monument is a natural area of the National Park System — Every natural thing—flower, trees, rocks, wildlife—is to be left undisturbed for others to enjoy. Squirrels, chipmunks or other wildlife are not to be fed or molested.

No one is permitted in the cave unless accompanied by an authorized guide.

The cave tour is not recommended for anyone with heart, breathing or climbing difficulty. You will walk through ½ mile of passageways, climbing a vertical distance of 240 feet. Some of the passageways are low and narrow. There are several steep steel and stone stairways to negotiate, consisting of 195 stair steps down and 345 steps up, as well as 470 foot exit tunnel at a 16% grade. The average time for the cave tour is one hour. The exit trail is 3/10th of a mile long, steep in places. BE CAREFUL!

Pets are not permitted in the cave, on trails or within buildings and must be kept attended and on a leash while outside the car.

Children under six years old are not allowed in the cave due to the steep ladders and strenuous climbing — it is not possible to carry a child through the cave.

Canes, tripods, or other staffs are not permitted in the cave as formations may be damaged with the use of these articles.

Smoking, food and beverage items are prohibited in the cave. Persons under the influence of alcohol are not allowed on the tour.

Bicycles, vehicles, motor bikes, and horses are prohibited on all trails within the monument.

Firearms and fireworks are prohibited within the monument.

All accidents and injuries must be reported to a Park Ranger as soon as possible.

V. OUTLINE OF CAVE TOUR
MANDATORY FACTS

To be included in *ALL* cave tour presentations. Information may be related at any *appropriate* location.

I. CAVE ENTRANCE

A. Welcome to visitors
1. State your name.
2. Explain your position as a guide working for the Oregon Caves Co., a concession under contract with the National Park Service.

B. Monument Administration
1. Oregon Caves National Monument was established on July 12, 1909, by President William Howard Taft.
2. It is administered by the U.S. Dept. of the Interior, National Park Service.
3. It is just one of about 300 such areas preserved for public enjoyment.

C. Regulations and Safety Precautions
1. The cave tour is strenuous and is not recommended for people with heart, breathing or climbing difficulties.
2. There are many low ceilings throughout the tour. Warn the visitors of these by stating "Low Bridge" and have the visitors pass this warning back to others.
3. Tell the visitors to stay with the group and to remain on the paved trail at all times.
4. Inform the visitors that picture taking is permitted and that refuse containers are provided.
5. Regulations prohibit the touching of cave formations as they are fragile and are susceptible to black staining from skin oils.
6. Smoking, food, and beverages are prohibited.
7. The tour will last between 1 and 1¼ hours.

D. History
1. The cave was discovered in 1874 by Elijah Davidson while on a hunting trip. His dog led him to the mouth of the cave while trailing a bear.
2. Hearing sounds of fighting from within, Davidson entered the cave using sulfur matches to light his way.

3. Elijah Davidson was the first human known to enter the cave. There is no evidence that Indians were here before him.
4. Give the completion of history at the River Styx.

II. WATSON'S GROTTO

A. Chandler B. Watson
1. The room is named for Chandler B. Watson, an early geologist and attorney.
2. He visited the cave in 1907 and subsequently did much of the legal work necessary to promote the establishment of the cave as a National Monument in 1909.

B. Formation of the marble layer
1. 200 million years ago (Triassic Period) this area of the Siskiyou Mountains was at the bottom of a shallow sea.
2. Small marine animals extracted calcium carbonate ($CaCO_3$) from the sea to form their shells. When they died the shells drifted to the bottom and accumulated there forming a layer of calcium carbonate.
3. Through the years rivers deposited sand, silt, and other sediments on top of this layer of shells. The weight of these sedimentary deposits exerted tremendous pressure on the layer of shells, compressing it into limestone.
4. 70 million years ago there was a period of mountain building and uplifting which produced much heat and pressure due to stresses in the Earth's crust. This intense heat and pressure altered the crystalline structure of the limestone changing it to marble (metamorphosis).

C. Fracturing and raising of the marble layer
1. During these disturbances in the Earth's crust, cracks formed in the marble layer.
2. Point out that the tour entered the cave through one of these diagonal cracks.
3. Point out other vertical and horizontal fractures in this room.

D. Dissolution process
1. At this point, the marble layer was located below the water table. The water table is the top of the saturated zone below the Earth's surface. (The zone of saturation is called the Phreatic Zone).
2. Precipitation falling through the air and flowing

through decaying vegetable matter in the ground picks up CO_2 forming a weak solution of carbonic acid, similar to the carbonated water in soda pop. Assure the visitors that this solution is harmless.

3. As the acid charged water seeped into the cracks in the marble, it began to dissolve the walls of the cracks and widen them into passageways and chambers. Point out the widening of the large vertical crack.
4. Note that the cave is *not* formed as a result of stream action or erosion, but as a result of the dissolution of marble by the standing or slow moving water below the water table. The rough, rather than smooth, walls in this room indicate this clearly.

E. Cave drainage
1. As the erosion of the sedimentary layer above the marble progressed, and the canyon outside was cut down below the level of the entrance, water began draining from the cave and the level of the water table dropped.
2. The River Styx is the present level of the water table. Possibly additional rooms are forming below it now.

F. Tickets
1. Before tearing and collecting tickets, give the visitors the opportunity to leave the tour with a full refund.
2. Have the visitors tear their tickets and then collect the shorter ticket stub from each.

III. PETRIFIED GARDENS

A. Room aeration
1. After the dropping of the water table, the rooms drained and filled with air.
2. This then is the second stage of cave development and occurs above the water table (in the Vadose Zone).

B. Calcite deposition
1. Even though the rooms drained and filled with air, the acid charged water continued to seep through the ground and into the cracks in the marble.
2. The water seeping through the cracks dissolves the marble and carries it in solution (as calcium bicarbonate solution).
3. Upon reaching an air-filled room it releases

CO_2 to the atmosphere and simultaneously becomes unstable and deposits its marble content in the form of calcite.

4. Thus the process beginning with shells, compressed into limestone, metamorphosed into marble, and finally dissolved and redeposited as calcite, did not alter the chemical formula, calcium carbonate ($CaCO_3$), but changed only the crystalline structure (or molecular arrangements) of the compound.

C. Cave decoration
   1. Gradually the calcite deposited, as described above, builds up into various shapes or forms that are collectively termed formations or speleothems.
   2. Dripstone — a calcite deposit left by dripping water.
      a. Stalactite — Dripstone formed by drops of water oozing from the cave ceiling, hanging for a moment, and depositing some of their calcite before falling to the floor and being replaced by other drops.
         1. Soda straw stalactite — Calcite is deposited as a single ring crystal around the circumference of each drop until a hollow tube is gradually formed (approximate diameter = ¼ inch).
         2. Carrot stalactite — When a soda straw tube plugs up with calcite , the excess water flows on the outside of the tube and deposits its calcite forming a carrot shape.
      b. Stalagmite — Dripstone formed by the drops falling to the cave floor, splashing, and depositing their calcite.
      c. Column — The joining of a stalactite with a stalagmite.
   3. Flowstone—smooth sheet-like calcite deposits left along walls and floors by flowing water.
      a. Flowstone drapery — Thin blades of flowstone formed on backsloping walls or under ledges by trickles of water.

IV. TREE ROOT
   A. Point out the roots of a Douglas Fir Tree growing on the surface 40 feet above the cave passageway.
   B. The roots followed clay-filled crevices in the marble

in search of water.

C. The roots extend 25 feet along the passageway.

V. RIVER STYX

A. Nomenclature
   1. Named River Styx after the river in Greek Mythology which separated the underworld (Hades) from the world of people above.
   2. Outside the cave it is called Cave Creek.

B. Life
   1. The stream contains only microscopic life which is intoduced into the water as it flows over walls containing algae, moss, bacteria, and mold.
   2. Other larger life forms are inhibited by the lack of nutritional materials for a food cycle.

C. Completion of history
   1. In search of his dog, Davidson reached this point on the River Styx, ran out of matches, and found himself in total darkness.
   2. Remembering the stream at the cave entrance, Davidson crawled down into the River and followed the direction of the current back to the entrance (water temperature 41 degrees).
   3. His dog also emerged later unharmed, and the bear was shot the next day.

D. Total darkness
   1. Eyes can never adjust to the complete absence of light.
   2. This is the natural condition of cave away from the openings.
   3. Green plants (algae, moss, ferns) require the energy of the artificial lights in order to perform photosynthesis. Therefore, these green plants appeared only after 1932 when the lights were first installed. The spores are carried into the cave by air currents, seeping water, animals, or on people's clothing.

VI. PASSAGEWAY OF THE WHALE

A. This passageway was originally no larger than the crack in the ceiling.

B. Acid-charged water seeped through the crack and gradually dissolved the walls of the crack into the present passageway.

C. It is called the Passageway of the Whale due to the resemblance of the ceiling to a backbone, and the side walls to ribs.

D. The smooth walls of the passageway suggest that the River Styx may have flowed through it at one time.
E. Water table horizons — Ledges in walls formed as a result of the water table remaining stable for an extended period. The actual dissolving of the ledges is a direct consequence of a greater concentration of carbonic acid (thus a greater dissolving action) at the surface of the water (as in soda pop).

VII. MAN-MADE TUNNEL
A. Built in 1937 by the C. C. C. to avoid 80 feet of backtracking and ladder climbing. (Before construction of tunnel, tour groups were forced to backtrack all the way to Watson's Grotto.)
B. The echoes in the tunnel are a result of bare marble walls. Natural cave walls are covered by a layer of calcite, which has a pitted surface that absorbs sound waves like acoustical tile. Bare blasted walls reflect the sound waves causing an echo effect as the waves bounce around the tunnel.
C. Slate lenses — During cave formation, intermittent layers of sedimentary materials were laid down within the large layer of shells. As the shells were compressed into limestone, the sediments were compressed into shale. During the metamorphosis that changed the limestone into marble, the shale layers were converted into bands of slate or slate lenses.

VIII. DRY ROOM
A. This room is located 50 feet above the entrance and 18 feet above the passageway to Adam's Tomb.
B. Breathing difficulty at this stop is due to the following:
    1. The air is thinner (contains less oxygen) at higher altitudes than at lower elevations (altitude at Dry Room is 4050').
    2. The air is thinner in the cave than it is outside. This is a consequence of the higher concentration of carbon dioxide in the cave as a result of the deposition of calcite formations.
    3. The physical exertion of climbing 50 feet above the entrance.
C. Natural bridge
    1. This natural bridge occured when undissolved rock was left arching over the passageway below.
    2. Several exist in the cave.

D. Dry ceiling
   1. Dry ceilings are due to the cracks in the ceilings being filled in with sedimentary material.
   2. Sedimentary material is insoluble in carbonic acid, thus preventing the cave decoration process.

IX. IMAGINATION ROOM
   A. Decorative imagery — point out the:
      1. Old Man in the Mountain
      2. U. S. Map
      3. Cave camel (3 humps)
      4. Coke bottle
      5. Inside-out gopher hole
   B. Point out the water table horizons.
   C. Safety — advise visitors to:
      1. Use handrails on all staircases.
      2. Avoid the overhanging rock on the right.
      3. Turn sideways to proceed through the narrow SQUEEZE.
   D. BEEHIVE ROOM
      1. Describe and locate this room before ascending the staircase.
      2. Point out the pendant formation resembling a beehive.
      3. Many of the formations in this room are covered with soft white Moonmilk — a rare semi-liquid form of calcite.
   E. Old passageway
      1. This was the passageway used before 1937 when the tunnel was blasted (from Watson's Grotto).

X. 110' EXIT
   A. This opening is located 110 feet above the entrance.
   B. It is the only other natural opening to the cave (exit is made through a man-made exit tunnel).
   C. Due to the narrow crawlways in the lower portion of the cave, this opening was used as the entrance for women in the early days.
   D. This point is ⅓ of the way through the tour.
   E. Advise the visitors that they may leave the tour at this point.
      1. The most strenuous portion of the tour lies ahead.
      2. Tactfully encourage visitors having difficulties to leave the tour at this point.
      3. Do not embarrass those wishing to leave.
      4. There is only a short walk back to Registration.
      5. Phone Registration here.

F. Helictites
   1. Helictites are formations growing contrary to gravitational force because of one or more of the following:
      a. Air currents
      b. Water currents
   2. This rough bumpy material on the walls is referred to as Popcorn, Coral, or Grapes.

G. Cave breakdown and jagged angular projections
   1. Intersecting vertical fractures were formed during the Earth's movement.
   2. In the area of the fractures, carbonic acid dissolved away the ceiling support, allowing the ceiling to fall. This process is known as Cave Breakdown.
   3. The unfractured and uncollapsed area remains here as the projections (on the left).

XI. BANANA GROVE
   A. Mention the Flowstone drapery formations resembling bananas.
   B. The green discoloration is due to the growth of algae.

XII POTATO PATCH
   A. Point out the stalagmites resembling potatoes.
   B. The "eyes" are formed when the rate of water flow (or rate of dissolution) exceeds the rate of deposition. Instead of calcite being deposited and adding to the stalagmite, the formation is gradually dissolved away.
   C. An active example of eyes in the process of forming will be shown in the Ghost Room.

XIII. NIAGARA FALLS
   A. This large cascading flowstone formation is named Niagara Falls.
   B. Vanadalism
      1. Point out the many signatures of early cave visitors. The earliest is 1878.
      2. Show the numerous broken stalactites and columns.
         (Note: the growth that rounded off the broken edges took place in approx. 100 years)
      3. Most of the cave vandalism occurred before 1909 when Oregon Caves was preserved as a National Monument.

XIV. KING AND QUEEN'S THRONE ROOM

A. Named for the "king and queen" stalagmites in the middle of the room.

B. Describe this room at Niagara Falls and have the visitors look on their way by (No Stop Necessary).

XV. NEPTUNE'S GROTTO

A. It is named Neptune's Grotto because of its resemblance to an undersea cavern.

B. This room is an example of a Domepit or Chimney and is formed as follows:

1. Formed late in the life of the cave, after the dropping of the water table and the draining of the cave.
2. During a period of heavy water flow, water descended through a vertical fracture and widened it by dissolution into this dome-shaped room.
3. When the water flow decreased, the process changed from dissolution to deposition forming the flowstone drapery on the walls.

C. Spiral staircase

1. Give the visitors adequate safety precautions for the spiral staircase and for the continuing straight section of stairs.
2. Wait at the bottom of the staircase until all the visitors have descended safely.

XVI. GRAND COLUMN

A. It is the largest column (by mass) in the cave — 7 feet tall and 1 foot through at the narrowest point.

B. The dark staining is caused by the skin oil of people touching it and by the smoke of the pitch torches of the early visitors.

XVII. WIND TUNNEL

A. The cave temperature varies only 7 degress all year (38-45 degrees F). This is due to the great thickness of the cave walls (hundreds of feet) which acts as insulation against temperature variation.

B. The wind is caused by the thermal difference between the inside and outside of the cave.

1. Summer — face wind — colder and denser cave air falls and flows out the entrance.
2. Winter — back wind — warmer cave air rises and flows out the exit 240 feet above the entrance.
3. No wind exists only when the inside and outside temperatures are the same.

XVIII. WISHING POST

A. Inform the visitors that they are permitted to touch this formation.

B. The top of the formation looks polished from the thousands of people touching it and making wishes.

XIX. JOAQUIN MILLER'S CHAPEL

A. This room is named after Joaquin Miller, the Poet of the Sierras, who visited the cave in 1907, referred to the cave as the "Marble Halls of Oregon" and helped to bring public attention to the cave.

B. Formations — point out the following:

1. The tallest column in the cave (8 feet tall).
2. The stalactite and stalagmite in the process of joining in a column.
3. Washington Monument — the largest stalagmite in the cave.

XX. RIMSTONE ROOM

A. Two theories of rimstone formation

1. Water flowing down gently sloping ledges (Rimstone Room).
   a. Calcite is deposited as the water is agitated while it flows over the natural ridges in the ledge.
   b. Calcite dams are gradually built up at the ridges.

2. Water dripping into standing pools of water (Paradise Lost).
   a. Water dripping into a pool causes ripples to move across the pool.
   b. Calcite is deposited at the meeting of the ripples in response to agitation.
   c. Again calcite dams are gradually built up as the calcite falls to the bottom of the pool.

B. Nomenclature

1. Right — Atlantic Ocean
2. Left — Pacific Ocean

C. At the light leaving the Rimstone Room, point out the translucent (not transparent) characteristic of calcite crystals.

XXI. GHOST ROOM TERRACE

A. Ghost Room size
   1. This is the largest known room in the cave.
   2. It is 250 feet long x 50 feet wide x 40 feet tall.
   3. Formation of a large room
      a. Large rooms are formed by basically the same process as the other cave chambers.
      b. More intersecting cracks in this area created more surface area upon which the carbonic acid could work.
      c. As the marble was dissolved underneath, it left the fractured rock above unsupported and allowed it to fall to the floor — *Cave Breakdown.*

      (Point out examples of large breakdown here.)

B. Clastic Dike
   1. Sedimentary material was deposited in a large crack in the marble.
   2. Sediments were compacted into rock.
   3. As sedimentary rock is insoluble in carbonic acid, the dike remained and jutted out into the room after the surrounding marble was dissolved away.
   4. Possibly it hung as a curtain at one time, and was broken off by Earth disturbances. (Point out the jagged edge as evidence of breaking and not dissolving.)

C. Clay Worms
   1. These formations are composed of clay particles grouped into small, winding ridges.
   2. Clay was brought in through the cracks by seepage from the outside as a very fine material in colloidal suspension (a solid suspended in a liquid — not a mixture).

D. Soda Straws
   1. The longest soda straw in this cave is about 12 inches in length.
   2. The longest soda straw known is in a cave in Australia and is 20 feet, 6 inches in length and is no larger in diameter than these (¼").

E. Carrot stalactites

F. Spitting Stone
   1. This is an active example of the dissolution rate exceeding the deposition rate as in the formation of the "eyes" in the Potato Patch.

XXII. PARADISE LOST

A. Base of staircase
   1. Inform the visitors that you will climb 45 stairs up to Paradise Lost and that you will return to the bottom of the ladder in approx. 5 minutes.
   2. Give the visitors the option of waiting for the party at the bottom of the staircase. Some of the formations may be viewed from the bottom.

B. Paradise Lost
   1. This room is considered by many to be the most beautiful room in the cave.
   2. This is a second example of a Domepit or Chimney.
   3. Point out the active rimstone pool.
   4. Demonstrate the colored lights to accent the flowstone drapery formations and their shadows.

XXIII. GHOST ROOM FLOOR

A. The room is named the Ghost Room because of the Ghost-like shadows cast on the walls by the torches of the early visitors.

B. Tributary of the River Styx
   1. This tributary collects water from a series of domepits in the South end of the cave.
   2. It flows into the River Styx which flows back to the cave entrance.

C. Location
   1. The ascent out of the cave begins at this point.
      a. 217 feet below the surface
      b. 1350 feet into the cave
   2. Point out the direction South, and point out that the entrance is located due North (through the Terrace).

XXIV. SPOTLIGHT — EXIT GHOST ROOM

A. Baconstrip drapery
   1. These are Flowstone drapery formations.
   2. The brown strip is the impurity, iron oxide (rust), that was brought in with the water flow and deposited along with the calcite of the drapery, now resembling bacon.

B. Angel Falls
   1. This is a delicate flowstone drapery formation.
   2. Pure white is the natural color of calcite without any impurities. Most of the calcite in this cave is light brown in color due to impurities (mud and clay particles).

C. Bird of Paradise
   1. Water dripping from the soda straw "worm" fell on the small ledge and built up a stalagmite.
   2. Water running over the ledge from the stalagmite built a stalactite beneath the ledge.
   3. Thus we have the reverse of the usual situation and have a stalactite under a stalagmite.

XXV. WEDDING CAKE ROOM

A. The room is named after the white flowstone formation resembling a wedding cake.
B. (Optional story of the wedding)
   Point out the old passageway back to the Ghost Room.

XXVI. LAST NATURAL ROOM

A. This is the last natural room in the cave system that is included on the tour route.
B. Before 1933, tour groups went back to the 110 Exit to complete the tour.
C. The man-made exit tunnel was built in 1931-1933 to allow a one-way tour of the cave.
   1. It is 470 feet long.
   2. It climbs at a 16% grade (climbs 1 foot UP for each 6 feet in LENGTH).

XXVII. LARGE CLAY POCKET

A. This is the largest of 3 rooms encountered during the construction of the exit tunnel.
   1. Water seeped down through the cracks in the marble and dissolved out these rooms in the usual fashion.
   2. Later the water carried in clay particles which were deposited in the rooms until they were practically filled with clay.
B. History
   1. At first the contractor shored up the clay in the tunnel with redwood timbers.
   2. When this proved unsafe, he began the task of extracting the clay from the rooms.
   3. Because of the tremendous amount of clay in the rooms, the contractor went bankrupt while removing it.
   4. The excavation had to be completed by laborers paid by the hour.

XXVIII. APPROACHING EXIT

A. These white stalactites have grown only since 1933 when the exit tunnel was constructed.
B. Their growth was unnaturally rapid due to the swift passage of dry air through the tunnel, which increased the evaporation rate of the water as compared to deep within the cave.
C. However this can be used as a very *rough* index of cave formation growth rate (these formations have been growing for over 40 years and are only ½" in size).
D. The covering on the gate was installed in an attempt to recreate the natural condition of the cave (decrease the air flow).

XXIX. CONCLUSION

A. The exit is 240 feet above the entrance, and looks West toward Cave Junction.
B. 2 alternatives exist for the return to Registration.
   1. Cliff Nature Trail — 1 mile winding over the cave. Not recommended for parents with children in Child Care.
   2. Cave Exit Trail — 3/10 mile directly back to Registration.
C. Smoking is permitted in the exit area, but NOT ON TRAILS.

XXX. INFORMATION ON CAVE ANIMAL LIFE

I. Harvester spider ("daddy long legs")
II. Rodents
   A. Pack Rats
   B. Mice
III. Bats
   A. Use the cave as a roosting place and as a place to hibernate in the winter.
   B. Bats are not blind. They have normal vision in the light. They use sound waves (similar to SONAR) to move about in the dark.
   C. They are active mostly at night (nocturnal) and feed primarily on insects.
   D. No vampire bats exist in the U.S.
   E. Eight varieties have been seen in the cave.

VI. PROGRESSIVE CAVE TRIP COMMENTS

The following is to be used as an example presentation only. You are required to give the information contained in each paragraph, although you may alter the wording to suit your manner of speech. **BE ACCURATE IN YOUR PRESENTATION!**

CAVE ENTRANCE

"Before we enter the cave, I wish to welcome you all to Oregon Caves National Monument. Oregon Caves National Monument, est. in 1909, is administered by the National Park Service, and is just one of about 300 such areas preserved by the Park Service for public enjoyment. My name is _____ and I will be with you for approximately the next hour. I'm sure you will enjoy the tour, but I would like to warn you to be careful not to step off the paved trail or bump your head. There are many places throughout the tour where the ceiling is low enough to bump your head. I will attempt to warn you of such places by calling out 'LOW BRIDGE.' If each of you will pass this warning back to the person behind you, everyone will be aware of the low area. Since 1923 we have guided over 3 million visitors through the cave without a serious injury.

"The tour is difficult at times for some people and is not recommended for persons with heart, breathing, or climbing difficulty."

"Feel free to take pictures inside the cave. We only ask that you remain on the trail, stay with the party and watch where you point your flash. Please use the refuse cans along the trail to dispose of your flashbulbs and other refuse. Also, the cave formations are subject to discoloration from skin oils. Use the handrails provided. Smoking and food and beverages are prohibited."

"The cave was first discovered in 1874 by Elijah Davidson, while on a hunting trip in this area. His dog, apparently trailing a bear, led him to the mouth of the cave. As far as we know, Mr. Davidson was the first human being to ever set foot inside the cave. We have no evidence that Indians knew of the cave. I will conclude the history later in the tour."

WATSON'S GROTTO

"This is Watson's Grotto, named for Chandler B. Watson, an early geologist who visited the caves in 1907 and helped in getting it established as a National Monument in 1909."

"In order that you may better understand what you see, I will give you a little background on the area. About 200 million years ago,

this area of the Siskiyou Mountains was the bottom of a shallow sea. Small marine animals living in the sea extracted calcium carbonate from the water to form their shells; when they died, the shells drifted to the bottom and accumulated there, forming a layer of calcium carbonate. Through the years, rivers emptying into the sea carried sand, silt and other sediments downstream and deposited them on the ocean floor. The weight of these sedimentary deposits exerted pressure on the layer of shells, compressing it into limestone. A period of mountain building followed, involving folding, uplifting, and a great deal of stress in the Earth's crust. Intense heat and pressure from these mountain building processes altered the internal crystalline structure of the limestone changing it to marble."

"During these disturbances in the Earth's crust, cracks formed in the layer of marble. We entered one of these cracks (show your group the diagonal crack), there is a much larger crack above us (point out the large vertical fracture in Watson's Grotto) and there is a horizontal fracture here (show visitors the horizontal crack in room).

"Keep in mind that at this point the marble layer was located below the water table. The water table is the top of the saturated zone below the Earth's surface (Phreatic Zone). Rain falling through the air picks up carbon dioxide. As it seeps through decaying vegetable matter in the ground, it picks up more carbon dioxide. This forms a weak solution of carbonic acid, much milder than you find in soda pop. Marble is only mildly soluble in water but it dissolves more easily in acid. As the acid-charged water seeped into the cracks in the marble it began to dissolve the walls of the cracks and widen them (show how large vertical cracks have been widened). As the canyon outside was cut down, the water table was lowered and when it cut below the cave entrance the water began draining out of the cave. The River Styx, which you see here, is the top of the present water table; other rooms and passages may be forming below us at this very moment. (Collect tickets and inform your group this is last chance for refund) Are there any questions? Please follow me."

PETRIFIED GARDENS

"At our first stop we saw how caves form within the saturated zone below the water table. After the water is drained, leaving empty rooms, the rain still continues to seep through the ground and the marble is still being dissolved in the smaller cracks above us. This dissolved marble is carried in solution in the water until it reaches an open room and carbon dioxide is given off.

When some of the carbon dioxide is lost, the solution cannot carry as much dissolved marble - so it is deposited on the ceiling and walls as *CALCITE*. Marble and calcite both have the same compositon, but they have a different crystalline structure and so have different names. As a drop of water oozes out of the ceiling, it hangs there for a while, some calcite is deposited and the drop of water falls to the floor to be replaced by another drop, which repeats the same process. As time goes by the calcite deposit on the ceiling grows and forms a *STALACTITE* (dripstone), like the many you see in this room. You may notice that some stalactites are hollow. When a drop hangs on the ceiling for just the right amount of time, carbon dioxide loss occurs on the outside of the drop of water. These are called *SODA STRAWS*, and may grow many feet in length but they always have the same diameter. When a drop falls to the floor, it splashes and releases more carbon dioxide. This leaves a deposit of calcite on the floor which grows up as a *STALAGMITE* (dripstone). Sometimes a stalactite and a stalagmite will meet, forming a *COLUMN* from floor to ceiling. On the wall you see *FLOWSTONE*, where water, flowing down over the walls, deposits calcite in a smooth sheet. Occasionally a trickle of water will run down the walls, such as this *FLOWSTONE-DRAPERY* over here. These formations are all composed of the same material—calcite, but differ in shape and the manner in which they are formed. All calcite deposits are referred to as *SPELEOTHEMS*. Are there any questions?

TREE ROOT

You may tell the party about this while you are stopped at Petrified Gardens and let them look at it as they go by.

"The roots you see here are those of a Douglas-fir which was growing on the surface 40 feet above us. These roots did not penetrate the solid marble to get here but followed clay-filled crevices and then extended some 25 feet along this passageway."

RIVER STYX

"The stream below you is called the River Styx, named after the river in Greek mythology which separates the underworld, or Hades, from the world of people. This is the same stream we passed as we entered the cave, but on the outside it is known as Cave Creek. Keep in mind the fact that the stream itself did not produce the cave and that its erosive action has served only to enlarge the existing passages. The real work is done deeper below the water table where the water moves slowly and dissolves

(rather than erodes) the marble. The stream contains only microscopic forms of life. Larger life forms are inhibited by the lack of nutritional materials."

"This is where Elijah Davidson found the stream while searching for his way out. It is said that he crawled down the stream to the exit in total darkness after he ran out of matches. The stream temperature remains 41°F.

"Before leaving this room I would like to let you all experience total darkness. Please take a firm stance before I turn out all the lights. Now pass your hand in front of your face. This is truly the natural condition of the cave, where light is unknown except near the entrances. Possibly some of you have never experienced total darkness before; outside the cave there is nearly always some light from the stars or moon or street lights. Now let's all be absolutely quiet for about 10 seconds and we will hear the natural sounds that have existed here for centuries. Thank you (Turn lights on).

PASSAGEWAY OF THE WHALE

"Look above you and see the crevice, or crack, that runs along the ceiling. This room was formed by water which first seeped slowly along the fracture and eventually enlarged it so that more acid-charged water could enter and dissolve out the passageway. The smoother walls here suggest that the River Styx may have once flowed through this passage before it found another route. Now if you can imagine that you are inside a whale, with the ceiling as the backbone and the sides as ribs, you can see why this is called the *PASSAGEWAY OF THE WHALE*. During the early beginning, this passageway was probably no larger than the crack directly above your head."

TUNNEL

"We are now in a man-made tunnel built in 1937, by the C.C.C., to avoid 80 feet of ladder climbing and backtracking. Do you notice the echoes? This is because of the unnatural walls of the tunnel. Natural caverns have a pitted surface which absorbs sound like acoustical tile. Here you can see the marble from which the cave was formed; the surfaces in *most* of the cave are covered with calcite. Overhead you see some impurities in the marble. While the limestone was being layed down occasional mud layers were also deposited. Today they are embedded as lense layers of slate within the marble."

NATURAL BRIDGE

"We are now 50 feet above the entrance and 18 feet above the passageway you see below us. You are standing on a natural bridge formed by the rock arching over this passageway which leads to a dead-end a short distance back. You will notice that most of the ceiling in this room is dry. This is because the cracks and crevices are filled in with sedimentary material to stop the flow of water."

"Near the two lights is one of the types of plants living in the cave. This is moss. Its spores are carried into the cave by air currents or seeping water or on peoples clothing. Why do you suppose it grows only near the lights? (**That is correct). Before the lights were installed in 1932, there were no living green plants in the cave. They require the energy of light to live and grow.

The reason you might find breathing difficult is that there is less oxygen in the atmosphere at this elevation. There is less oxygen relative to carbon dioxide in the cave due to the deposition of calcite."

IMAGINATION ROOM

"This is called the IMAGINATION ROOM. This formation is called Old Man in the Mountain. Here we have an inside out gopher hole. (Point out other natural formations of interest — Coke Bottle, Camel Map.)

"In this room, you can see grooved evidence of several fairly stable levels of water that occured during the formation of the cave. It has been found that there is a heavier concentration of carbonic acid near the surface of the water so there is faster dissolving in that area. The resulting grooves are called water table horizons. At various intervals the water apparently dissolved new channels of drainage and dropped quickly to the next level. Eventually the water table dropped farther and left the room empty." (Point out old passageway)

"We will now climb the first of several stairways in the cave. Please use the handrail and watch your step. At the top of the stairway is a narrow place we call the squeeze. You may wish to turn sideways or duck under it."

"Just beyond the squeeze climb the marble steps to the right into the Beehive Room named after the pendant formation resembling a beehive. Notice that many formations in the room are covered with a rare semi-liquid form of calcite called moonmilk."

110 EXIT

"We can rest here a bit at the other natural opening of the cave. This opening has been used in the past as an entrance (in the early days this opening was the entrance for the women - due to the narrow crawlways in the lower portion of the cave) and is now referred to as the 110 Exit. We have climbed 110 feet getting here and are approximately one-third of the way through the cave. We will go out a man-made tunnel. Before it was built, all parties had to return here to leave the cave.

If anyone would like to leave the cave for any reason, I will be glad to let you out this gate. It is only a short walk back to the Chalet where you registered." (CALL REGISTRATION BY PHONE AT THIS POINT)

"The bumpy material on the wall over here is called "POPCORN." This is a form of Helictite. Helictites are formations that grow contrary to gravity in response to air currents or water currents. You will notice this popcorn throughout the cave."

Behind you are some jagged, angular surfaces on the ceiling that you may have noticed as you came into this room. These are intersecting fractures formed during earth-movement. Carbonic acid dissolved marble along the fractures and left the pieces in the fractured area without support and they fell out. This process is called Cave Breakdown.

BANANA GROVE AND POTATO PATCH

"Here is the caveman's own *BANANA GROVE*. This is one of many forms of flowstone drapery on which water has run down over the sides, thickening the deposits so they look like bunches of bananas. You will notice they aren't yet ripe. The green coloration is caused by algae. Algae have no true roots, stems or leaves. Algae are very low forms of plant life; yet they grow in every part of the earth, from the deep ocean to the highest mountains and are present throughout the cave, needing only the introduction of light energy to appear."

"Over here is a group of stalagmites we call the *POTATO PATCH*. Can you see the eyes in the potatoes? The eyes are formed when the flow of water exceeds the evaporation rate."

NIAGARA FALLS.

"This room contains a fine example of cascading flowstone. Long ago it was named *NIAGARA FALLS*. Many of the earlier visitors to the cave left their signatures. The earliest we have

found is 1878. Notice the broken columns and stalactites? Thoughtless vandalism such as this occured for many years, destroying many formations. This is one reason why the National Park Service carefully protects the features of the Parks and Monuments — so that they will be preserved for the enjoyment of future generations. Just imagine what the cave would look like if each of the 3 million visitors had taken just one sample.

KING & QUEEN'S THRONE ROOM

"This room is named after the stalagmites, the King & Queen."

NEPTUNE'S GROTTO

"Here the scene suggests to many people an undersea cave, hence the name *NEPTUNE'S GROTTO.*

"Notice the particularly fine examples of clay worms on the rock surface. These are composed of clay particles which have become grouped together into small, winding ridges. Clay worms are found in most caves and are usually composed of the same material that overlies the caverns. We may assume that the material is brought in by seepage from the outside as a very fine material in colloidal suspension."

"This room is called a *DOMEPIT* or chimney and was formed late in the life of the cave, after the water had been drained. There was probably a spring or a stream running into a sinkhole directly above here at one time and the water coming down carved a vertical passage to the the water table."

"After the flow of water lessened there was a change from dissolution to deposition, and we now have our beautiful calcite decorations. The water has virtually ceased to flow in this room but farther along we will see a domepit wherein the calcite is being actively deposited."

"We are now going down two ladders for about 25 feet. Please hold onto the rails and be especially careful of your footing on these steps."

"Just beyond the bottom of the stairway a stalactite has grown from the ceiling to within about two feet of the floor and has joined with a stalagmite that has grown up from beneath. The column is about 7 feet in height and a foot through at the narrowest point. DON'T TRY TO GIVE AN ESTIMATE OF ITS AGE. One feature of interest here is the dark stain, which is not plant growth. This stain is from countless people putting their hands on the same spot. The oils and dirt from the skin have

made the stain. (AGAIN CAUTION PEOPLE NOT TO TOUCH ANY OF THE FORMATIONS). Because of its size, we have named this formation the *GRAND COLUMN* (STOP HERE).

WIND TUNNEL AND WISHING POST

"As we pass through this passageway, notice the breeze. This is caused by the variation between the temperature inside the cave and the temperature outside the cave. The cave walls are hundreds of feet thick and will absorb a great amount of heat, so the air that comes from the outside soon reaches the temperature of the cave walls. Since warm air tends to rise and cold air to fall, the temperature within the cave varies only seven degrees throughout the year, the outside summer air is warmer and the cave air tends to fall and pour out the entrance. In winter the reverse is true, causing the air inside the cave to rise and flow out the exit 240 feet higher. This is what causes a wind in this passageway except when the temperatures both inside and outside the cave are the same.

"At the far end of this passageway, on your left, is the *WISHING POST*. The top of this formation has been polished from the thousands of people rubbing it and making a wish."

JOAQUIN MILLER'S CHAPEL

"Some of you folks may have heard of Joaquin Miller, known as the poet of the Sierras. When he and a party of friends were here in 1907 he became very enthusiastic about the cave, referring to it as the 'Marble Halls of Oregon'. In 1909, when the National Monument was created, this room was dedicated as *JOAQUIN MILLER'S CHAPEL* in recognition of what he had done to bring public attention to the cave and to other features of the coast states."

"Here we have a completed column and one in the process of growing. If this stalactite and this stalagmite were to join, we would have a gateway. Behind it is the largest stalagmite in the cave. It is known as the *WASHINGTON MONUMENT*. On the bench immediately above is the *GARDEN OF THE GODS*."

RIMSTONE

"Crouch down and look across. To your left we have the *PACIFIC OCEAN*. On the other side is the *ATLANTIC OCEAN*. This type of formation is called *RIMSTONE*. These are dams formed by water flowing down gentle slopes. Calcite is deposited in response to agitation as water flows over the lip of the dam, giving off carbon dioxide.

TRANSLUCENT FLOWSTONE

"In front of this light is another example of the crystalline structure of flowstone. If you look closely, you will see the many calcite crystals. Calcite is a well known mineral formed from calcium carbonate. It occurs in most limestone or marble regions and in this form is translucent but not transparent."

GHOST ROOM TERRACE

"This is the largest known room in the cave, the *GHOST ROOM*. It is 40 feet high, 50 feet wide, and over 250 feet long. It was formed in basically the same way as the other chambers in the cave, but there were more cracks intersecting here, as is indicated by the number of passages leading out, and so there were more surfaces for the carbonic acid solution to work upon. As the marble was dissolved underneath, it left the fractured rock above unsupported and allowed it to fall to the floor, just as you saw at the 110 Exit. Overhead is an interesting formation called a *CLASTIC DIKE*. This was caused by eroded sedimentary minerals — being deposited in a crack in the marble. Later on, the material was hardened by compaction. Unlike the marble; this new rock was not soluble in carbonic acid. So, as the marble was dissolved the dike was left to jut out into the room. You can see it has been broken off by some ancient disturbance, rather than dissolved.

"Across the ceiling in the light you can see many soda straws. Notice their appearance of being almost pure white. If they were to get a sudden increase in flow of water from the outside, they would change their shape and become the common 'carrot' type such as we have over there. In a cave in western Australia there is a soda straw, no larger in diameter than these, but it is 20 feet 6 inches long.

SPITTING STONE

"Here is how the eyes were formed in the potatoes."

BOTTOM OF STAIRWAY LEADING TO PARADISE LOST

"From here we will climb 45 steps to one of the more beautiful rooms in the cave. Then we will come back to the Ghost Room floor. If any of you would rather not climb up and back, you may wait here at the bottom of the stairway and we will return in about 5 minutes.

PARADISE LOST

"This room is called *PARADISE LOST.* This is another domepit or chimney formed in the same way as Neptune's Grotto. Now I am going to put on some colored lights for a moment, ... then the white lights. This is considered by many to be the most beautiful room in the cave. On the floor a formation similar to the Atlantic Ocean and Pacific Ocean is forming."

GHOST ROOM FLOOR

"Flowing along the lower side of the room is a tributary of the *RIVER STYX,* the same stream we saw at the entrance. This tributary collects water from a series of domepits in the south end of the cave (Point out south — also cave entrance north).

"From this point, we start out of the cave. We have come some 1,350 feet into the cave and are approximately 217 feet below the surface. At various points in this room we have examples of pure white calcite which is free of almost all impurities. I'll point out some from the next landing."

SPOTLIGHT- GHOST ROOM EXIT

Here is another example of drapery. For a time, while this drapery was being deposited, impurities were brought in with the water and deposited to make this resemble a strip of bacon; this type of drapery is called *BACONSTRIP*. Over here is a spectacular formation called the *ANGEL FALLS."*

"As you go up the second ladder, look to the left, in front of the light, and see the *BIRD OF PARADISE.* He is waiting for the little 'worm' hanging over his head. The Bird of Paradise is a little unusual. Water dripping from the soda straw 'worm', fell on the small ledge and built up a stalagmite. Water running down from the stalagmite built a stalactite beneath the ledge. So, here we have a stalactite beneath a stalagmite, which is a reversal of the usual procedure."

WEDDING CAKE ROOM

"This room is named after this flowstone formation resembling a wedding cake (Point out old passageway).

LAST NATURAL ROOM

"This is the last natural room in the cave system that is included on the tour route. Years ago, it was necessary to go back from here to the 110 Exit. Then in 1931-32-33, the exit tunnel was constructed to allow a one-way tour of the cave. It is 470 feet long and climbs at a 16% grade. We will stop to rest along the way."

LARGE CLAY POCKET

"This is the largest of the clay pockets discovered when the tunnel was drilled. As the water seeped down through the cracks in the marble, it dissolved out pockets, such as this. Later, the water carried in clay particles which were deposited in the pockets until they were practically filled with clay. As a safety measure, in case of slides, the clay was later dug out and removed. Sometimes bats roost here, but there is no need to worry about them. An interesting ability of bats is the means of flying in total darkness. Bats navigate by *echo-location,* a system similar to the Navy's Sonar. They emit ultra-sonic squeeks (too high for human ears), then interpret the shape of objects by the echo that bounces back to their ears. They even locate and catch flying insects in this manner.

EXIT TUNNEL NEAR EXIT

'Notice the thin white deposits of calcium carbonate along the walls, and the tiny stalactites on the ceiling at this point. These have grown since 1933 when the tunnel was built. Of course this may be an unnaturally rapid growth due to the swift passage of dry air through the tunnel. The evaporation rate is certainly more rapid here than deep in the cave. Still this is a rough index of the rate of cave growth. If this tiny crust took over 40 years to form, imagine for yourself the great age of the larger formations inside the cave."

"The covering over the exit gate has been placed there in an effort to recreate the original cave conditions. Remember my explanation of the air flow throughout the cave."

CONCLUSION

"This concludes our cave trip. We have attempted to tell you why the National Park Service administers this area and something of the cave's history and geologic story. We hope that you have enjoyed your visit. We are 240 feet above the entrance. If you wish you may take the Cliff Nature Trail that winds above the cave to the registration booth. The trail overlooks the Illinois Valley

and the Siskiyou National Forest. This trail is a little less than a mile and takes off just ahead on the unpaved trail to your left. You may, if you wish, accompany me to the starting point, three tenths of a mile down the trail where our beautiful Chateau is located. Overnight accommodations and dining facilities are available at very reasonable rates. If you would like more information, or if I can be of any assistance in making reservations, I would be glad to help you. You may sit here and smoke or rest awhile and look out over the Siskiyous. You're now looking West toward Cave Junction. There is no smoking on the trails. Thank you for your attention throughout the tour.

VII. OTHER SIGNIFICANT FEATURES OF THE MONUMENT

The discovery of certain plants in this area is a source of interest to scientists who deal with plant distribution. The composition of the associated species of the area is so singular that it attracts the attention of authorities, since many species find in this cave the southern limit of their range, while species otherwise limited to California find here the northern limit of their range.

Natural stands of Port-Orford-cedar, one of our most graceful native trees, are important features. Other plants include the snow-plant; Sierra wildginger, with beautifully molted leaves; and the phantom-orchid. Labels are placed on many of the plants along the trails that lead out of the central area.

Last, but not least in interest, are the little plant colonies, mostly of simple types like algae (similar to green pond scum) and mosses, growing in the depths of the cave under electric lights, that receive from this source certain rays needed for growth. The colors of the lights at various parts of the cave doubtless affect the growth rates of the plants, but probably none precludes growth entirely, since the food manufacturing process in plants makes use of any part of the entire range of visible light. It is likely that some other factor—for example, length of time the lights are on—is responsible for their not becoming established at some places.

The large white and gray birds that come so readily to be fed at the Chalet are the gray jays. The jays with the black topknot are Steller's jays. It is incorrect to call them "blue jays."

At the same place, vying for peanuts, are the golden-mantled ground squirrels, often mistakenly thought to be chipmunks. However, these ground squirrels are much larger than chipmunks and do not have stripes on the face. The Townsend's chipmunks also occur here, and it will be readily noted that they are smaller, have smaller feet, more pointed noses, and stripes running along the sides of the face. The large, gray squirrels with a blackish patch between the shoulders are California ground squirrels.

At least eight kinds of bats have been observed in the cave. There are no large colonies that pour out of the entrance like smoke, as at Carlsbad Caverns. No blind animals are known from the cave.

The rugged, forested, wild beauty of this spot—where there is no logging, hunting, trapping, or grazing—presents a charm that is of the utmost attractiveness to those who visit from places not so well endowed with wild land as Oregon.

VIII. GLOSSARY

Applegate Group: rock laid down during the Triassic period and metamorphosed later. The marble of Oregon Caves is a part of this group.

Aragonite—a crystalline form (*rhombic*) of calcium carbonate (See also calcite).

Bacon—a thin sheet of calcite having alternating dark and light bands which give it the appearance of a strip of bacon. The dark bands are usually caused by an iron oxide stain (rust).

Bedding plane—the stratification or meeting place of two different layers of sedimentary rock.

Botryoid—a descriptive term of mineral deposits formed in such a way as to resemble a bunch of grapes (helictite).

Boxwork—a calcium carbonate deposit resembling a honeycomb due to a closely intersecting network of joints.

Breakdown—heaps of rubble on a cavern floor caused by the collapse of walls or ceiling.

Calcium bicarbonate—an unstable compound occurring in solution when carbonic acid comes into contact with calcium carbonate.

$(CaCO_3 + H_2CO_3 = Ca^{++} + 2HCO_3^-)$.

Calcium carbonate—a mineral with the chemical formula, $CaCO_3$. It crystallizes in two forms, calcite or aragonite.

Calcite—a crystalline form (rhomobohedral) of calcium carbonate ($CaCO_3$). It is the chief mineral making up limestone, chalk, cave formations and marble (See also, aragonite).

Carbonic acid—a weak acid occurring only in solution, having the chemical formula H_2CO_3.

Cascadian Revolution: A period of orogonic mountain building.

Cave—a hollowed out chamber in the earth - a cavern.

Cavern – (see cave).

Cave pearl—a roundish unattached mass (concretion) of calcium carbonate formed in cave pools.

Chamber—a natural cavity or room.

Chimney—a narrow vertical shaft in rock. It may be a rough tube resembling the chimney of a house, or it may simply be a narrow cleft between two more or less parallel walls of rock.

Clastic dike—a dike made up of fragments of pre-existing rocks (See text).

Cohesive force—a force causing pieces or particles to stick together.

Column—a speleothem formed by the growing together of a stalactite & stalagmite.

Cretaceous Period: a geological period of time starting about 120 million years ago and ending about 60 million years ago.

Deposit—a natural occurrence or accumulation of mineral material, such as an iron ore deposit; or in the vocabulary of the speleologist, any cave formation originating from deposition.

Deposition—act or process of depositing.

Drapery—hanging speleothem which takes the form of a curtain or drape.

Dripstone—a calcite deposit left by dripping water.

Flowstone—calcite deposited by water running down a cave wall or over a cave floor.

Formation—a term geologists use to describe a body of rock, but it is also applied to cave deposits such as stalactites (Speleothem is a better term for the latter).

Fracture—a break in rock.

Gallery—an underground passage.

Grape formation—see botryoid.

Ground water—water within the earth, such as supplies wells and springs.

Helictite—a variant form of stalactite which does not hang vertically or which has side growths resembling branches or twisted roots of plants.

Hydrology—the science that deals with surface water and underground water.

Hydraulic pressure—a force caused by water pressure.

Igneous rocks: rocks formed as the result of volcanic activity.

Jurassic Period: a geological period of time lasting from about 155 million years ago until 120 million years ago. This period marked the beginning of primitive mammals.

Laramide Revolution: a period of orogonic mountain building during which the Rocky Mountains are formed.

Lime—may be any of several caustic compounds containing calcium.

Limestone — a rock consisting chiefly of calcium carbonate, usually an accumulation of organic remains such as shells.

Marble—(proper) differs from limestone in being more or less crystallized by metamorphism.

Metamorphose—to change into a different form, such as to change sedimentary rock (limestone) into a metamorphic rock (marble).

Metasediments: metamorphosed sedimentary rocks.

Metavolcanics: metamorphosed igneous rocks.

Moonmilk—a rare form of calcium carbonate which is semi-liquid.

Nevadian disturbance: orogonic in nature but of less intensity than a revolution.

Nodule—a rounded mass of irregular shape; a little lump.

One-stage theory—an explanation of the origin of caves which holds that they were created by acid-bearing vadose water at or above the water table.

Orogony: a mountain building process.

Phreatic stage—according to the two-stage theory, this is the period during which caves originate by solution in the phreatic zone.

Phreatic water—see phreatic zone.

Phreatic zone—the region, below the water table, in which rock is saturated with water. The water in this zone is called phreatic, from the Greek word meaning "well."

Popcorn—(see botryoid).

Recrystallize—to crystallize again or repeatedly.

Rimstone—a calcium carbonate deposit around the edge of a pool of water.

Room—a chamber.

Sandstone—a sedimentary rock consisting of sand, usually quartz, united by some cement, as silica, iron oxide, etc.

Schist: the final product of the alteration by heat and pressure alone of a mixture of hydrated and oxidized minerals. Schists can be distinguished from primary rocks (sedimentary and igneous) by micaceous banding and a predominance of one mineral.

Sedimentary rocks: rocks formed by the depositon of sediments which are then compacted into rock.

Shale—a sedimentary rock formed by the consolidation of clay, mud, or silt, and having a finely laminated structure.

Sink—a depression in the landscape caused by collapse of the roof of a cavity beneath the surface.

Sinkhole—an opening that leads steeply downward from the surface to a cavernous area. Such holes may appear in the bottoms of sinks or their mouths may be flush with the surface of the surrounding terrain.

Soda straw—a small, hollow stalactite inside which drops of water descend.

Solution—the process by which a substance is homogeneously mixed with a liquid. Also, the state of being so mixed.

Solution cavity—a cavity produced by the process of solution.

Speleologist—one who makes a scientific study of caves.

Speleology—the scientific study of caves in all their aspects.

Speleothem—a general term used to describe the deposits in caves, of calcite, aragonite and gypsum. The word is more and more frequently used instead of the word "formation" which geologists use to describe large bodies of rock. Thus, a cave may be said to be in a certain limestone formation.

Spelunker—one who explores caves as a sportsman or as an amateur speleologist.

Squeeze—a passageway in a cave that is very tight from a human point of view.

Stalactite—a calcium carbonate speleothem which grows downward, icicle-fashion, as a result of deposits left by dripping water.

Stalagmite—a deposit of calcium carbonate which is built upward from a cave floor by dripping water.

Travertine—a term loosely applied to several forms of calcium carbonate deposits.

Triassic Period: the geological period from 190-200 million years ago to 155 million years ago. This period is often called the age of reptiles.

Two-stage theory—an explanation of the origin of caves which holds that they were created by acid-bearing phreatic water below the water table; and that then, in a later stage, when the cave was drained of water and lay above the water table, a calcium-bearing vadose water deposited the speleothems.

Vadose stage—according to the two-stage theory, this is the second stage or cycle in which caves become partially or completely filled with formations deposited there by vadose water.

Vadose water—see vadose zone.

Vadose zone—the region lying between the surface of the earth and the water table. Water which seeps or flows through this region under the pull of gravity is called vadose water.

Volcanic (rock)—rock formed by solidification of a magma (molten rock) poured out over the earth's surface from a volcano or other surface eruption.

Water table—the meeting place of the phreatic and the vadose zones. Below it, the rock is saturated with water; above it, water under the pull of gravity is continuously flowing downward.

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Appendix A
ROADS AND TRAILS
Roads Mileages

Cave Junction	20 miles	(via 46)
Crater Lake National Park	150 miles	(via US 199, I5 Oregon 234, & 62)
Crescent City	77 miles	(via US 199)
Grants Pass	50 miles	(via US 199)
Lava Beds National Monument	198 miles	(via US 199, I5 Oregon 66, & 39)
Medford	80 miles	(via US 199, I5)
Portland	330 miles	(via US 199, I5)
Roseburg	130 miles	(via US 199, I5)
San Francisco	451 miles	(via US 199, I5)
San Francisco	470 miles	(via Medford, US 199, 99)
Eugene	185 miles	(via US 199, I5)
John Day Fossil Beds National Monument	443 miles	(via US 199, I5)

Trails

Big Tree	1.3 miles
Big Tree Loop	3.3 miles
Mt. Elijah	4.1 miles
Cliff Nature	1 mile
Lake Mountain	5 miles
No Name	.3 mile (short)
	1.1 miles (long)
Cave Exit	.3 mile
Cave (Inside)	.6 mile

Ask a Ranger for further information,
especially about other trails.

Appendix B

GEOLOGY OF THE KLAMATH MOUNTAINS
(Modified from Baldwin, Geology of Oregon)

The complex Klamath-Siskiyou Mountains occupy southern Oregon and northern California, bounded on the north by the Coast Range, with which they interfinger, on the east by the Cascade Range, which they underlie, on the south by the Marble Mountains of California, and on the west by the Pacific Ocean.

The region is probably older than any other part of Oregon, for schists are abundant in an area east of Oregon Caves National Monument. These are primarily medium- to dark-green quartz-eipdote-chlorite schists, derived by metamorphism of mafic volcanic tuffs and sedimentary rocks. Similar schists occur in California, 20 miles southeast, overlaid by sedimentry rock which contain Silurian fossils. This relationship suggests an age of 425 million years or more for the schists.

Following folding and erosion of these Paleozic rocks, great series of volcanic and sedimentary rocks were deposited in the Ashland-Grants Pass- Cave Junction area late in the Triassic Period—The Applegate Group. Most importantly, lenses of limestone were interbedded with other Applegate rocks, as invertebrate shells collected in primeval seas. Silt and lava deposits intermixed with and formed between many of these limestone layers.

During the Jurassic Period stresses developed in Nevada which folded and metamorphosed this Applegate Group, producing steeply-dipping metavolcanics and metasediments—the latter composed of argillite, shale, chert, quartzite and marble. It was this act that created the marble and shale of the future Oregon Caves.

A trough was created during late Jurassic, which extended from the southwest corner of Oregon, north to northwest across the Galice area. The sediments and volcanics that accumulated here were moderately metamorphosed to create (from west to east) the Dothan, Rogue and Galice formations. The latter is in fault contact on its eastern edge with the older and more highly metamorphosed Applegate Group.

Also during late Jurassic, masses of course-grained peridotite or dunite were injected into many formations of southwestern Oregon, then partially altered to the yellow—to black-green serpentine so prevalent today.

At the end of the Jurassic Period, the Nevadian disturbance culminated with extreme folding and faulting in southwestern Oregon, and intrusion of several bodies of granitic rock—most commonly composed of diorite, quartz diorite and granite. Many geologists believe it was the culmination of this Nevadian disturbance that triggered the major upheaval that pushed up the Rocky Mountains—the Laramide Revolution. Additional intrusions occurred during the early part of the Cretaceous Period.

During much of the Cretaceous Period the Siskiyou area was under water, accumulating sediments. Crustal unrest, however, further folded, deformed and elevated the Klamath Mountains. There was then a waining of the Laramide Revolution orogenic forces, followed by a 16 million year period of erosion, which reduced the area to low rolling hills. Sediments of the Klamath Mountains were carried to northwest seas during this period, contributing to the thick Umpqua and Tyee formations.

About 47 million years ago the Cascadian Revolution began, as fissures poured lava over 200,000 square miles of the Northwest, forming the Columbia River Plateau. Another great upheaval occurred with this volcanic action, and the Siskiyou area was lifted once more. The pace erosion was renewed and continued for 40 million years until only a flat plain with sluggish, meandering streams remained—the Klamath Peneplane.

Between 10 and 15 million years ago, while the great basalt flows were still building up to the east, the land above Oregon Caves eroded to a level that allowed water to seep into the marble lenses dissolving it.

Another upheaval occurred about 7 million years ago, when only 2,000 feet of material lay above the marble of Oregon Caves. The Klamath Peneplane was lifted to 7,000 feet in the east, 2,000 feet in the west, forming a high, inclined plateau. Erosion then cut the valleys and steep canyons present today. Pressures accompanying the volcanic activity of the Cascade area also lifted and tilted the entire west coast of Oregon, forming the Coast Range.

The many warpings and crustal movements in the Klamath Mountains area were accompanied by fissure creating earthquakes. Serving as pathways, the fissures permitted ground water, highly charged with carbonic acid, to dissolve the marble. This dissolution probably began 10 million years ago, or more, but it was the final uplift 7 million years ago that allowed the present-day canyons to be cut, permitting the caves to drain and allow dripping water to form the intricate calcium deposits seen today. The final features of Oregon Caves then, are less than 7 million years old.

Appendix C

GEOLOGIC HISTORY OF THE SISKIYOU MOUNTAINS

The Siskiyous are a steep and rugged group of mountains in southern Oregon and northern California. They lie west of the Cascades and are separated from them by Bear Creek which runs through Medford. They are south of, and interfinger with, the Coast Range Mountains in the vicinity of the Coquille River. The peaks rise to 7,000 feet in the east and 2,000 feet in the west, indicating the former presence of a high, inclined plateau.

In southern Oregon and northern California, perhaps 425 million years ago, a volcano poured out lava which was later covered with sedimentary deposits. By the action of heat and pressure these lava flows were changed into schists. Similar schists about 20 miles south, in California, are overlain by Silurian fossils so these may be the oldest rocks in the state of Oregon. They are located on Mt. Ashland near Medford and are a part of the Siskiyou Mountain System.

The Siskiyou area subsided and was covered by the sea and mud and sand were deposited to form shale, mud-stone and sand-stone. Approximately 200 million years ago, in the Triassic Period, an abundance of small shelled animals were living in the sea and as they died they drifted to the bottom where their shells formed the limestone which later housed Oregon Caves. During this time floods of silt were occasionally brought down rivers and deposited as lenses of shale within the limestone. One such lense can be seen in the ceiling of the first man-made tunnel in the caves. Lava flows are also to be found interbedded with the limestone.

Under what is now the state of Nevada, pressures began to build up about 165 million years ago and these affected the Siskiyou area. Rocks under the sea were compressed, bent and deformed and due to this great heat and pressure the rocks were metamorphosed. The shale became slate and the limestone was changed into marble. A wrinkle was also being pushed in the earth's surface and this subsiding trough was slowly filled with sediments. This trough extended from the coast, northeast across the Galice area and contains the Dothan, Rogue and Galice formations. The Applegate formation, of which Oregon Caves marble is a part, is older than the other three as is indicated by the relative amount of metamorphosis that has taken place. At this time there was a peninsula of land extending north along the Oregon coast to about Coos Bay but during the next 30

million years this too sank beneath the sea and sedimentary deposits continued to build up to tens of thousands of feet above the Siskiyou region.

About 135 million years ago, at the end of the Jurassic Period, the Nevadian disturbance culminated with extreme deformation, folding and faulting of the sedimentary beds in this area and the intrusion of granitic rocks. This is also the time of the intrusion of the massive Coast Range, Sierra Nevada and Idaho bathyliths. Many geologists believe it was the culmination of the Nevadian disturbance that triggered the next major upheaval, the Laramide Revolution, which pushed up the Rocky Mountains.

For the most of the next 72 million years, during the Cretaceous Period, the Siskiyou area was under water and accumulating more deposits. The crustal unrest to the east was exerting pressures which further folded and deformed the rocks and by the end of the period forced them above the sea and pushed them up to form mountains.

The end of the Cretaceous Period is sometimes called the "Time of the great dying." This was the end of the Mesozoic Era and the end of the age of great reptiles. In the geologic record a million years may be compressed between two stones so that what appeared to be a sudden dying out of certain animals really took place slowly over many millions of years. There was also a dying out of the orogenic forces of the Laramide Revolution followed by a period of rest for the next 16 million years. The rains were falling on the land and eroding the sharp peaks until they were worn down to a land of low rolling hills and grass lands. During this time of quiet the land to the north was under water and the rivers wearing away the mountains brought down sand and silt which were deposited in this sea contributing to the thick Umpqua and Tyee formations to the northwest.

About 47 million years ago the Cascadian Revolution was getting under way and great fissures were pouring out lava flows across eastern Oregon, Idaho and Washington, building up basalt thousands of feet thick. With this volcanic action there was another great upheaval and the Siskiyou area was lifted up once more to where the rivers ran faster and had more cutting power to erode away the land that had accumulated during the millions of years under water. For 40 million years this wearing away continued, cutting down the mountains and filling in the low places until once more there was a great flat plain with slow, sluggish, meandering streams running across it. This low flat area is called the Klamath Peneplane.

Sometime between 10 and 15 million years ago, while the great basalt flows were building up to the east, the land above Oregon Caves was eroded away until water began to seep into the area of the marble. About 7 million years ago the land had been worn away until only about 2,000 feet of material overly the marble of Oregon Caves and there was another uplift. Pressures accompaning the volcanic activity of the Cascade area lifted and tilted the entire west coast of Oregon, raising the coastal deposits from beneath the sea to form the Coast Range Mountains. The Klamath Peneplane was lifted on an incline to about 7,000 feet in the east and 2,000 feet in the west forming a high inclined plateau. Erosion then cut out the valleys and steep canyons we see here today.

Volcanism in the High Cascades continued until around 3,000 years ago, building the peaks of the High Cascades and pouring out lava and ash in the eastern Oregon area. Today there are still areas of smoke, steam and hot rocks along the summit of the range and hot springs along the base, indicating that volcanism isn't dead but that the mountains are merely dormant.

The successive warpings and crustal movements in the area were undoubtedly accompanied by many earthquakes which caused cracks in the marble. Ground water, charged with a weak solution of carbonic acid, filled the cracks and dissolved out the caverns. This dissolution probably started shortly prior to 10 million years ago but it was the uplift around 7 million years ago that caused the canyons to cut into the marble and allow the caves to drain and the dripping water to form calcite deposits. It may be assumed from this that the cave decorations in Oregon Caves are considerable less than 7 million years old.

Appendix D

BASIC SPELEOLOGICAL CONSIDERATIONS OF OREGON CAVE

Bulletin #11

Miscellaneous series
Western Speleological Survey
(W.S.S. Serial #31)

December, 1963

William R. Halliday

SUMMARY

Oregon Cave is a large mountainside strike-oriented cavern in marble, with unusual features suggesting that its upper, southern end has served as a collecting area for stormwater access to the shallow phreatic zone in which most of the rest of the cave developed. Its scanty speleothems are exclusively calcite. A moderate biota is present.

Generally but incorrectly known as "Oregon Caves," Oregon Cave is a large, intricate limestone solution cavern located at an elevation of 4000 to about 4390 feet, on the slopes of Mt. Elijah in the Klamath Mountains of southwestern Oregon, in the southeastern ¼ of section 9, T40S, R6W. Its entrance is shown on the Oregon Caves quadrangle.

Discoverer of the cave was Elijah J. Davidson, whose dog chased a bear into the cave. Davidson (1922) placed the date as October, 1873 in an account prepared many years later. On July 27, 1877 (Fidler, 1922), an account of the first attempt to explore the cavern stated that Davidson's discovery was in 1874, and the first exploration was in 1877, by F. M. Nickerson, Davidson, John H. Kincaid and John Chapman. Because Nickerson subsequently developed a financial interest in the cave, his claim of first exploration is suspect.

In 1880, an attempt was made to commercialize the cavern by two squatters, Homer and Ernest Harkness (Watson, 1909). Much work was accomplished, and had they not been fleeced by a confidence man, the venture might have succeeded (Watson, 1909). In 1907, poet Joaquin Miller visited the cave with Watson, Nickerson and Kincaid. Two years later, President Taft proclaimed the establishment of Oregon Caves National Monument as a result of public interest largely stimulated by Miller and Watson. In 1910, "Old Dick" Rowley became ranger-in-charge, and did a great deal of work in the cave. He continued in various positions until his retirement about ten years ago.

Oregon Cave is in an area of biological transition between the California Mountains and the Northwest evergreen forest. Normally, the region receives several feet of snow annually, but rare winters are snow-free. No evidence of glaciation has been noted in the vicinity. Mantle is heavy, and aside from the vicinity of bare marble outcrops, karstic features are scant. A small swallet is said locally to be present several hundred feet above the cave. The mountainside near the cave is incised by streamcourses, but they are shallower than those of nearby non-calcareous topography.

The bedrock of the cave is a finely crystalline, irregularly banded marble which has been subject to clastic flow. Bedding planes are rather indistinct except at contracts with other rocks of the Applegate formation, which is of Triassic age (Wells et al, 1949). Bedding planes are of minimal speleogenetic significance.

The dip of the marble tends to be indistinct. Near the main entrance, it appears to be vertical, but near the Passageway of the Whale, it appears almost horizontal. At the west end of the 65-foot tunnel, the beds appear to dip eastward about 20 degrees; between the Ghost Room and the Exit Tunnel, about 25 degrees. The strike is roughly north-south, and the overall alignment of the cavern is along the strike of the marble, roughly parallel to the hillside. The main entrance is the northernmost and lowest point in the cave; the Southern regions are considerably higher. Several well-demarcated levels are present, but are not at uniform elevations throughout the cave.

Stream flow in Oregon Cave and its immediate environs is complex, and also somewhat obscured by surface modifications of recent years. Most of the Cave Creek emerges from a drainpipe at a point several dozen yards downstream from the Chalet. Only a small rivulet, artificially diverted to the lower trout pond from

the cave stream, follows the original course of Cave Creek between the Chalet and the artificial resurgence. A rather extensive system of large pipes underlies the service parking area, the road downhill from the cave entrance, and the paved trails in Cave Creek Gulch above the Chalet. According to the staff (Hennessay, V., oral communication, 1963), this drain system receives:

1. the original flow in Cave Creek Gulch.
2. small tributaries of Cave Creek above the developed area.
3. most of the cave stream.
4. small resurgences south of an independent of the cave stream.
5. surplus water diverted from another creek for domestic use.

Probably the cave stream represents a perched water table. Its origin is about 300 feet inside the cave. Fluorescein placed in the smaller stream in the Stream Grotto of the Ghost Room appeared at the entrance in less than 4 hours, but had not appeared in 1¾ hour.

The Ghost Room steam may reappear in a nearby, intermediate-level passage. That stream cascades 15 feet to a short lower level and enters a narrow siphon at an altitude about 20 feet higher than the resurgence of the main cave stream some 450 feet northwest.

The Ghost Room stream is formed by a confluence in the distal part of the Stream Grotto. A small tributary stream can be followed beneath breakdown and ladders to a narrow intermediate level passage extending westward for more than 100 feet, and not fully traced by our parties. The main stream can be seen and heard at intervals, east of and below the east side of the Ghost Room and south-end crawlway, to about the midpoint of the latter. It is presumably an augmented continuation of the stream of the Waterfall Complex south of the Dome Complex. No tracers have been employed in this area.

In addition to these streams, there is evidence of intermittent torrential flow in the Well Complex of the south end of the cave, and perhaps other areas. Overall streamflow is augmented by apparently relatively constant dripping water in the Shower Room and Paradise Lost. Somewhat lesser amounts of dripping water accumulate in catchment basins in the Moonmilk-Royal Gorge Complex, the Seneca Lake and Grand Column areas, Joaquin Miller's Chapel and the complex south of the east end of the Exit Tunnel. Smaller amounts of drip are present in many portions of the cave. The re-solution of speleothems in the South End section suggests a rapid transit.

These multiple routes of water ingress unite fortuitously in a branchwork pattern, due to the overall slope of the cave. The system might be considered a series of perched water tables separated by abrupt descents.

A wide variety of non-speleothemic fills is present in the cave, but their sequence must await a prolonged study. Stratified fills are particularly prominent in the south end of the cave, with some alternation of sand and gravels. Mudflows are present near the Rathole. Large cobbles are scarce. An impression was obtained that, in general, silts tend to predominate over coarser fills progressively in the lower, northward regions of the cave. Detailed studies should be conducted to confirm or disprove this impression. A fill feature not noted by me in any other cave is present distal to the Rathole: small pisolite-like pebbles which are remnants of speleothems undergoing re-solution. Throughout much of the cave, only fleeting remnants of perched fills remain to outline speleogenetic sequences.

Commonly, speleothems rest on stream deposits. No clear-cut example of stream deposits atop speleothems was noted, except perhaps a few feet south of The Rathole. Vermiculations of types 3 and 4 of Parenzan (1963) and perhaps others overlie speleothems and bare walls alike. Near lighting units, some of these have a green color and appear to consist at least partly of algae. Near the extreme upper end of the cave, they appear to intergrade into a broad expanse of mud on a wall of the cave.

Oregon Cave consists of an intricate complex of corridors at different levels, aligned along vertical or oblique (and rarely other) joints. The master joints vary greatly in dip and orientation, but tend to be aligned along the strike of the bedding. At intervals are chambers of various sizes. Only one — The Ghost Room — may properly be called *large*. Breakdown is extensive locally; relatively few sections of the cave are free of it. Chimneys are present in several areas; none are classical domepits, and their characteristics are predominantly phreatic. In general, speleogens show both phreatic and vadose phases in a complex sequence. Near the lower, southern end of the cave, vadose speleogens are uncommon except immediately adjacent to the cave stream. Joint pockets are prominent. Sponge work is not.

In the midportion of the cave, ceiling meanders and perched stream horizons are marked. Especially at the south end of the Ghost Room, some are heavily fluted by northbound flow. Some very recent vadose re-solution is present in a chimney north of the Golden Stairs, and west of the entrance to the Devil's Washboard area. At the south end of the Ghost Room is a broad

expanse of horizontal ceiling of solutional origin which appears to be a water table feature.

Present in the Ghost Room is a "clastic dike." Thin-section analysis of this material by George W. Moore (unpublished data, National Park Service) revealed material unlike the Applegate formation. In it, quartz is very abundant. Abundant are plagioclase and probably oligoclase. Green hornblende and epidote are fairly abundant. In the abundant rock fragments of the dike are tremolite schist, altered volcanics, marble, quartzite, fine-grained clay-rich rocks and a rock composed of green hornblende.

Similar but much smaller features are found elsewhere in the cave, locally forming a poorly developed boxwork. These features are particularly vulnerable to vadose corrosion, and the extensive exposure of the clastic dike in the Ghost Room is of particular speleogentic significance.

Farther south, the incised meanders are still more prominent than in the mid-portion of the cave, and vadose grooving and related speleogens are locally common. The Canyon appears to be a vadose feature, although its features have not yet received proper study. The south end of the cave has the appearance of an entry and collecting area for flood waters where sediment-bearing and clear water successively entered a shallow phreatic cavern under pressure. The more northerly, lower parts of the cavern appear less modified from a typical phreatic cavern. Until the complex fill sequence is established, however, details of the sequence cannot be outlined. The increased precipitation of the glacial periods may well have exerted a major role in speleogenesis.

Speleothems of the cave are patchy and not of great variety. In some remote areas, they are white and pristine. Elsewhere, they tend to be muddy, discolored and vandalised. Some of the speleothems were brown originally.

Tubular stalactites occur locally. Some are exceptionally thin-walled. Beneath some are relatively large stalagmites. In general, stalagmites predominate over stalactites. Flowstone is more massive than dripstone. Helictites are rare. Coralloids are uncommon. Rimstone deposits are locally prominent. Some gours contain fine dog-tooth spar. Unusual crystals, perhaps partially the result of re-solution, are present on the ceiling at the south end of the Ghost Room and in the south end of the cave. Draperies and ribbons are scant. A few unremarkable colites are present. Calcitic moonmilk (Davies, W.E., unpublished data,

National Park Service) is present extensively in the near-surface upper level which nearly overlies Watson's Grotto. Unlike many western caves, cyclic speloethem deposition is not prominent. Analysis of crystals from gours in Paradise Alley and The Atlantic Ocean, shelfstone and flowstone south of the exit tunnel entrance all showed pure calcite (Quinlan, James F., unpublished data in National Park Service files). No aragonite has been identified in the cave.

The biota of the cave is moderate. Bats are frequently seen, singly or in small groups. About 400 Corynorhinus rafinesquii and Myotis spp. were banded several years ago, but no significant conclusions were obtained. Eptesicus fuscus also has been identified in the cave, (Brown, Richad, personal communication).

Our parties noted one salamander, Dicamptodon ensatus, in the Ghost Room, and Park Service personnel have reported fairly infrequent sight records of this salamander elsewhere in the cave.

Rodent nests are present in several parts of the cave. Collembola are found in several locations. A variety of insects and at least three kinds of spiders have been noted (Brown, Richard, pers. comm.) On February 22, 1959, colonies of harvestmen and two varieties of slug were noted in the moonmilk area. Algae, mosses and ferns grow near electric lights in much of the cave.

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Appendix E
GEOLOGIC TIME CHART

YEARS IN MILLIONS	EPOCH	KLAMATH EROSION	COAST RANGE EROSION	CASCADES VOLCANISM	LIFE MAMMALS	
		UPLIFT		High Cascades	Mammoth	
			UPLIFT	Cascan Fm.	Smilodon	
10	Pliocene	Peneplation			PLIOHIPPUS	
		Truncation		Troutdale Fm.	MERYOPIPPUS	CASCADIAN REVOLUTION
		Erosion		Columbia Basalt		
	Miocene		Begin UPLIFT	Mollalla Fm.		
				Nimrod Granite	MIOHIPPUS	
30		Erosion		Mehama Volcanics	MESOHIPPUS	
36	Oligocene				Brontotherium	
40		Erosion				
				Calapoya Fm.		
		. . . . .	TYEE Fm.	S. Cascades		
		UPLIFT	Deposition	Clarno Fm.	EOHIPPUS	
50		Erosion		Columbia Gorge		
			Umpqua Fm.	WESTERN		
58	Eocene	Erosion	Deposition	CASCADES		
60		Erosion				
63	Paleocene				Early Mammals	
		. . . . .				
70		UPLIFT			Hesperornis	
					Pterandodon	
					Archelon	
					Mesosaur	
80		Deformation			Protoceratops	LARAMIDE REVOLUTION
90		Metamorphosis			TRACHYDON	
					TYRANNOSAURUS	
		Folding			TRICERATOPS	
					Ankylosaurus	
100		Deposition			ZELAMBDALESTES	
110		Deformation				
120		Deposition				
130		Grantic				
135	CRETACEOUS	Intrusions				
		Metamorphosis				
140					Belemnite	
		Folding			Ctenacodon	
150		Faulting			ARCHEOPITRYX	
					PLESIOSAURUS	
		Deformation			ICHTHYOSAURUS	
160					Allosaurus	
		Deposition			STEGOSAURUS	
					BRONTOSAURUS	
170		metamorphosis				NEVADIAN DISTURBANCE
		Deposition				
180	JURASSIC					
181		Metamporphosis			CYNOGNATHUS	
					Phytosaur	
190		Galice Fm.			Plateosaurus	
		Rogue Fm.				
		Dothan Fm.				
200						
		APPLEGATE FM.				
		Limestone				
210						
	TRIASSIC	Deposition				

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