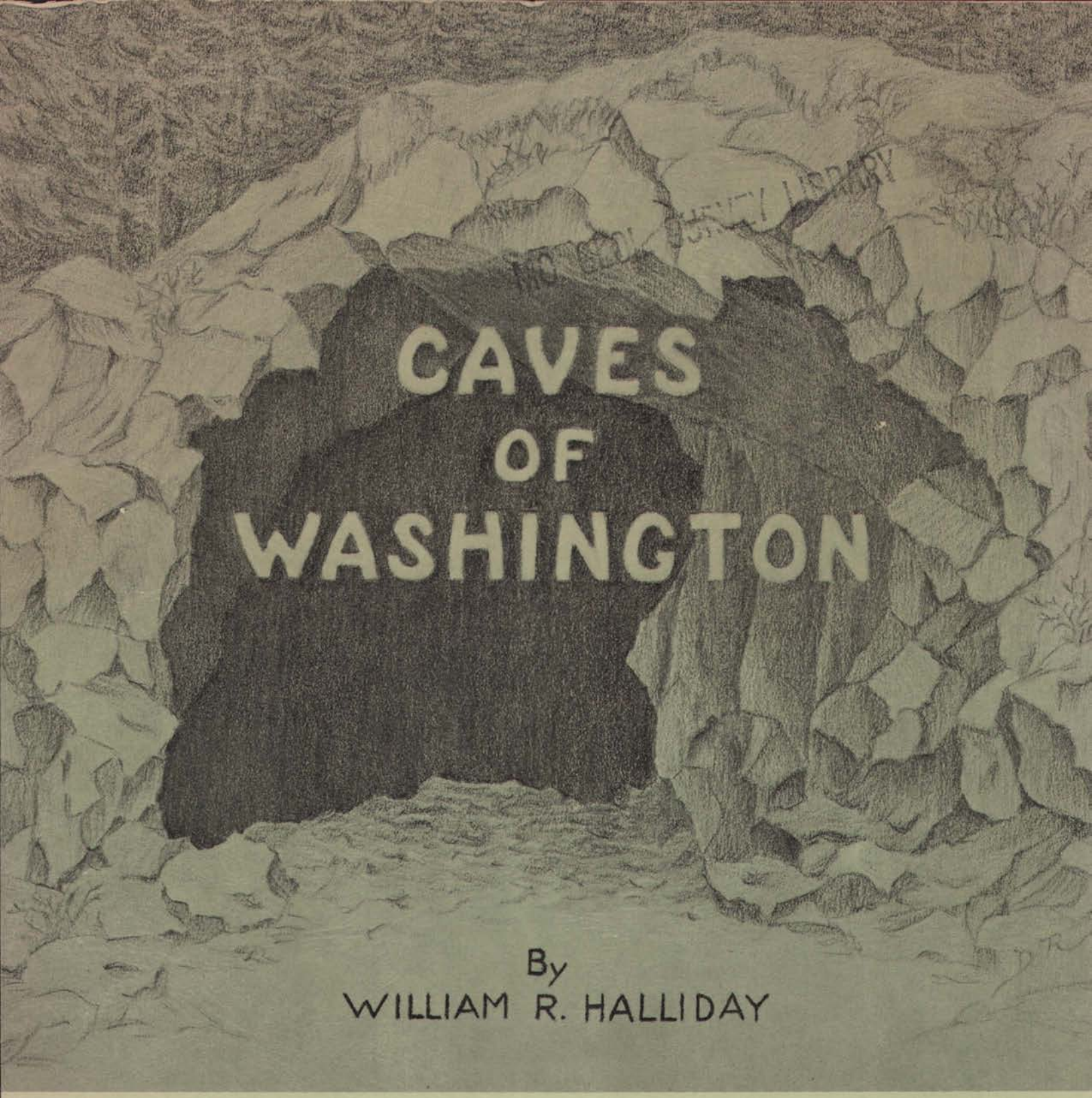

CAVES OF WASHINGTON

By
WILLIAM R. HALLIDAY

WASHINGTON DEPARTMENT OF CONSERVATION
DIVISION OF MINES AND GEOLOGY

INFORMATION CIRCULAR NO. 40

1963

State of Washington
ALBERT D. ROSELLINI, Governor

Department of Conservation
EARL COE, Director

DIVISION OF MINES AND GEOLOGY
MARSHALL T. HUNTTING, Supervisor

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Director,

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FOREWORD

Spelunkers and scientists are familiar with caves in many parts of the country, but only few know of the caves in Washington. This familiarity stems from extensive explorations of the known caverns and from the excellent reports published by several agencies. At least six State Geological Surveys have published comprehensive reports on the caves of their respective states, and other agencies have published cave reports for at least five other states.

When we learned that Dr. William R. Halliday, Director of the Washington Speleological Survey, was compiling an inventory of the caves of Washington, an agreement was made whereby the Division of Mines and Geology would publish his report. We are fortunate to have the services of Dr. Halliday in this work. Although his profession, medicine, makes heavy demands on his time, he has found time to examine hundreds of caves in the United States and has explored almost all the known caves in Washington.

Some 110 caves are described in this report. The limestone caverns here are relatively small, but Washington's lava-tube caves are large, numerous, and complex. Cave explorers and geologists will find these tubes interesting not only for their scientific values but also for their opportunities for adventurous recreation. In addition, this report will be helpful in evaluating the State's caves as war-time shelters and underground storage facilities.

Marshall T. Huntting, Supervisor
Division of Mines and Geology
Olympia, Washington

August 15, 1963

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CAVES OF WASHINGTON

By William R. Halliday

INTRODUCTION

Washington is not generally considered to be a "cave state." For those speleologists who are concerned wholly with solution caverns in limestone and other soluble rocks, this is a reasonable concept. It was not until 1942 that the National Speleological Society, the nationwide organization of speleologists and spelunkers, was able to determine that any solution cave existed in Washington (Bischoff, 1942). The total slope length of the passages of the largest limestone cave in Washington, Gardner Cave, is only about 1,050 feet. Nevertheless, the limestone caves of Washington are of interest because the unusual variety of their environments is reflected in their differing natures, features, and contents.

Persons concerned with broader implications of speleology will find Washington a fruitful area of study. This is particularly true of the student of lava tubes and of vulcanism in general. Ape Cave, the longest lava-tube cave known in the continental United States, and perhaps the world's longest, is in Skamania County. The concentration of lava-tube caves in Washington is not so great as in Lava Beds National Monument in California, or perhaps in the Bend area of Oregon. However, Washington's numerous and extensive lava tubes provide a great variety of features of these caves and their enveloping bedrock. To a lesser degree, the littoral (sea) caves of Washington, pounded out by wave action on fissures and by compression of air therein, are also of specialized interest.

In discussing the caves of Washington, it is convenient to divide the State into four regions—the Olympic Peninsula-Willapa Hills area, northern Cascade Mountains, southern Cascade Mountains, and the Columbia lava plateau.

The basalt flows of Miocene age in the Columbia lava plateau of eastern Washington contain no known lava tube or sizable remnant thereof. The Mesozoic and Cenozoic limestones of limited extent in the Olympic Peninsula and Willapa Hills region contain no known limestone cave. Both areas, however, contain numerous caves of other types. In 1954 (Swanson and Bryan, 1954) the Washington Archeological Survey recorded 188 caves in the state, 99 percent of which, it was stated, were in Miocene basalt, mostly in the Columbia plateau region. As far as is known, the latter were all rockshelters rather than true caves. In that report some lava tubes of the southern Cascade Mountains were erroneously listed as occurring in Miocene basalt.

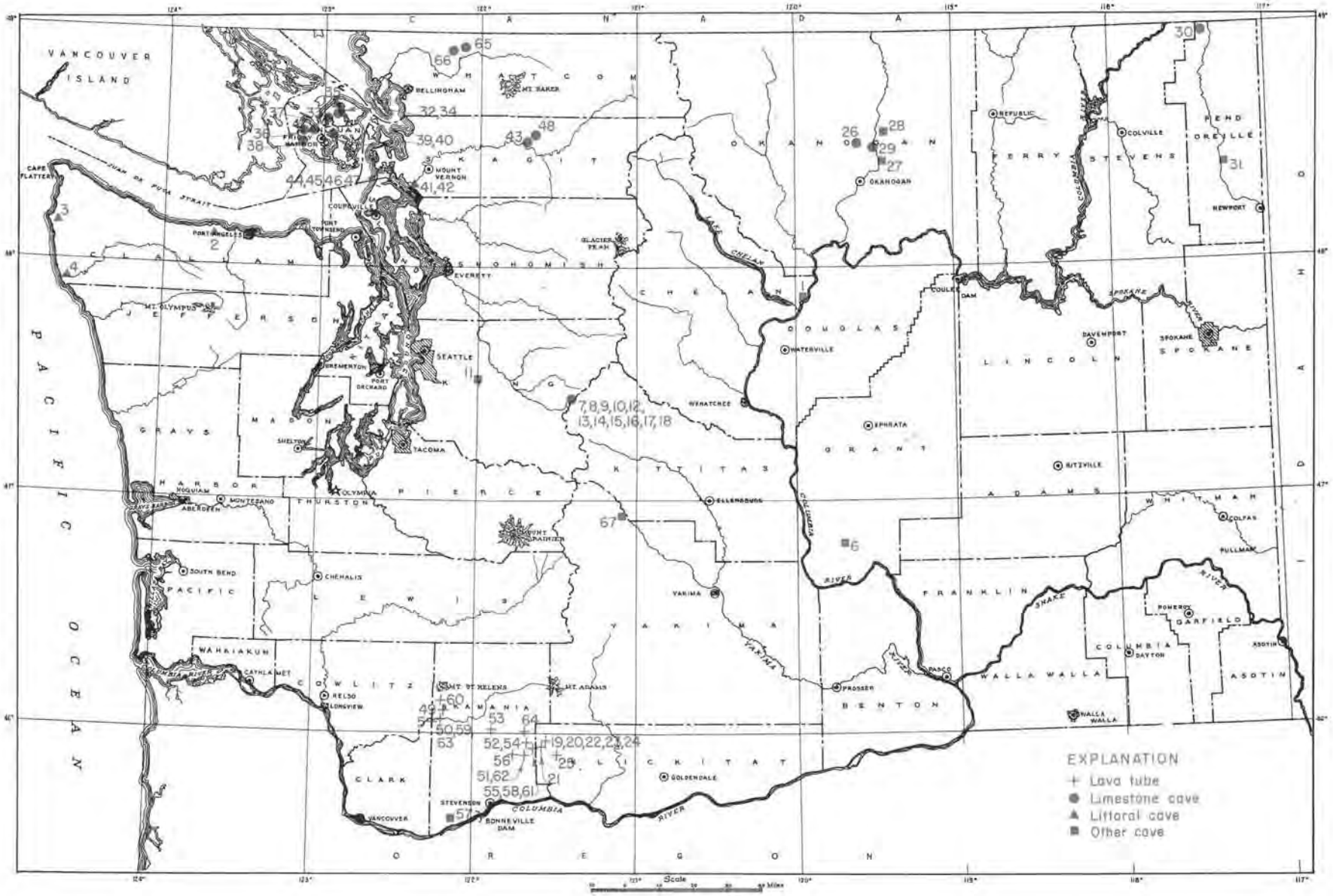

Figure 1.—Map of Washington showing locations of caves. The numbers on the map correspond with the numbers following individual cave names in the text.

The limestone cave region of Washington is its northern strip, which includes the San Juan Islands, the northern Cascade Mountains, and the Okanogan Highlands. In this strip there are caves in limestones that appear to range from Cambrian to Permian (?) age, although age determinations in most of these limestones are difficult or impossible.

The other speleoliferous region of Washington is the southern Cascade Mountain area, where lava tubes have been found in a number of lava flows in a wedge-shaped area south of Mount St. Helens and Mount Adams, extending from east to west across the central part of Skamania County and into adjoining counties. No evidence has been found that any of these caves are in flows that were extruded prior to the Pleistocene epoch, and it appears that all these tubes were formed in late Pleistocene and Recent time (Halliday, 1960b).

This report on the caves of Washington is based on a correlated 10-year field and bibliographic study, initiated by the Cascade Grotto of the National Speleological Society, continued by individual members of The Mountaineers after the temporary inactivation of the Cascade Grotto, and revitalized by the Washington Speleological Survey, a unit of the Western Speleological Survey.

The goals of this Survey have been to locate, survey, study, and describe in detail every limestone cavern and related karstic phenomenon, and every major lava tube in Washington. This report is the result. The Survey has not attempted to locate and record every rockshelter or every littoral, talus, or fissure cave in Washington, as these are of minor speleological importance, even though they may be significant to archeologists, biologists, and others in fields allied to speleology. Only cursory mention has been given to such caverns in this report, although an attempt has been made to list everything in Washington that has been termed a cave. This has been done not only for the reference of students of the allied sciences, but in order to prevent future confusion about the nature of minor caves, some of which have received surprisingly wide publicity in print and by word of mouth.

Because of the logistic problems of a volunteer effort of this kind, the rugged terrain and heavy vegetation of most of the cave areas, and the scant stratigraphic and geomorphic knowledge about much of the State, the goals of this Survey have not been reached in full; even though additional exploration and mapping will be completed in future years, they will probably always remain mere goals. As indicated further in the text, it has not been possible to locate a few caves that have been reported to exist. One Washington cave is so difficult to find that the Survey has been unable to locate it again after an initial cursory visit. It is entirely probable that a few important caves have not come to our attention, and even more probable that there are a number of important caves not yet discovered because of dense vegetation or lack of human visitation. Undoubtedly, there are still others that are choked with glacial deposits, alluvium, or logging debris. Additions, corrections, and further information of any kind on Washington caves would be extremely welcome, as would be the assistance of individuals who wish to aid the future work of the Survey in any other way.

In this report the limestone caves of the State are discussed in more detail than has been customary in other state speleological surveys. It appears that the origin and development of limestone caves in

Washington, like those of other regions, are intimately related to regional and local geomorphic cycles. Solution of the limestone by acidic ground water begins beneath the water table, in a honeycomb or latticelike pattern, along joints and other zones of greater permeability. Subsequently, in certain areas preferential solution occurs under the influence of gravity and hydrostatic factors of sub-water-table flow, and modified by stratigraphic and other factors. At a later stage the cave is drained by regional uplift and (or) downcutting, and subsequently modified by vadose solution and speleothem deposition. Still further modifications result from deposition of fills, under either vadose or phreatic conditions. The complexity of the recent geomorphology of most of the limestone areas of Washington is reflected to a considerable degree within its caves.

Because these caves are so few, are scattered so widely, and occur under such varied environmental conditions, it has seemed appropriate to discuss their features and speleogenesis individually and in terms of the locality rather than as a group. As in caves of other areas, both phreatic and vadose features are evident. The high-elevation caves of Mount Snoqualmie show marked modification by, for example, solution by films, trickles, and drips of descending water, whereas the two large limestone caves of eastern Washington (elevation 2,900 feet) have the massive speleothems that the other limestone caves in Washington lack.

Discussion of the features and speleogenesis of the lava tubes of Washington has been hampered by additional factors. As elsewhere, they are found only in flows of pahoehoe basalt. Accurate surveying of lava tubes is a very difficult process, not only because of compass deviations caused by magnetite in the lava flows, but also because in many lava tubes the physical effort of mapping approaches the endurance barrier. This report discusses lava tubes in much more detail than do previous, similar studies of other areas. Nevertheless, much progress is still to be made.

The study of lava tubes is also hampered by the lack of a standard classification and specific descriptions of their individual features. As a result, some of the terminology in this report may be somewhat vague and may overlap or contradict usages elsewhere in the world. With the exception of a few terms such as "cupola" and "contraction fissure," which it is hoped are used in the same sense as by their originators in Hawaii, the terminology of the features of lava tubes used here is largely original, and is as descriptive as possible. The study of lava tubes is in its infancy, and detailed sequential speleogenetic studies are needed. It is evident from even these preliminary studies that lava-tube speleogenesis is much more complex than is generally recognized. Many features and partial sequences indicative of this complexity are listed in the descriptions of individual caves. This writer tentatively holds a modified version of the theories of Wentworth and Macdonald (1953) on the origin of lava tubes. On the basis of preliminary study of the lava tubes of Washington, it appears that they originate as sinuous, roughly cylindrical structures, which may be simple or complex depending on prior surface and subsurface topography, as a result of effluence of molten lava and with some effects due to hot gases, and most of them are markedly modified by the passage of lava through the primitive tube or system under a variety of conditions. Additional studies will be necessary to determine or disprove the validity of this theory, and

to determine the nature of many details of these caves. Studies of these processes are in progress and will be the subject of a later report.

In passing, it should be noted that this report follows the standard practice of nomenclature of caves in glaciers and caves in various rocks that trap cold air and form ice. The former are glacier caves; the latter are ice caves or glacieres. For a detailed study of ice caves and their meteorology the reader is referred to an earlier report (Halliday, 1954).

All the lava tubes examined during this survey occur in pahoehoe basaltic lava flows on gentle slopes. The thickness of roofs ranges from 1 to about 50 feet. Calcareous speleothems are absent or minute. Lava stalactites and stalagmites formed by dripping of lava are present in a few caves. Ridges and grooves on the walls of most of the caves record temporary levels of flow of a lava river.

All the caves can be entered through breakdowns in the roof caused by collapse. Where not covered by rubble, most, but not all, of their floors show typical congealed surfaces of lava rivers. Some are typical smooth or ropy pahoehoe lava; others are granulated. Most of the lava tubes have effluent or confluent branches or both. Several of them have two or more gently sloping sections connected by short steep pitches. Others have as many as five superimposed levels, connected by pits of at least two types.

Most of the tubes' original surfaces are heavily glazed by secondary remelting. Breakdown of some tubes is so great that the pile of rubble on the floor is higher than the original roof. In other tubes, only a thin veneer has fallen, revealing multiple layers, each with a surface glaze. Some stretches of the tubes are inaccessible as a result of trenchlike collapse of the roof; others because of solid fills of undrained lava. None show explosion features, although two or three are entered through schollendoms. None were noted in pressure ridges.

The slope of the floors of the tubes is subject to some variation and may be related to the pre-lava topography. These caves contain many features that indicate the conditions present during their origin and development, and in some a complex series of events can be traced. They appear to have functioned as conduits of lava flow. Some show distal ramification; others definitely do not. In several of these caverns there are features that seem to indicate the existence of multiple extra-tubal lava sources that have intersected the tubes at various points. As a group, these tubes do not seem entirely in accord with the traditional concept of these caves as simple lava conduits with distal ramifications.

It must be stressed that many Washington caves, like those elsewhere, are dangerous and also fragile. A cave visitor should never break, destroy, or remove any feature of any cave unless it is essential for study by competent authorities. It may well not be replaced within the life span of the human race, as many cavern features were formed under different conditions than now prevail. Because most of the caves of Washington are at least potentially dangerous, neophytes interested in caves would do well to accompany parties of experienced cavers, rather than explore alone or with other inexperienced persons. The writer[1] will be glad to assist such persons upon request.

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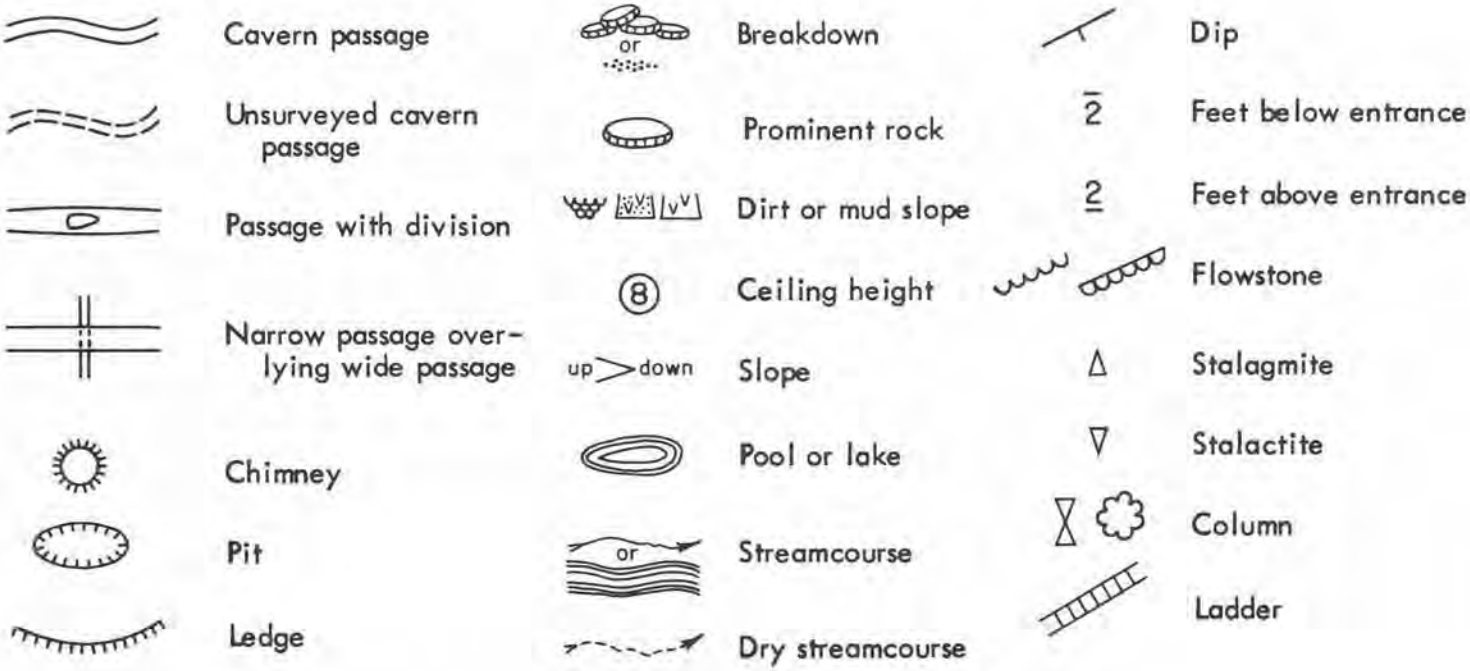
[1] The author's present (1962) address is 1117 - 36th Ave. E., Seattle, Wash.

ACKNOWLEDGMENTS

Speleology requires teamwork, and a great many persons have assisted in the preparation of this report and the research that preceded it. Their help is deeply appreciated. W. R. Danner, of the University of British Columbia, contributed much of the information on limestone deposits of western Washington and other valuable assistance, including critical review and several photographs. Homer I. Spencer aided greatly in the survey of the Trout Lake area, as did (elsewhere) Carl Nielsen, Miss Ruth Brown, and Datus Perry. Members of the San Juan Reef Raiders and of the Washington Foldboat Club supplied data on various littoral caves. Without the cordial assistance of Harry Reese, the extremely important lava tubes of the Mount St. Helens flows would still be largely unknown. Senator Nat Washington supplied information on caves near Soap Lake. Richard Snyder, of the University of Washington, kindly identified salamanders; and Thomas C. Barr, of Tennessee Polytechnic Institute, identified the invertebrates mentioned, with the exception of the grylloblattids, which were studied by Ashley B. Gurney, of the U.S. National Museum. Howard Coombs, of the University of Washington, identified the puzzling red autobrecciated lava seen in Ape and Lake Caves. Bob and Ira Spring kindly contributed some of their magnificent photographs. Charles I. Barker also supplied a photograph and arranged for the use of those by Bill Lancaster. Special credit is due Bill Dailey of Portland for preparing the original maps used as a base for the tracings used in this report. David Brannon, Jr. and Leonard Libbey gave valuable bibliographic assistance. So many persons helped in field work that it is impossible to name them all here. Assistance of the U.S. Forest Service, the National Park Service, the National Speleological Society, the Western Speleological Survey, the Seattle Public Library, and the University of Washington Library is gratefully acknowledged.

MAP SYMBOLS



DESCRIPTIONS OF CAVES

ADAMS COUNTY

Adams County is not known to contain any limestone. Only one cave has been reported.

MEYER CAVE

This is a rockshelter near Ritzville in Miocene basalt (Swanson and Bryan, 1954).

ASOTIN COUNTY

A little limestone occurs in the southeastern corner of Asotin County, but no caves of any type have been reported. There are a number of rockshelters in the basalt walls of the canyon of the Snake River.

BENTON COUNTY

No limestone is known in Benton County. Rockshelters undoubtedly are present, but no caves have been reported.

Figure 2.—Cavernous fissure southeast of the Ideal Cement Company quarry near Soda Springs, Chelan County. Photo by W. R. Danner.

CHELAN COUNTY

Chelan County contains small scattered deposits of limestone, but, despite rumors of their occurrence, the Survey has been unable to locate any limestone caves in this county. The most extensive limestone areas are west of Lake Wenatchee, in the valley of the Little Wenatchee River. In that locality there are numerous karstic features, including collapse and solution sinks, a narrow cavernous fissure (fig. 2), a sinkhole swallet, and a resurgence. The latter two features are, respectively, in and below the Soda Springs quarry of the Ideal Cement Company. Another karst area with sinks and at least three swallets is located on the hillside on the south side of the Little Wenatchee River for about 1 mile eastward from Rainy Creek (W. R. Danner, written

communication). Caves have been locally reported about 2 miles southwest of Cashmere, but none were found during field work, and this is not a limestone area.

CHELAN ICE CAVE (1)*

This is a small overhang at the lower end of a talus slope, near the bottom of the canyon 6.2 miles south of the Chelan-Okanogan county line on U.S. Highway 97, east of the highway. It is a typical example of cold-trapping talus, and in warm weather the overhang serves as the egress of slowly released cold air remaining from the previous winter. Because of its heavier weight, the cold air slowly migrates downward through the irregular spaces among the talus fragments (Halliday, 1954). Ice usually remains on the floor of the "cave" in late spring, and temporarily extends past the overhang for a few feet. Other, similar occurrences are listed in this report, and local inquiry has produced the information that they are relatively common in Chelan County. Because of its location beside a main highway, Chelan Ice Cave has been known for more than 50 years (Steele, 1904, p. 700).

CLALLAM COUNTY

The only caves reported in Clallam County are littoral. Most widely known are probably those at Agate Bay, but sizable littoral caves are reported at the south end of Shi Shi Beach, at Point of Arches, north of Cape Alava, and north of La Push (fig. 3).

AGATE BAY CAVES (2)

Sec. 20, T. 31 N., R. 8 W., Joyce quadrangle.

The extent of these littoral caverns is undetermined. They are of interest largely because of the Indian legend which claims that, long before white men came to the Northwest, two adventurous braves paddled into one of the caves and were never seen again.

CARSON CAVE (3)

Sec. 13, T. 31 N., R. 16 W., Ozette Lake quadrangle.

This is a major littoral cavern 2 miles north of Cape Alava. A large variety of marine life inhabits the cavern (Anon., 1960).

HOLE-IN-THE-WALL (4)

This is a tunnellike littoral cavern (fig. 4) that extends through a headland about 2 miles north of La Push. There is a smaller, somewhat similar tunnel north of Yellow Banks (W. R. Danner, oral communication).

*The numbers following cave names correspond with the numbers that indicate the locations of the caves on the map (fig. 1) on page 2.

Figure 3.—Typical small littoral cave on the Washington coast, north of La Push.

Figure 4.—Hole-in-the-Wall, a littoral cave extending completely through a small headland about 2 miles north of La Push.

CLARK COUNTY

No limestone and no Recent or Pleistocene pahoehoe lava flows are known in Clark County. There is said to be a small cave near Washougal, but it was not found during field work.

COLUMBIA COUNTY

No caves have been reported in Columbia County.

COWLITZ COUNTY

The western fringes of the Mount St. Helens lava-tube area extend into Cowlitz County. To date, only one small lava tube has been found within the county, however.

STRING CAVE (5)

Sec. 25, T. 7 N., R. 4 E., Cougar quadrangle. Elevation about 1,100 feet.

This small cave was found by the writer on Nov. 5, 1960, but the presence of rotting string within the cave indicates that it had been visited previously. The main entrance is about 8 feet wide and 4 feet high. The cave continues northwestward for about 60 feet as a stoopway and crawlway. About 25 feet from the entrance is a chimney to the surface 10 feet overhead. Debris on the floor indicates that the cave is a seasonal streamcourse. Tree casts and a few flow marks are present.

OTHER CAVES

On the southwest side of Grass Lake, west of the Mount St. Helens cave area, there is said to be a lava sinkhole plugged by logs standing on end as if drawn into it by a whirlpool. It is believed locally that this is the opening of a swallet that engulfed flood waters of Grass Lake on December 24, 1933, the resurgence of which, on that date, excavated Christmas Canyon, a prominent landmark on the north wall of the canyon of the Lewis River.

DOUGLAS COUNTY

A "cave dwelling" north of Orondo is shown on current State road maps. This is undoubtedly a rockshelter site, as neither limestone nor pahoehoe lava occurs near Orondo. There are local reports of a glaciere in talus, between Bridgeport and Brewster.

FERRY COUNTY

No caves are known in Ferry County. The Washington Division of Mines and Geology (written communication, 1960) reports that a supposed ice cave near Covada is an old mine adit, which penetrates about 75 feet of cold-trapping talus before entering solid rock.

GARFIELD COUNTY

No caves have been reported in Garfield County.

GRANT COUNTY

No limestone is known in Grant County. Most of the bedrock is basalt of Miocene age. A considerable number of rockshelters in this county have been termed "caves."

ARROW SHAFT CAVE

This is a large rockshelter east of Lake Lenore (Washington, 1958), one of at least seven in the area.

BEVERLY ICE CAVE (See Smyrna Ice Cave.)

BLUE LAKE CAVE

This is a small rockshelter near Blue Lake (Washington, 1958).

BLUE LAKE RHINO CAVE (See Rhinoceros Cave.)

BOY SCOUT CAVE

This is a small cave in talus, west of the north end of Soap Lake (N. W. Washington, oral communication).

CRAB CREEK CAVE (Wilson Creek Cave)

This cave was not found during field work. It is believed to be a rockshelter near the town of Wilson Creek.

DRY FALLS CAVE

This small rockshelter (fig. 5) in basalt is near the trail descending into the Dry Falls basin from the observation platform on the rim. The opening extends about 60 feet back into the sheer cliff.

Figure 5.—Dry Falls Cave. Photo by Bob and Ira Spring.

EAST LENORE CAVES

Besides Arrow Shaft Cave, six small rockshelters have been reported in the area east of Lake Lenore (Washington, 1958).

HORSETHIEF CAVE

This is a 300-foot cave with two entrances in the cliff north of Soap Lake. The description is suggestive of a block-creep cavern. (N. W. Washington, oral communication.)

INDIAN CAVE

This is an easily seen rockshelter (fig. 6) about 1 mile south of Vantage, on the east bank of the Columbia River. The name is also applicable to a number of other rockshelters in this area, which is under study by various archeological organizations.

JASPER CAVE

This is a large rockshelter on the west wall of Jasper Coulee (Washington, 1958).

MOONSHINER'S CAVES

These two adjoining rockshelters are in T. 23 N., R. 23 E. A spring emerges from the floor of one of them (Washington, 1958).

Figure 6.—Indian Cave near Vantage, Grant County. This is a typical rockshelter in the basalt of eastern Washington.

Figure 7.—Smyrna Ice Cave, a typical example of cold-trapping talus, with an "ice cave" at the lower end. A door closes the "cave" entrance.

OWL CAVE

This is another rockshelter in basalt in the Grand Coulee area (Osborne, n.d. a).

PICTOGRAPH CAVE

This is a small rockshelter in T. 24 N., R. 26 E. (Osborne, n.d. b).

RHINOCEROS CAVE (Blue Lake Rhino Cave)

The mold of a rhinoceros in pillow lava at the mouth of Jasper Canyon has been termed a "cave" in both popular and technical (Chappell and others, 1951) usage. The mold is about 8 feet long and is entered through a small opening in the left thigh region.

SMYRNA ICE CAVE (6) (Beverly Ice Cave)

This is an artificial "cave" (fig. 7) dug into cold-trapping talus, 5 miles west of Smyrna. Its location is shown on the U.S. Geological Survey Smyrna quadrangle.

SOUTH CAVE

This is a rockshelter in the lower Grand Coulee (Gallagher, 1959).

WEST LENORE CAVES

There are several rockshelters west of Lake Lenore in lower Grand Coulee (Washington, 1958).

WILSON CREEK CAVE (See Crab Creek Cave.)

GRAYS HARBOR COUNTY

No limestone cave has been reported in Grays Harbor County. There are a number of littoral caves on the shore of the Quinault Indian Reservation. One extends completely through a small island near Elephant Rock (Doward, 1958).

ISLAND COUNTY

No caves have been reported in Island County.

JEFFERSON COUNTY

Little limestone is present in Jefferson County. A number of littoral caverns are south of La Push. The largest, about 100 feet long, parallels the cliff and is open at both ends. Other small littoral caves, in basalt of the Crescent Formation, are along the west side of Dabob Bay and at Pulali Point on Hood Canal (W. R. Danner, oral communication).

LAKE LENA CAVES

These are talus caves at the end of Lower Lena Lake (Morgan, 1952). Their status as glacieres is uncertain.

KING COUNTY

King County contains the largest limestone caves known in western Washington. A number of caves of other types are also in this County.

ADAIR'S CAVE (See Prospector's Cave.)

BLACK RIVER CAVE

Sec. 16, T. 23 N., R. 5 E., Renton quadrangle. Elevation about 50 feet.

Although this is not a limestone area, there is said to have been a small natural cave in the cut-bank of the Black River in Renton, below Maple Street and the Seattle highway. There is no trace of such a cave today. One may have collapsed here about 20 years ago (Douglas, 1957). The present residents report that a sinkhole developed in their backyard about 1955, but it was filled to prevent accidents.

BREAKDOWN CAVE (See Danger Cave.)

CLARK'S CAVE (7)

Sec. 28, T. 23 N., R. 11 E., Snoqualmie quadrangle. Elevation about 4,750 feet.

This tiny cave was the first discovered of the Snoqualmie Pass group. It is at the base of the slopes on the south side of the hanging valley on the south side of Mount Snoqualmie, just upstream from a small pond. Its entire length of about 35 feet consists of tight crawlways (Steinburn, 1952). This cave and a small, impenetrable fissure a few feet farther up the gulch serve as resurgences after periods of heavy rainfall and are dry only in late summer.

CLIFF CAVE (8)

Sec. 28, T. 23 N., R. 11 E., Snoqualmie quadrangle. Elevation about 5,200 feet.

This small cavern is hardly more than a rockshelter in limestone. It is at the south end of the small ridge that forms the east border of Cave Ridge, and is south of Red Cave.

DANGER CAVE (9) (Breakdown Cave)

Sec. 28, T. 23 N., R. 11 E., Snoqualmie quadrangle. Elevation about 5,075 feet.

Danger Cave (fig. 8) is treacherous, deep, and moderately sizable, with about 250 feet of passages and chambers. It reaches a depth of about 150 feet. The cave is on the southeast side of the

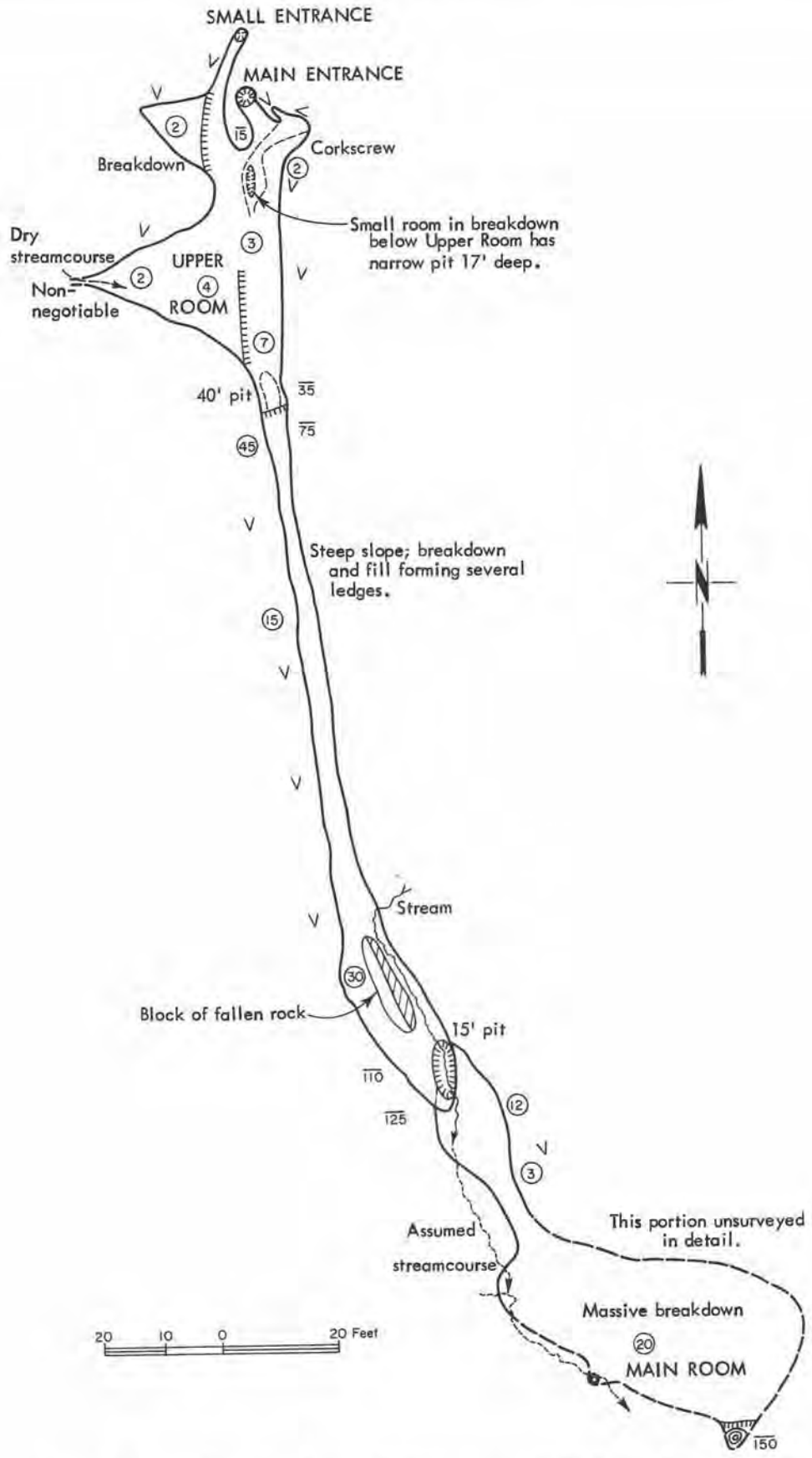


Figure 8.—Danger Cave, King County. Preliminary survey by Washington Speleological Survey, December 1960. Distances below entrance are estimated.

area locally called Sinkhole Amphitheater, opposite Red and Hellhole Caves, and is at the south end of a small lapies ravine about 100 yards long. The immediate environs are not forested, but low alpine growth is present. Perhaps because of its position on the open ridge, Danger Cave is a little warmer than the other caves of the group. Its name is due to the loose rock in the cave, which is a prohibitive risk to all but experienced cavers.

The bedrock at Danger Cave is a marble member of the Denny Formation, which is believed to be of Permian age (Foster, 1960). It is heavily fractured and appears to dip about 30° S., as in most of Cave Ridge. The beds exposed on the opposite sides of the main passage do not correspond, suggesting that the cave has been formed along a fault aligned parallel to the dip of the bedrock. Extensive slumping and breakdown are present throughout the cave, and deposits of sand, gravel, and boulders are prominent in its lower areas.

Figure 9.—Breakdown-strewn entrance chamber of Danger Cave, King County. Photo by Bob and Ira Spring.

The main entrance of the cave is a narrow opening in a small hillock. A steep, narrow passage leads downward about 20 feet to the low entrance chamber (fig. 9), which can also be reached by a crawlway from a tiny second entrance 15 feet north of the main entrance. The crawlway passes approximately beneath the main entrance. The entrance chamber, known as the Upper Room, is 2 to 6 feet high, is irregular in outline, and has a maximum width of 38 feet at a place where a narrow dry stream channel enters the room from the west. This chamber ends at a 40-foot pit, 55 feet from the entrance. It contains no speleothems. On the ceiling is a half-tube that appears to be of phreatic origin.

Just inside the main entrance of the cave, a tortuous narrow pit leads to two small breakdown chambers beneath the entrance room. One contains a fissurelike pit, 17 feet deep, aligned with the main fissure of the cave.

The 40-foot pit (fig. 10) at the end of the Upper Room is actually a dropoff to a steeply sloping passage about 3 feet wide that extends southward. Its floor is covered with large accumulations of breakdown and stream deposits, which form several "levels," pits, and ledges. In widened horizontal joints, miniature ceiling pendants are locally prominent. At a point about 100 feet downslope from the base of the pit, a large block of fallen rock about 12 feet long divides the passage. By ascending this block, a small "upper level" can be entered, where vertical waterfall slots are prominent. One group of slots approaches dome pit proportions. Extremely thin blades of impurities project from the walls, and a little boxwork is developed locally.

Figure 10.—The 40-foot pit in Danger Cave, King County.

Near the point where the fallen block divides the main passage, a stream enters from the east and flows down the east branch of the passage to a 15-foot pit beyond the block.

Below this pit is the breakdown-choked main room of the cave. Its floor plan is irregular. The central part of its south wall is about 30 feet southeast of the base of the pit. From this point it is 55 feet to the farthest point of the east wall. Great masses of breakdown are present. At the southeast corner a sloping, gravel-strewn pit about 15 feet deep leads to a small pool that is the only visible part of a more extensive water surface beneath the breakdown. Nearby are two short tubular stalactites and a small white stalagmite, the only major speleothems in the cave.

At the southwest corner of this chamber a series of partly tubular bedrock passages permit the flow of the cave stream to another small pond. These are the only passageways in the cave that are not heavily modified by breakdown. During the wet weather other, smaller streams enter the cave through waterfall chutes near this place.

Danger Cave is being enlarged and flushed by vadose water. Speleothem deposition is almost nil. Despite the great accumulations of breakdown and stream deposits, there is evidence of a sub-water-table origin of the cave, but no sign of integration by shallow sub-water-table flow. Of particular interest are the ceiling pendants in widened horizontal joints along the main passage, which appear to have developed when that passage was temporarily filled with sediment.

DANGER CAVE ANNEX (10)

About 50 feet southeast of Danger Cave and 20 feet lower than its entrance is a small cavern. The cavern is aligned parallel to Danger Cave and consists of a steeply sloping passage about 30 feet long with a single short, tight crawlway to one side.

DON'S CAVE (11) (Mount Issaquah Cave)

Approximately sec. 36, T. 24 N., R. 6 E., Snohomish quadrangle.

This is a talus cave 111 feet long, roofed almost completely by a single enormous boulder. It is on the western face of Mount Issaquah.

DONLAN'S CAVE

Repeated search for this cave, supposedly on Denny Peak, has been fruitless. The informant, Joseph P. Donlan, in 1952 was unable to recognize any landmarks in the area where he believed that he had discovered the cave 50 years earlier. There is an abandoned limestone quarry on a different part of Denny Peak. The sound of running water can be heard through a crack near this quarry, and a small stream issues from talus farther down the slope.

GROTTO CAVE (See Lost Cave, King County.)

HELLHOLE CAVE (12)

Sec. 28, T. 23 N., R. 11 E., Snoqualmie quadrangle. Elevation about 5,180 feet.

Hellhole Cave is a few dozen yards south of the crest of Cave Ridge, about 200 yards west of Red Cave. It is in a small flat above the northwest end of the so-called Sinkhole Amphitheater, about 100 feet northeast of a large collapse sink. The small entrance sink of the cave is about 4 feet in diameter and 8 feet deep, and is almost concealed by heather and other low alpine plants.

The actual entrance of the cave is a triangular orifice at the bottom of the sink. It is about 12 inches on each side, and barely admits an agile, slender person. Below is a free 60-foot drop to the floor of a large sloping chamber about 100 feet long, 35 feet wide, and 20 to 60 feet high. On the floor are masses of breakdown, much of which is unstable. Because of the danger involved, the cavern has been only partially explored. There are several narrow, roughly parallel side passages, but none has been found to be more than about 100 feet long. Pits leading to a total depth of more than 100 feet below the surface have been partially explored.

Figure 11.—Drip slots at the bottom of the 60-foot drop in Hellhole Cave, King County, look as if they had been incised by pneumatic drills. The helmet, to the left side of the upper part of the slots, shows their size.

Most of the breakdown consists of fragments of schist from a bed of that material in the Denny Formation overlying the tilted marble in which the cave was formed. Although irregular vertical vadose grooving (fig. 11) is prominent, the rounded shape of the cavern where not disrupted by breakdown appears to be of sub-water-table origin. One short sinuous re-entrant passage between two parts of the larger chamber evidently carried a heavy flow of water at some period before the time of collapse. Its walls are fluted to a height of several feet.

Speleothems are sparse in Hellhole Cave. There are a few small stalactites. Red terraced flowstone, like that found in Red Cave, is present in several areas.

Entry into this cave and travel on its floor are slow, difficult, and dangerous. Persons planning exploration in it should consider the fact that an injured explorer cannot be hoisted through the narrow entrance, a passage that is difficult even under ideal conditions.

LEDGE PIT (13)

Sec. 28, T. 23 N., R. 11 E., Snoqualmie quadrangle.
Elevation about 4,950 feet.

Formed in limestone at the base of a ledge about 200 feet above Clark's Cave, this pit is about 10 feet deep. The entrance (fig. 12) is approximately 2 feet wide, but the pit widens at the bottom to form a room about 5 feet wide.

Figure 12.—Entrance of Ledge Pit, a very small cave near Snoqualmie Pass.

LOOKOUT CAVE (14)

Sec. 28, T. 23 N., R. 11 E., Snoqualmie quadrangle. Elevation about 5,125 feet.

The 1961 Cave Ridge expedition of the Washington Speleological Survey discovered that at the bottom of a prominent sink about 100 yards southeast of Hellhole Cave a large rock had moved or been moved, permitting entry into a major cavern (fig. 13A). This sink is on a small flat on the southwestern edge of Cave Ridge, affording a magnificent view of Snoqualmie Pass and wide expanses to the south (fig. 13).

A descent of 6 feet through a vertical opening 2 feet in diameter conducts the explorer to the floor of a low passage about 3 feet wide, in which is some soft, terraced, red-orange flowstone. Ten feet to the northwest is a pit with an upper orifice about 1 foot wide and 2 feet long. It was necessary to enlarge this opening to permit entry and return of the initial explorer.

Figure 13.—Sinkhole entrance of Lookout Cave, and adjacent flat, King County.

This pit is the uppermost part of a fissure-like passage trending SSW. for about 30 feet. Its upper part is about 12 to 18 inches wide, but its lower part is wider, and contains some irregular grottos. The floor is a mass of steeply sloping breakdown and mud. Some black flowstone is present on the walls, as are vadose groovings. Noncalcareous impurities are exposed in the country rock. The ceiling is unstable at its south end.

At the lower (southern) end of this passage is a large, fairly stable pile of debris about 10 feet high. Beyond is a partly overhanging descent of 35 feet into the Big Room. This irregularly shaped chamber is about 35 feet long and 5 to 15 feet wide. Its ceiling height is 30 to 50 feet. Several alcoves and orifices are present, and breakdown subdivides the chamber. There are some vertical vadose groovings and at least one intermittent watercourse. Some curious but minor flowstonelike mud deposits are on the walls, and a little moonmilk has been noted. In a small upper grotto off the east side of the Big Room are some oblique ceiling pendants and a sloping vadose grooving adjacent to the opening through which a high-velocity seasonal rivulet flows. Some small quartz crystals have been observed in the noncalcareous impurities in the wall of the Big Room.

A small orifice leading north from the eastward extension of the Big Room conducts the explorer downward to a small chamber, from which a crawlway continues to a more spacious level passage leading eastward for about 30 feet to a small sloping chamber that appears to be blocked by breakdown and mud, although the passage can be seen to continue. This passage also may be reached by way of a pit about 15 feet deep near the easternmost point of the Big Room.

The south end of the Big Room is a steeply sloping grotto. At its lower end a short semivertical passage opens westward into a pile of breakdown at the northeast side of another chamber, about 10 feet in diameter. This room slopes to the south and is the lowest point in the cave, at an estimated depth of 125 feet below the entrance. From the northwest end of the chamber a long, steep, rock-strewn passage leads upward for about 50 feet. In breakdown to the east of this passage, some very tight orifices remain unexplored. There are several tiny white calcareous speleothems in this area. The total slope length of known passages is about 200 feet. Biota is scant except in the entrance zone, where rodent nests are present. It is doubtful that this cave is connected to nearby Hellhole Cave. Smoke bombs released in the latter on September 7, 1962, were not detected in Lookout Cave.

Because of loose rock and difficult conditions of exploration, only competent speleologists should enter this cave.

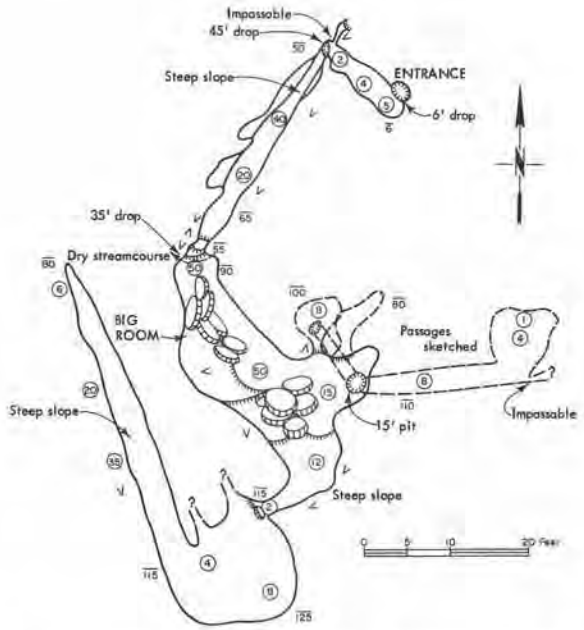


Figure 13A.—Lookout Cave, King County. Compass and tape survey by Washington Speleological Survey, September 2, 1962. Depths estimated.

LOST CAVE (Grotto Cave)

Sec. 12, T. 26 N., R. 10 E., Skykomish quadrangle.

This cave, north of U.S. Highway 2 between Grotto and Baring, has not been found during field work, although the entrance shown on a photograph (fig. 14) supposedly of the cave has been located and partially excavated. The cave may have been filled during construction of the power line tower directly above its supposed location. It was reported to be a limestone cave slanting steeply downward and into the hillside, deep enough to require early explorers to place a rude ladder inside, and having water at the bottom.

Figure 14.—This site is said to be the blocked entrance of Lost Cave near Grotto, King County. Photo by W. R. Danner.

There are a number of sinkholes in other outcrops of limestone nearby, and also in limestone deposits to the south, on Palmer Mountain and Maloney Peak.

MINER'S CAVE (See Prospector's Cave.)

MOUNT ISSAQUAH CAVE (See Don's Cave.)

MOUNT SNOQUALMIE CAVES

Sec. 28, T. 23 N., R. 11 E., Snoqualmie quadrangle. Elevation about 4,750 to 5,200 feet.

The ridge immediately south of Mount Snoqualmie, and between that mountain and Guye Peak, is the leading cave area of western Washington. In it are located Clark's Cave, Danger Cave, Hellhole Cave, Lookout Cave, Newton Cave, Prospector's Cave, Red Cave, Second Cave, and a number of other openings. The ridge itself has no official name, but it is called Cave Ridge by many persons interested in the area.

Cave Ridge is separated from the main section of Mount Snoqualmie by a small seasonal stream in a small glacial hanging valley. At the lower lip of this valley is the higher of two waterfalls, below

which the stream joins the South Fork of the Snoqualmie River. At the upper end of this hanging valley an arm of Mount Snoqualmie joins the ridge to the Mountain.

The summit line of Cave Ridge runs roughly from east to west, but it swings somewhat toward the south at the west end, where a series of spurs complicate the topography. The arm of Mount Snoqualmie and the curving ridge form a horseshoe-shaped open basin. This shallow basin contains many sinks, largely developed along low parallel outcrops, or lapies, which are strike ridges of the dipping limestone members of the bedrock. This basin is locally called Sinkhole Amphitheater. Cave Ridge and Sinkhole Amphitheater contain some of the most pronounced karst topography yet observed in the Pacific Northwest.

This is an alpine area, irregularly covered by alpine forest. Heather and low alpine plants are thick. Bare limestone appears only on the lapies and immediately adjacent to some of the sinks, except for a few unmantled areas on the arm of Mount Snoqualmie, where the limestone shows glacial striae. Sometimes as much as 15 feet of snow remains throughout the summer in the hanging valley, which overlooks a precipitous 2,000-foot descent to the glacial valley below.

The bedrock in which the caves occur is the Paleozoic, probably Permian, Denny Formation, which consists largely of alternating beds of marble and schist (Foster, 1960). The dip is generally north-northeast at about 30°, though there is some local variation. The caves tend to be formed primarily along the dip or strike, with breakdown of overlying schist quite marked. In general, they are narrow, and most of them are difficult and dangerous to explore.

The entire area is a fine example of glaciated, partly mantled mountain karst. A post-Miocene erosion surface, deeply dissected subsequent to uplift, has been partially demarcated in this area, but its relation to the caves has not been determined (Smith and Calkins, 1906). Some of the caves appear to show partial correlation with local "flats," but others do not.

Initial discovery and exploration of most of the caves in this area were by Thomas Steinburn, although Robert Clark reported the two small caves at the lower end of the hanging valley (Steinburn, 1952, Halliday, 1960a).

NEWTON CAVE (15)

Sec. 28, T. 23 N., R. 11 E., Snoqualmie quadrangle. Elevation about 5,175 feet.

Although not yet fully explored, Newton Cave (fig. 15) is the second longest limestone cave discovered in Washington, with a total slope length of about 500 feet of explored passages and an estimated depth of about 180 feet. It is a complex of narrow passageways and small, mostly elongate chambers. Steep slopes, pits, jagged chimneys, short crawlways, and a great quantity of broken rock are characteristic of the cave.

Newton Cave is located in the same lapies trench as Red Cave, and is about 100 yards north of that cave, close to the rim of the hanging valley that separates Cave Ridge from Mount Snoqualmie. The cave is formed in a marble member of the Denny Formation, the stratigraphy of which is complex.

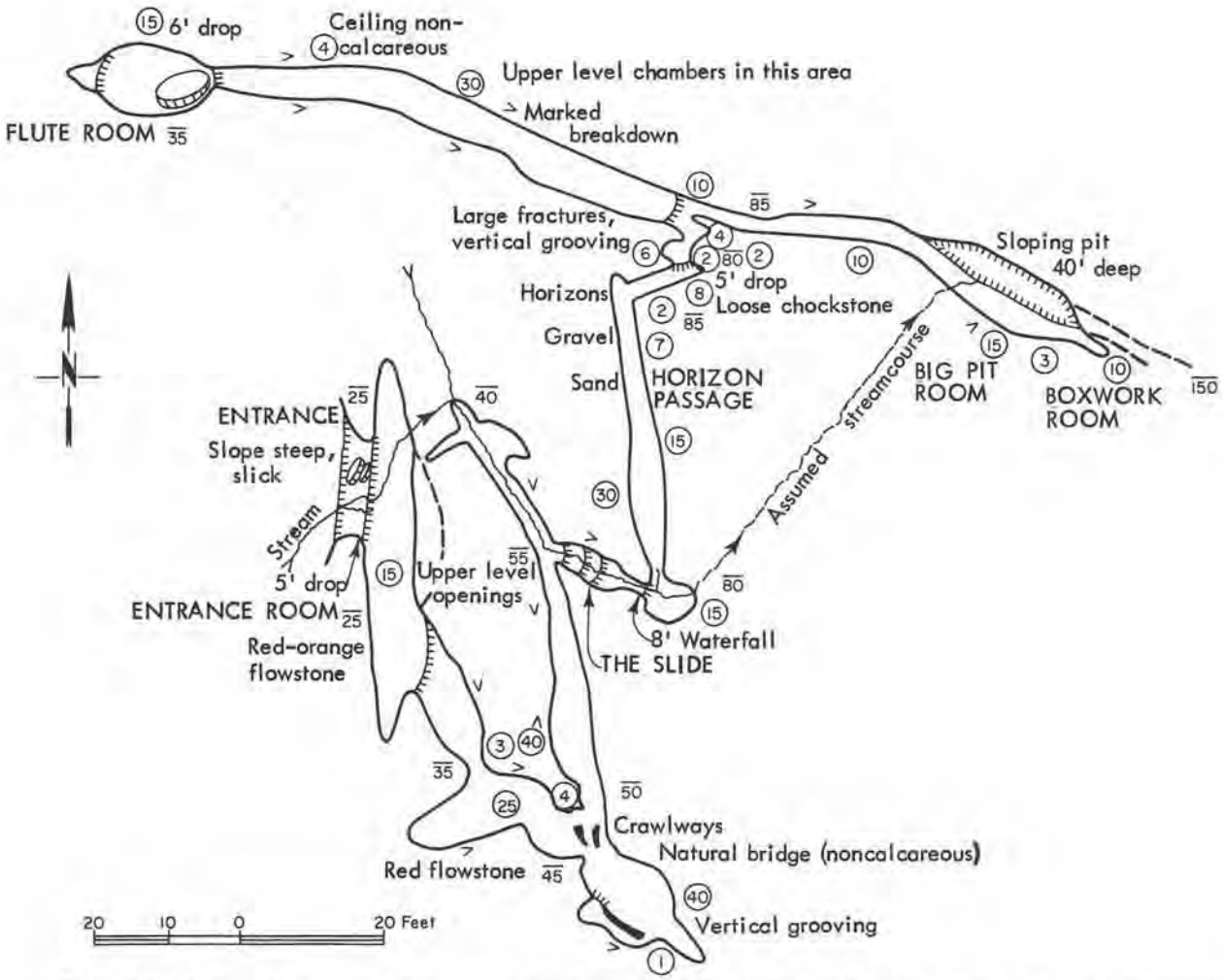


Figure 15.—Newton Cave, King County. Preliminary survey by Washington Speleological Survey, 1960. Depths below entrance are estimated.

Metamorphism in this area was more intense than is evident in the walls of the other caves of the Mount Snoqualmie group. The marble is fine grained, and varies in color from milk white through faintly banded white to a blue-white "curly" patterned marble. The joints exposed in the cave appear to bear little or no relation to the bedding, even where the latter is distinct. At the west end of the Flute Room, and possibly elsewhere in the cave, schist of the Denny Formation is exposed. Much more prominent than the schist are outcrops of other, unidentified noncalcareous intrusions or inclusions, which range from thin veinlets to masses several feet thick. The passages leading down from the Flute Room and The Slide appear to have developed along or to be aligned with large masses of this material. Another example can be seen at close range as the visitor climbs down a rope ladder in the cave entrance. Water dripping off the ledge formed by this mass has dissolved in the underlying marble several short but well-developed circular waterfall slots, which resemble miniature dome pits.

Figure 16.—Entrance of Newton Cave, King County.

The entrance of Newton Cave (fig. 16) is an asymmetrical sinkhole slanting eastward beneath a small limestone bluff. A steep slope 20 feet long terminates with a sheer drop of 10 feet to the floor of the Entrance Room.

The Entrance Room is 55 feet long. Its height averages 15 feet, and it is about 5 feet wide at floor level, although the upper part of the room is wider. There are several possible passage openings in broken rock high on its east wall. Features of interest include a complex of drip slots beneath the entrance, and deposits of orange-red flowstone on the southern part of the west wall. The seasonal stream that enters the cave entrance disappears in rubble near the northern end of this room.

A short sloping passage leads downward from the southeast side of the Entrance Room to a steep chimneylike chamber in which red flowstone has been deposited along the steep slope. Beyond is a small antechamber from which openings lead south and southeast.

A squeezeway to the southeast opens into a high-ceilinged chamber with marked vertical vadose grooving. High on the wall of this chamber is a small hole that leads into a small grotto, from which a narrow slot extends back down to the floor of the main room.

Two muddy crawlways at the north end of this high-ceilinged chamber and the opening to the east from the antechamber just described join at the south end of a straight corridor about 40 feet long. Several large chimneys with extensive vadose grooving are in the wider southern half of this passage. Its north end is at a junction. To the east of this junction is The Slide. To the north is a steep stream passage that conducts the entrance stream to The Slide.

The Slide is a steep, narrow passage floored by a noncalcareous mass that is coated with a slick organic (?) material. The upper part of this passage is in marble. Below The Slide, a gently sloping passage a few feet long leads to a vertical 8-foot waterfall that flows over the same noncalcareous material. Lateral to the deposit, differential solution has caused a separation of about 1 inch between the marble and the insoluble mass.

At the base of this 8-foot waterfall is a small chamber. The stream disappears again, into its floor. North of this chamber is an interesting 42-foot passage (the Horizon Passage) containing a variety of fill materials, including sand and gravel. On the walls at its north end are at least three horizons showing lateral solution at the water table, at successively lower levels. Stream fluting is present in this passage, but it is indistinct because of superimposed fine vertical fluting.

Extending east from the northern end of this passage is a short crawlway that leads to a short complex of small chambers and smaller passages. Immediately above the east end of this crawlway there is a dangerously unstable chockstone.

Beyond this small complex is another junction. A broad but steep and breakdown-choked passage leads down from the Flute Room, which is 80 feet to the west. Both the Flute Room and the lower part of the breakdown passage have well-developed vadose vertical grooving and slots.

East of this junction a narrow sloping passage continues downward about 30 feet to the Big Pit Room, which is a laterally sloping chamber about 30 feet long. The cave stream reappears high on its recessed south wall, cascades to the ledge that is the main part of the room, thence cascades 5 feet and plunges about 40 feet to a lower level visible below. This lower area has been explored for about 50 feet.

A duck-under at the east end of this ledge leads to a little chamber that contains a small amount of boxwork.

Aside from the red-orange flowstone, Newton Cave is almost lacking in speleothems. Tubular stalactites as much as half an inch long are present in some of the lower parts of the cave, as are traces of stalagmitic deposits. Tiny coralloidal nodules projecting on thin stalks also occur locally, on minute projections of the walls caused by slight differentials of solution. Their location may prove to be of significance in explaining their origin.

The speleogenesis of Newton Cave is complex, and is difficult to decipher because of breakdown and the occurrences of noncalcareous material. Very active vadose solution by drips and films of water is in progress, and most of the high, narrow passages appear to be joints widened by vadose solution of this type. The Horizon Passage shows the least evidence of these phenomena of any part of the cave, and even in it there is faint vertical grooving. The horizons indicate that this passage developed in the shallow sub-water-table zone, and was enlarged by water-table flow at three successive heights. It seems likely that the rest of the cave also is of sub-water-table origin but has much vadose development.

The biota of Newton Cave appears scanty, but no detailed search has been made.

The history of this cave is controversial. The name was applied in 1959 by the leader of the party that first explored the cave, on the belief that Mr. Newton had found the cave. Actually, another member of the party had noted the cave earlier. It is believed by some that Thomas Steinburn entered the Entrance Room in about 1953. However, the writer visited the entrance in September 1956 and noted it as promising but blocked with debris.

About 25 feet east of the cave entrance there is a rounded pit about 3 feet in diameter and about 20 feet deep. It has several waterfall grooves but is not regular enough in section to be considered a dome pit. This pit does not connect to the cave system.

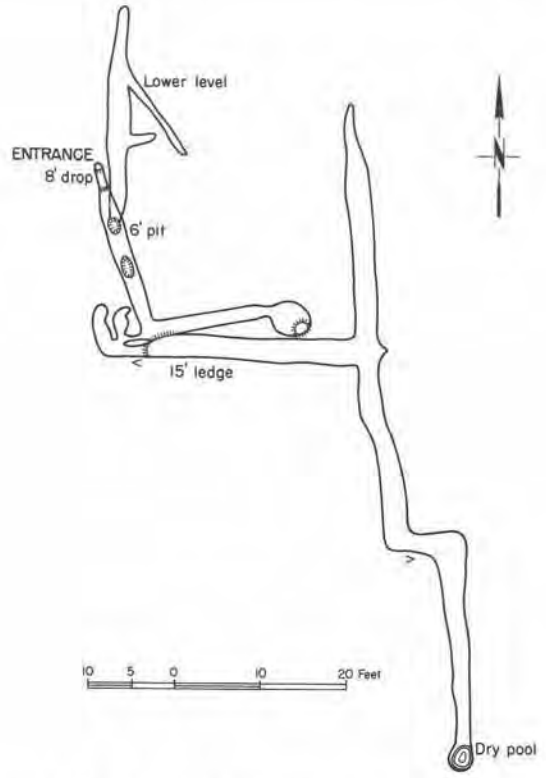


Figure 17.—Prospector's Cave, King County. Survey by W. R. Halliday and T. Steinburn, Washington Speleological Survey, September, 1956.

Figure 18.—Entrance of Prospector's Cave, King County, actually a narrow slit at the rear of this alcove.

PROSPECTOR'S CAVE (16) (Miner's Cave, Steinburn's Cave, Adair's Cave)

Sec. 28, T. 23 N., R. 11 E., Snoqualmie quadrangle. Elevation about 4,850 feet.

This small cave (fig. 17) has a total of about 200 feet of narrow, linear passages. It is about 100 yards northeast of Clark's Cave and about 50 feet above the hanging valley floor, on the north slope of Cave Ridge. The hillside is covered with heather, and no karst is apparent at the cave. Its entrance, a narrow slit about 9 inches wide and 3 feet high (fig. 18), is just above a small but prominent prospect pit. Immediately inside the entrance is an 8-foot drop, beyond which the cave widens slightly.

The bedrock is a well-fractured, fairly thick-bedded marble member of the Denny Formation. The marble alternates with shale, which is exposed as a hanging wall ceiling at the rear of the cave. The dip is approximately 35° NE.

The cave has been developed primarily on dip and strike joints. Many of the wall surfaces show the vertical jagged grooving of descending films of water, and no clearly phreatic speleogens were noted by the writer despite the pattern of the cave that strongly suggests a sub-water-table origin. Most of the passages are about 2 feet wide and 8 feet high. The only speleothems that have been found are delicate white coralloids in a lower passage not far from the entrance. One small clump appears to be intergrading with filiform helictites, but the deposit and the individual speleothems are too small for this to be determined with certainty. Breakdown is fairly extensive near the rear of the cave but is slight elsewhere.

RED CAVE (17)

Sec. 28, T. 23 N., R. 11 E., Snoqualmie quadrangle. Elevation about 5,175 feet.

This small, single-chambered cave is in a small karst ravine bounded by lapies, about midway along the section of the arm of Mount Snoqualmie that joins Cave Ridge. Its entrance is at the south end of the third collapse sink in this ravine south of the east end of the hanging valley. A few dozen feet farther east the ridge drops away steeply to a small flat above Commonwealth Basin. A thin alpine forest is near the cave, and heather and other low plants grow thickly.

The entrance of Red Cave is an irregular opening amid large breakdown blocks at the southern end of the sink. A sloping passage 41 feet long enlarges near its lower end to form a chamber about 15 feet wide and 20 feet high. Breakdown chokes a pit at its lower end. This pit is of considerable depth but is impenetrable. A 30-foot chimney above the west side of this room almost reaches the surface. In this chimney is the deposit of bright-red terraced flowstone that is the source of the name of the cave.

The bedrock is a markedly fractured marble member of the Denny Formation. The overlying schist is exposed in the roof and the eastern wall of the cave. The beds dip about 65° north-northeast, but at the entrance the bedding is grossly distorted by the presence of a wedgelike intrusive body. The cave is formed along the marble-schist contact, and much breakdown has accumulated. Vertical vadose grooves (fig. 19) and related speleogens are very marked in the cave, and no clearly phreatic speleogens were noted. Nevertheless, its overall contour appears to be phreatic.

SECOND CAVE (18)

Sec. 28, T. 23 N., R. 11 E., Snoqualmie quadrangle. Elevation about 4,760 feet.

About 100 feet upstream from Clark's Cave is the tiny entrance of the second cave discovered of the Mount Snoqualmie group. It is even smaller than Clark's Cave (Steinburn, 1952).

SNOQUALMIE CAVES (See Mount Snoqualmie Caves.)

STEINBURN'S CAVE (See Prospector's Cave or Second Cave.)

STEINBURN'S CAVES (See Mount Snoqualmie Caves.)

OTHER CAVES

Sec. 28, T. 23 N., R. 11 E., Snoqualmie quadrangle.

The 9-inch-high entrance of an unexplored cave is at the base of the north face of a prominent limestone outcrop just northwest of the crest of Cave Ridge, approximately on a line between Hellhole and Clark's Caves. The cave slopes steeply downward for several feet, then levels off and continues for an undetermined distance.

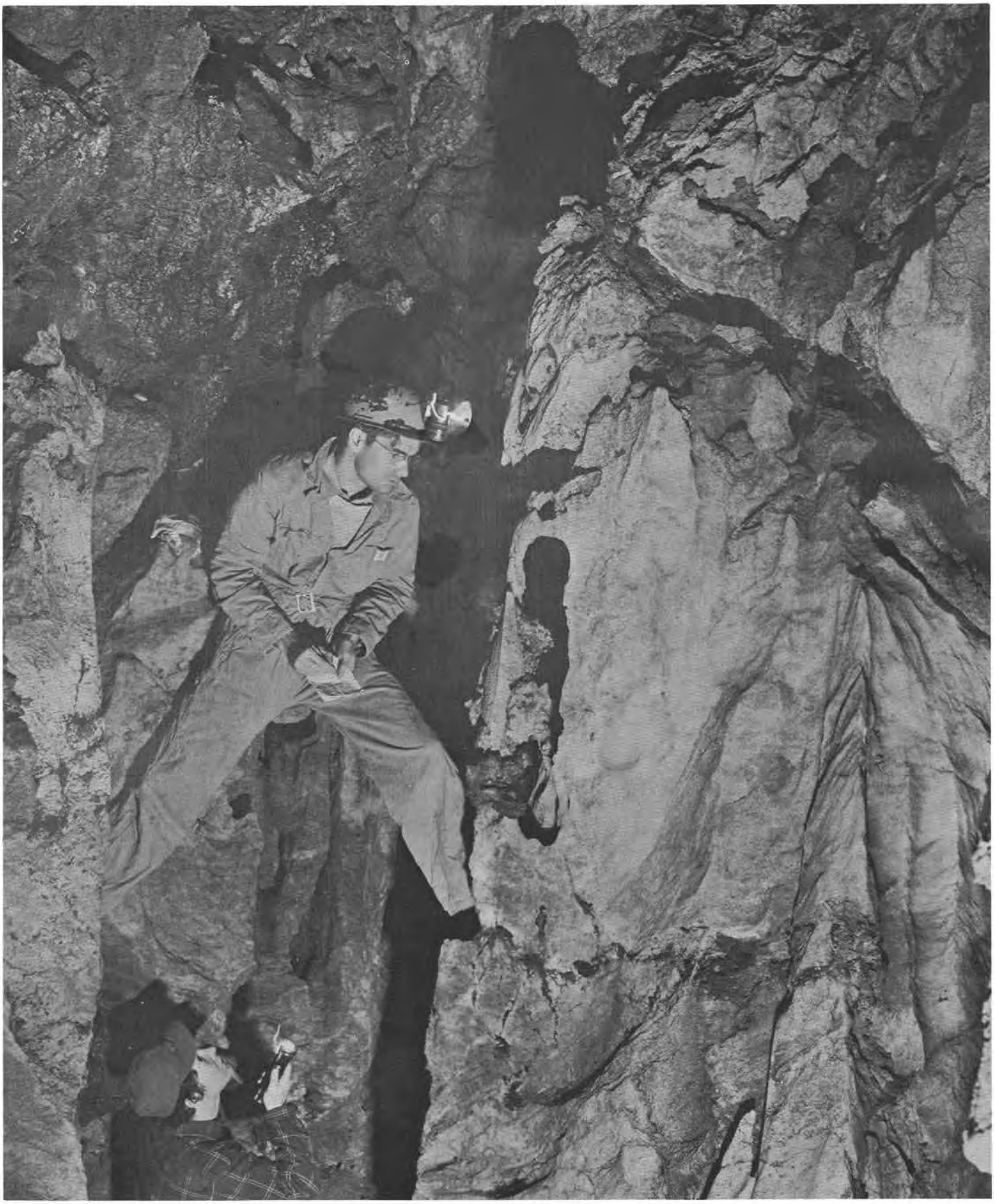


Figure 19.—Irregular vertical vadose grooving in Red Cave, King County. Photo by Bob and Ira Spring.

About 100 feet west of Danger Cave, a descent of approximately 30 feet in breakdown in an open fissure leads to a small linear solution cavern about 40 feet long, trending east and west. It has no features of especial interest.

KITSAP COUNTY

No caves have been reported in Kitsap County.

KITTITAS COUNTY

Only one deposit of limestone is known in Kittitas County. It is west of Cle Elum Lake, and no caves have been reported there. Most of the bedrock of the eastern part of this county is basalt of Miocene age. In this basalt are many rockshelters, some of which have come to be known as caves. In some biological papers, Yakima County's Boulder Creek Cave (Boulder Cave) erroneously has been listed as being in Kittitas County.

COX CAVE

This is one of several small rockshelters north of Vantage (Swanson and Bryan, 1954).

TRINIDAD CAVE

This is a rockshelter near the town for which it was named (Swanson and Bryan, 1954).

VANTAGE CAVE (See Cox Cave.)

KLICKITAT COUNTY

Klickitat County includes the southeastern part of the Mount Adams pahoehoe lava flows, which contain several important lava tubes. There is no limestone in this county.

BIG LAVA CAVE (See Cheese Cave.)

BRANCHING CAVE (See Red Cave, Klickitat County.)

BUTTER CAVE (19)

Approximately center, south edge of sec. 21, T. 6 N., R. 10 E., Willard quadrangle.
Elevation about 2,075 feet.

This small fragment of a once-extensive lava tube (fig. 20) is of note historically and geologically. It is at the confluence of two largely collapsed lava tubes that joined about three-quarters of a mile southwest of the Trout Lake sawmill. Because of the numerous logging roads and lack of landmarks in this area, the cave is difficult to find.

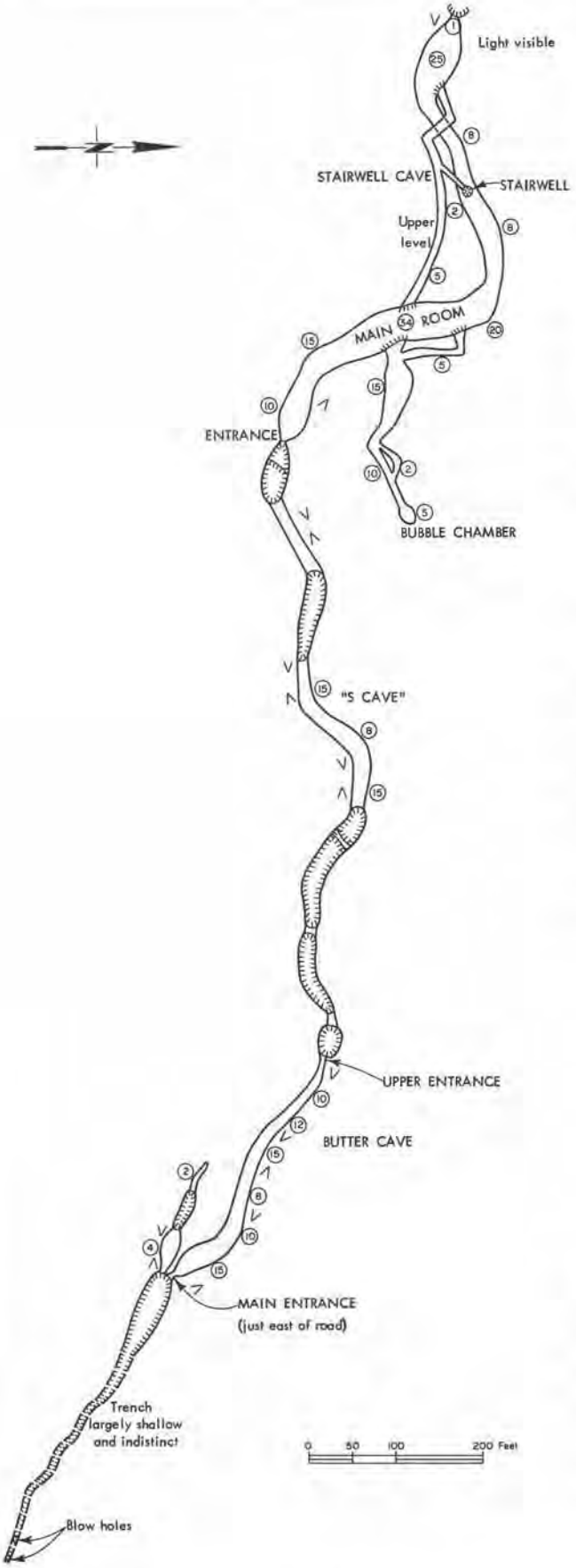


Figure 20.—Butter-Stairwell Tube Complex, Klickitat County.

The main entrance sink of this Y-shaped cave is on the southeast side of the road. A low passage about 20 feet wide extends about 60 feet westward beneath the road to a smaller sink. At the far end of this small sink is an additional 30-foot remnant of collapsed tube.

The entrance of the main part of the cave has been enlarged, so that it is now about 5 feet high and 3 feet wide. There are remnants of a door jamb at the entrance. Immediately inside is a broad chamber about 15 feet high, which was used for the storage of butter during pioneer days (Anon. 1909b). Old wooden skid rails are still in place.

About 100 feet from the entrance the chamber narrows, and a breakdown-strewn lava tube about 10 feet high and 20 feet wide continues another 250 feet northwestward to a small upper entrance at the lower end of a sinuous lava trench in which several short sections of tube remain. Stairwell Cave is several hundred feet farther up this trench.

Because both entrances of this cave are small, protected, and semivertical, the cave traps much cold air, and often is nearly blocked with ice until midsummer.

CHEESE CAVE (20)

(Big Lava Cave, Lava Cave, Spencer's Cave)

East edge of sec. 21, T. 6 N., R. 10 E.,
Willard quadrangle. Elevation 2,020 feet.

Aside from Ice Cave, this impressive lava tube (figs. 21 and 22) is the best known of the Mount Adams lava caves. Because the temperature ranges from 42° to 44° F. (Homer I. Spencer, oral communication), for many years a small part of the cave was used for the storage of potatoes (Anon. 1909b) and, more recently, for the commercial production of Roquefort cheese.

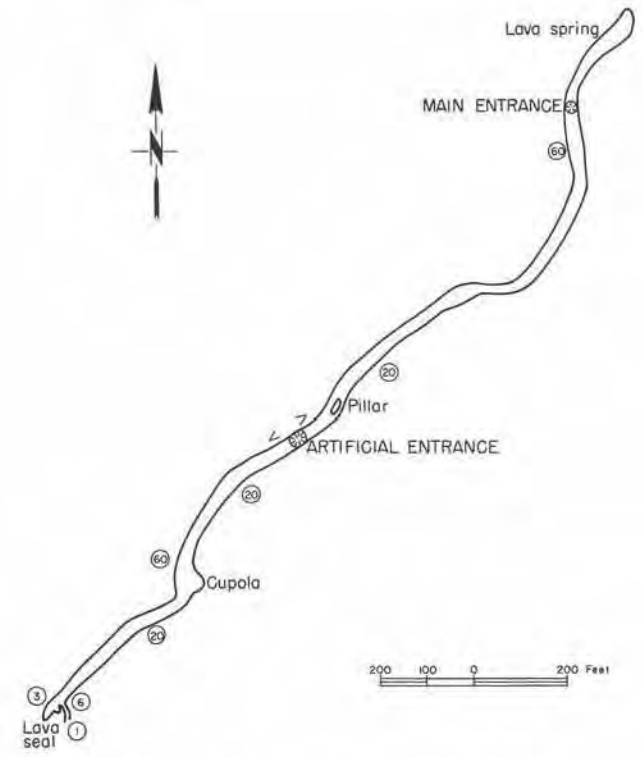


Figure 21.—Cheese Cave, Klickitat County. Plane table survey by Homer I. Spencer (uncorrected).

Figure 22.—Cheese Cave, near Trout Lake, Klickitat County. Photo by Filloon.

Cheese Cave was discovered in the winter of 1894 by Joseph Arnie, an inhabitant of nearby Trout Lake. Mr. Arnie noticed a plume of vapor emerging from a small opening in a lava outcrop. He marked the spot and returned later with an exploring party. Peter Smith was lowered 45 feet to the floor of the cave, and was the first person to enter it, probably early in 1895 (Homer I. Spencer, oral communication). The lower entrance of the cave is artificial.

The single natural entrance of the cave (fig. 23) is a low, thin-crusted dome. Part of the adjacent course of the cave is revealed by a faint linear ridge on the surface. The entrance appears to be of collapse origin rather than a blow-out. It is 246 feet south of the upper end of the cave, which consists of a lava spring in a rounded chamber with an asymmetrical upward bulge above a ledge on the east side of the passage. In contrast with the upper end of Ole's (Mount St. Helens) Cave, in Skamania County, there is no subsidence. Downslope from the entrance the cave extends as a unitary tube, with a single pillar, to a small side complex and terminal crawlway leading to a lava seal. This complex is 1,814 feet from the entrance. In general, the cave trends from north to south, although it is somewhat sinuous.

This easily accessible cave contains many features of unusual scenic and scientific importance. Because of its broad, high-vaulted vistas and level floor, it is especially pleasant to visit. Breakdown has occurred in only a few places.

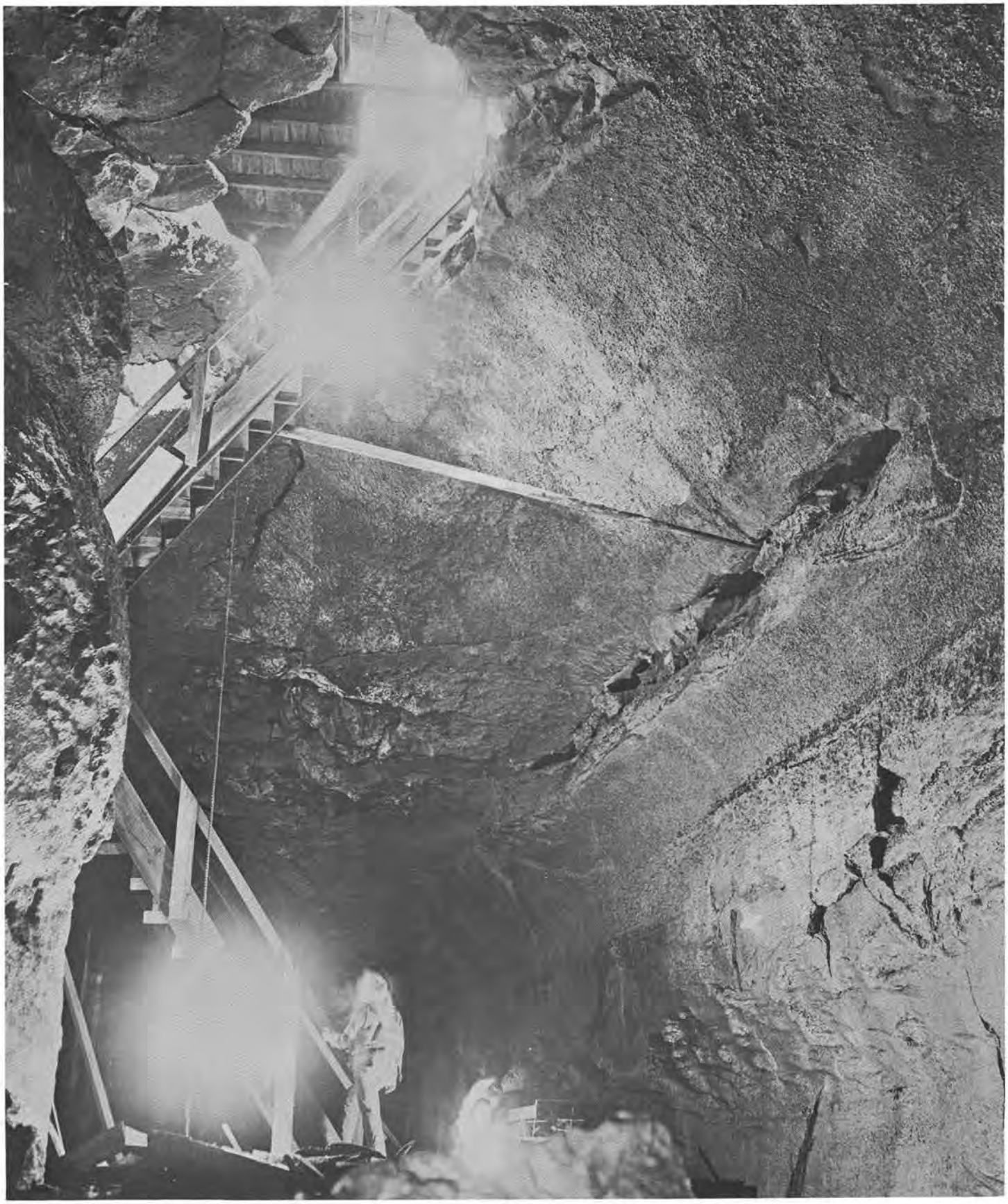


Figure 23.—Upper entrance of Cheese Cave, Klickitat County. Photo by Bob and Ira Spring.

Figure 24.—Splash ring or concentric, resulting from rockfall into a molten flow in a lava tube.

Near the upper end of the cave there is a particularly fine splash concentric (fig. 24). At several places there are lateral "waterfalls" of cinder-surfaced lava on the walls. Especially, downslope from the Cupola Room there are vertical or oblique scratches where more of such material has slid down the walls. Lateral flow deposits are fairly well developed both high and low on the walls, and longitudinal flow grooves along the course of the tube may be seen on the ceiling and walls, especially on and near the east side of the large pillar that divides the passage upslope from the artificial entrance.

The Cupola Chamber, downslope from the artificial entrance, is unusually large; its height is about 65 feet, its width more than 80 feet, and its length 100 feet. The tube beyond this chamber has an unusual "boxwork" of potholelike ceiling cavities about 2 feet in diameter. They appear to have been the result of coagulation or lack of remelting along fractures, which permitted ingress of cooler air or gases during the thermal phase of the cave.

At a pile of breakdown about 200 feet from the end of the cave there are two adjacent side passages on the east side of the tube. The somewhat hidden upslope passage is a long crawlway with its flow entering the main tube. The downslope side passage is the more prominent, but it is blocked within a few feet by the flow that entered it from the main tube.

Near the lower end of the cave are well-developed lava stalactites, with corresponding multiglobular, highly vesicular stalagmites as much as 6 inches high. Lava flowstone from the base of these stalagmites is nonvesicular.

A detailed biologic study of Cheese Cave would be valuable. At least two kinds of salamanders, including Ambystoma microdactylum, have been discovered in the cave. Bones of unidentified small animals have been found in several places. Toadstools grow on rotting wood deep in the cave. "Runaway" mold from the cheese process, and also a different mold are present on sections of the ceiling.

ICE CAVE (See Trillium Cave.)

LAVA CAVE (See Cheese Cave specifically, and all caves of this county generally.)

LAVA BRIDGE CAVES (21)

Sec. 31, T. 6 N., R. 10 E., Willard quadrangle. Elevation about 2,575 feet.

Several cavernous remnants of a mostly collapsed lava tube are about half a mile east of the Skamania County line, north of Cave Creek. One of these, about 50 feet long, served as a natural bridge for the old Trout Lake-Peterson Prairie road. This "bridge" is near the midpoint of a segment of lava trench about 1,000 feet long, interrupted at intervals by short lengths of uncollapsed tube. At each end are longer segments of tube, the northernmost being about 275 feet long and terminating with a dirt fill. A few flow grooves are in this breakdown-strewn segment of tube. The cave at the south end is more extensive, with a slope length of about 365 feet. Its entrance section also contains much breakdown, and its lower section possesses a beautifully convoluted lava flow and other interesting deposits. There is a small amount of lava tube slime in the cave.

The Lava Bridge system is not a unitary tube, however. A short confluent passage is in the short segment of tube upslope from the "bridge," and there is a complex series of small sinks and short segments of tubes about 100 feet east of the main tube in that general area.

MEAT CAVE (See Trillium Cave.)

RED CAVE (22) (Branching Cave, Spencer's Red Cave)

Approximately sec. 28 or 29, T. 6 N., R. 10 E., Willard quadrangle.
Elevation about 2,150 feet.

This little-known lava tube cavern is in a densely forested area of obscure landmarks and changing logging roads. It has been explored principally by Homer I. Spencer. Only a small section of the cave was visited by the Survey, as rediscovery was not effected on a subsequent trip to the area.

The main entrance sink is the lowermost of a series of collapse sinks along a passage length of several hundred feet. From this sink four passages lead off. The main passage is upslope, leading roughly north. The openings of the other three passages are roughly on the east, southeast, and south sides of the sink.

It is reported that the lowest passage is a comparatively straight section of lava tube. The other two side passages rejoin, and then join the lower passage. Until filled during logging operations, the uppermost of these two side passages could be entered through a small collapse sink.

In the main tube, upslope, there are two additional small collapse sinks at intervals of about 100 feet. Farther north is a long, uninterrupted passage, with a double-level tube still farther upslope. It is reported that each of these levels leads to a separate collapse sink. Detailed study of this cave will be very instructive when it is found again.

Because of a great quantity of breakdown, the floor of much of the cave is very rough. In the entrance section this rubble has a brick-red color, which gave the cave its name.

SPENCER'S CAVE (See Cheese Cave.)

SPENCER'S RED CAVE (See Red Cave, Klickitat County.)

STAIRWELL CAVE (23)

Sec. 21, T. 6 N., R. 10 E., Willard quadrangle. Elevation about 2,100 feet.

Stairwell Cave (fig. 20, on p. 31) is an interesting but small lava tube complex about 1,000 feet up the sinuous trench from the upper entrance of Butter Cave. Between the two caves are several sinks and short segments of uncollapsed tube.

The spacious first 170 feet of Stairwell Cave slopes downward over breakdown, even though the trend is actually up-tube. At the end of the slope the cavern widens into what is termed the "Main Room," which has a width of 40 feet and a ceiling height of 35 feet. In this sinuous main corridor, which in this area trends roughly north, are two other tube openings. That on the east extends about 250 feet to the domed "Bubble Chamber," one of the few parts of the cave that are free of breakdown. Most of this side tube is spacious. Along its northern wall are two other branch tubes, the first of which rejoins the main passage up-tube from the "Main Room." It is noteworthy for its smooth clean pahoehoe floor. The second side tube leads to a breakdown crawlway containing a lava spring. It is possible to return to the side tube near the Bubble Chamber by passing through this breakdown.

On the west wall of the Main Room, about 25 feet above the floor, there is an opening of another tube. About 10 feet high and 6 feet wide at first, the tube soon narrows in breakdown, then widens again. About 150 feet from the entrance of this tube a side tube enters at a sharp angle from the right. It extends about 50 feet to a point above the main route, to which it is connected by a circular opening reminiscent of an old-fashioned stairwell. Beyond the junction with this upper side passage that leads to the stairwell, the main upper passage continues about 75 feet and rejoins the main route about 125 feet below the upper end of the cave, but maintains its identity for an additional 30 feet.

Beyond the Main Room the main passage of the cave pursues a sinuous course north, then east for about 450 feet to a hole in breakdown through which light is visible. Most of the intervening passage is spacious, but beyond the Stairwell is one crawlway section. Total passage length is about 1,350 feet. Because of the complexity of Stairwell and Butter Caves, the speleogenesis of this area is a particularly interesting problem.

TRILLIUM CAVE (24) (Ice Cave, Meat Cave)

Sec. 21, T. 6 N., R. 10 E., Willard quadrangle. Elevation about 2,050 feet.

This short length of lava tube served the pioneer immigrants of the Trout Lake area as a refrigerator in which meat was stored. Its modern name arises from the cold-trapping action of the sink adjacent to the entrance of the cave. The cold air trapped in the sink and cave causes retardation of plant growth, so that the sink contains a profusion of blooming trilliums in midsummer.

Trillium Cave is about 300 yards northwest of the entrance of Cheese Cave, and about 100 yards north of the road from that cave to Butter Cave. It consists of a single grottolike segment of lava tube about 60 feet long. It is about 25 feet wide at the entrance, and the floor plan is roughly parabolic. The ceiling height is about 15 feet in most of the cave, although at the rear of the cave it descends abruptly to a height of about 6 feet, then rises again to form a small inner grotto, which is the location of

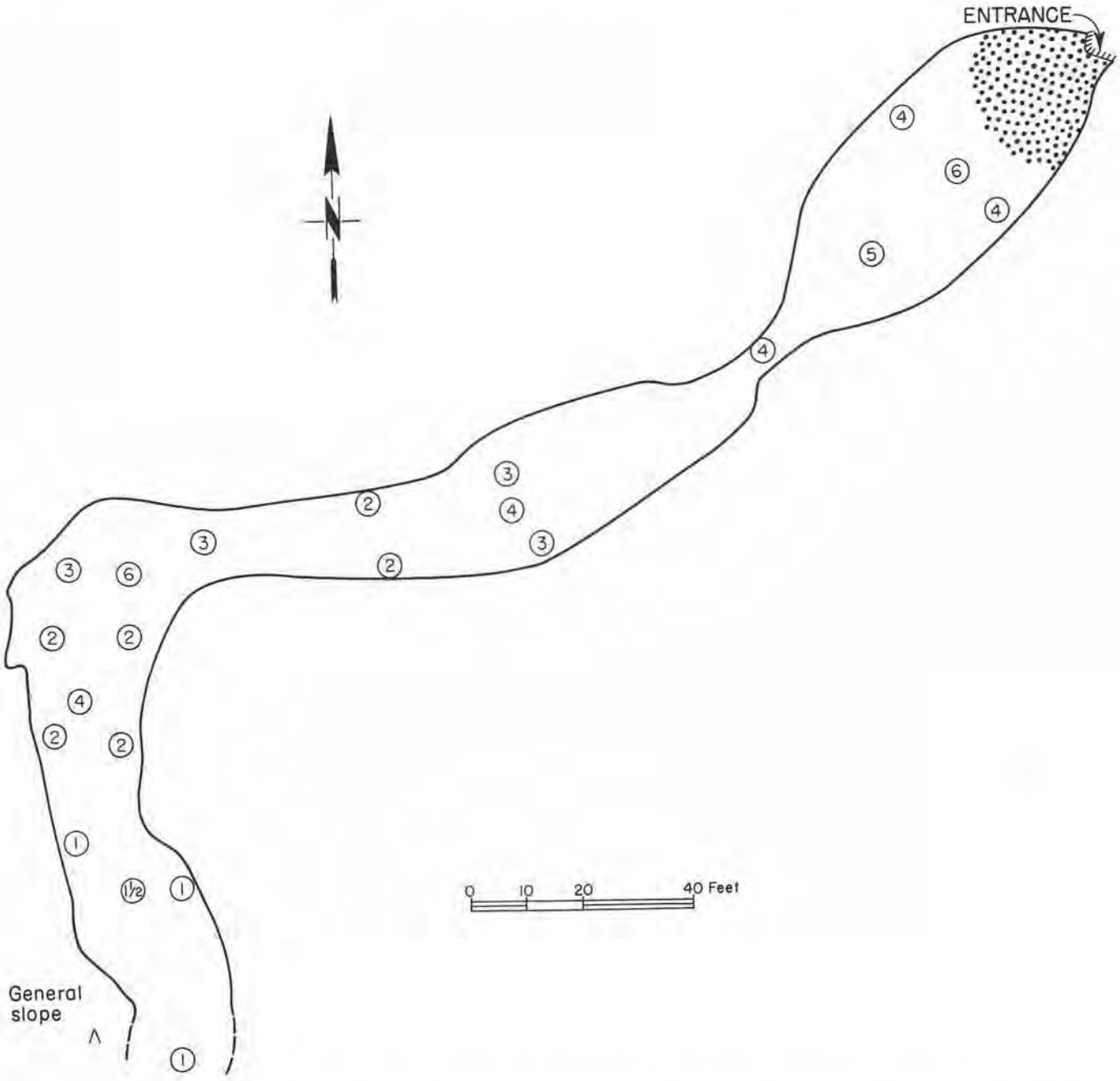


Figure 25.—Twidwell's Cave, Klickitat County. Compass and tape survey by Washington Speleological Survey, July 16, 1961.

well-developed, transient ice speleothems. On July 2, 1956, additional ice was noted amid the floor rubble and in the form of melting stalactites and stalagmites in the rear third of the cave. On that date névé was present in the entrance, which faces northwest. The cave is in a dense second-growth forest.

TWIDWELL'S CAVE (25)

North edge sec. 13, T. 5 N., R. 10 E., Husum quadrangle. Elevation about 1,430 feet.

This small unitary lava tube (fig. 25), the southernmost known of the Mount Adams group of lava tubes, appears to be unusually simple in nature. Its explored length is only 300 feet, and neither termination can be viewed. The possibility of lower levels cannot be excluded, although their presence does not appear likely. The overall appearance of the tube is that of the upper part of a larger tube that now is filled almost to the ceiling by lava. Consequently, although neither glaze nor flow grooves or ridges are present (except for a little elevation of the edges of the floor), the possibility of a more complex speleogenesis than is apparent at first glance cannot be completely excluded.

As shown on figure 25, the cave has the form of a sinuous, low, broadly arched tube with a single constriction without corresponding increase in height. The ceiling height gradually decreases to the point at which the tube is impassable. The floor is a moderately granular rippled flow uninterrupted by breakdown except at the entrance. The ceiling is cracked in many areas, and many roots are pendant. The entrance is in a shallow sink, in a very small area of sinks and low domes. At least one other opening appears penetrable, but ingress is blocked by broken glass and other trash.

OTHER CAVES

Other caves in addition to Red Cave are rumored to be in the area between Butter Cave and the Lava Bridge complex. They have not been found by the Survey.

LEWIS COUNTY

No caves have been reported in Lewis County.

LINCOLN COUNTY

No caves have been reported in Lincoln County.

MASON COUNTY

No caves have been reported in Mason County.

OKANOGAN COUNTY

Okanogan County contains a considerable expanse of limestones and dolomites, which crop out over an area several miles long and more than a mile wide, northwest of Omak and Riverside. Other,

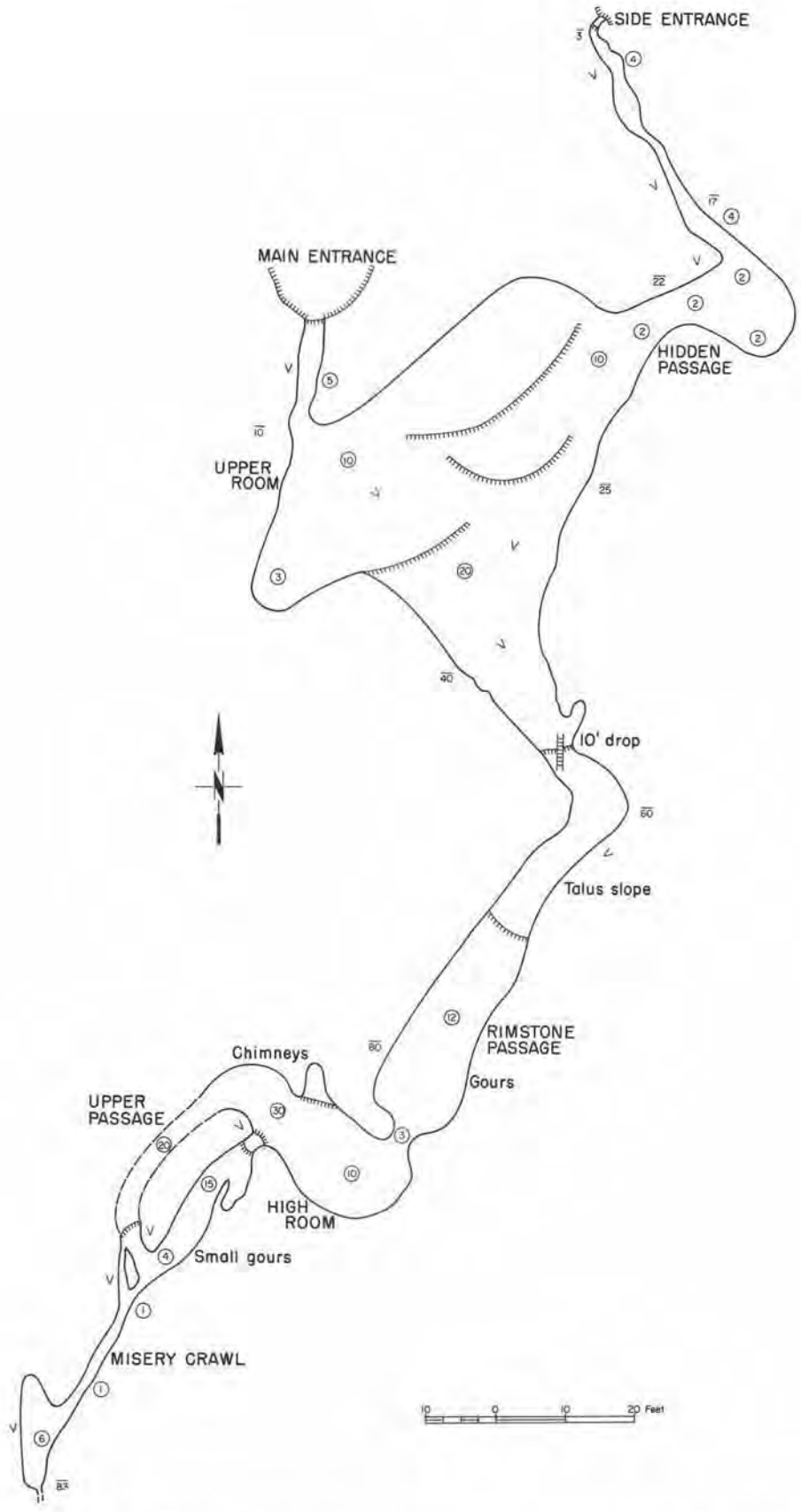


Figure 26.—Allbright Cavé, Okanogan County. Plan. Compass and tape survey by Dale J. Green and William R. Halliday, July 1958.

smaller deposits also occur. The second largest limestone cave known in eastern Washington, Allbright Cave, is near the southern end of this "lime belt."

ALLBRIGHT CAVE (26)

Sec. 18, T. 35 N., R. 26 E., Conconully quadrangle. Elevation about 2,880 feet.

Allbright Cave (figs. 26 and 27) is atop a narrow limestone ridge about 1 mile north and 2 miles west of the junction of the Riverside-Conconully and the Okanogan-Conconully roads. On recent maps this 1,000-foot ridge has been termed "Cave Ridge." At its foot is the farm of Thomas Tugaw, from whom permission to cross the property to the cave must be obtained. The two entrances of the cave are in small sinks in the summit line of the ridge.

Allbright Cave is the second largest limestone cave known in eastern Washington. The slope length of its passages totals about 400 feet. Its lowest point is about 85 feet below the upper entrance, which is a few feet higher than the main entrance. This cave is near the southern end of the local "lime belt," in a thick-bedded gray coarsely crystalline limestone that dips about 50° slightly east of south. The limestone is thought to be of Triassic age (Waters and Krauskopf, 1941; Bennett, 1944). Other shallow sinks and impenetrable cracks are visible on the almost unmantled southern slopes of the ridge, and there are lapies 6 feet high in the saddle southeast of the cave. A few pine trees grow atop the ridge, but its southern face is typical northwest sagebrush desert.

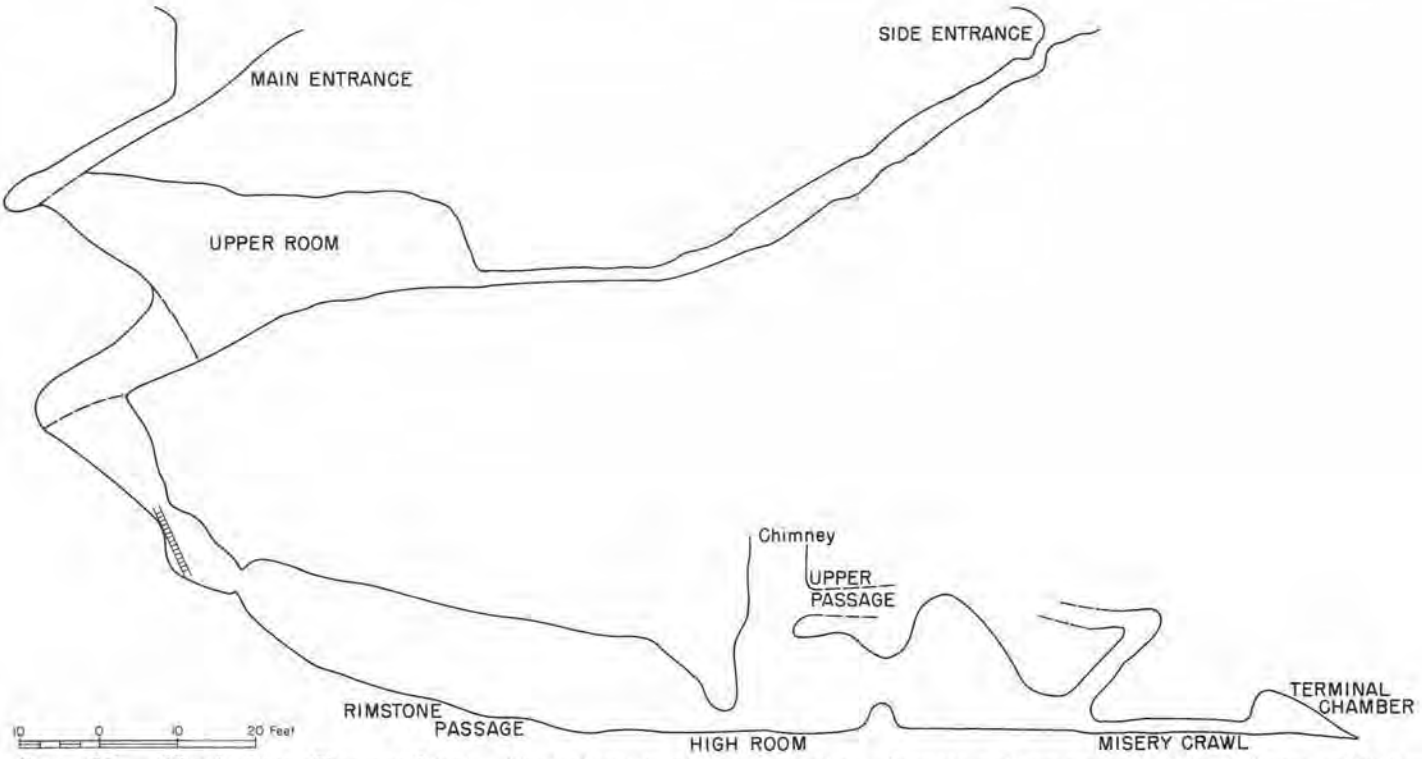


Figure 27.—Allbright Cave, Okanogan County. Vertical section along traverse line. Compass and tape survey by Dale J. Green and William R. Halliday, July 1958. All slope lengths correct between points.

Allbright Cave shelters much animal life. In July 1958, the following were noted during a single cursory visit: woodrat, bats (probably Corynorhinus sp., which were collected on a previous visit), toad, mosquitoes (twilight zone only), small diptera, crickets, small moths, spiders, and possibly a campodeid. Flat-topped mushrooms were growing in the entrance, and two types of mold were growing from rotting wood and from rat droppings. When the cave was visited 18 months later, in winter, a bear was found hibernating in the upper room of the cave.

The history of this cave is imperfectly known. It is said locally to have been discovered by members of the Samuel Allbright family, who formerly occupied the farm below the cave. The name "Allbright," with the date March 22, 1903, has been inscribed in the lower level of the cave.

The main entrance (figs. 28 and 29) of Allbright Cave is a hole about 3 feet in diameter at the bottom of a dip-influenced sinkhole. A sloping passage about 20 feet long and 4 feet in diameter extends south-southwest to the Upper Room. The upper part of this large, irregularly shaped chamber parallels the strike of the bedding, but its sloping, funnel-shaped lower end plunges down dip. The longest measurement in this room, from the mouth of the passage below the main entrance to the rim of the pit leading to the lower level, is nearly 80 feet. Aside from a single short talus slope downslope from this pit, almost the entire vertical range of the cave occurs in this room and in the entrance passage. Much breakdown is present here, and there are no important speleothems.

An 8-foot drop at the funnellike lower end of the Upper Room leads to the lower level of the cave. The passage at its beginning is locally sinuous and sloping, but it soon broadens into a long, spacious corridor trending south-southwest, called the Rimstone Passage. Some shallow gours and a little flowstone are present. At the downslope end is a short crawlway that separates this corridor from the next chamber.

The ceiling height of this next chamber, the High Room, is the greatest in the cave. The chamber contains a large chimney about 30 feet high. Along the wall of this chimney is the opening of a short

Figure 28.—Entrance of Allbright Cave, in a hilltop sink.

Figure 29.—Entrance of Allbright Cave, Okanogan County.

upper level, which is entered more conveniently by another chimney at the end of the next passage. The floor of the High Room is level, and appears to have been deposited in quiet water. A water-level stain is visible on the wall about a yard above the floor.

A clay bank about 3 feet high partially obstructs the entrance of the next passage, which is about 27 feet long. It is aligned with the Rimstone Passage, but is offset the breadth of the High Room. This passage contains some small gours in which there are some small, rough pisoliths. A few tiny helictites and some short tubular stalactites are also present.

At the downslope end of this passage a steep, bedding-plane side passage enters from the northwest. Atop a 20-foot ascent, a short upper level passage extends back to the large chimney mentioned previously. A narrow opening from this bedding-plane passage also bypasses the entrance of the crawlway at the downslope end of the section of the main passage just described.

This crawlway, Misery Crawl, about 18 inches in diameter and 20 feet long, is basically a continuation of the main passage. It opens into a small bedding-plane-determined chamber that is the end of the cave. A small hole at the chamber's south end serves as a swallet of a small seasonal stream, which has left a channel in the dirt floor.

A second entrance to Allbright Cave consists of a narrow slotlike pit east of the main entrance. It is most readily found from within the Upper Room. A low eastward extension of this room continues for about 20 feet to the end of a narrow passage about 50 feet long, which slants down from the second entrance. This passage contains a large quantity of rubble. A little weathered flowstone is on its walls.

The speleogens of Allbright Cave are almost exclusively phreatic. There is a suggestion of a steeply inclined, incised ceiling channel at the pit separating the two levels. Just below this pit there are a few perched remnants of a red clay fill similar to that in certain Missouri caves described by Bretz (1956). It is the only Washington cave in which such a red clay has been found. The vadose streams that flushed this and other fills have not significantly modified the bedrock.

The cave developed mostly on vertical joints parallel to the strike, at successively lower levels down dip. Development along the bedding plane and on dip and oblique joints is of lesser importance. Breakdown has been great only in the Upper Room. Development of such a cave would seem to require a deep phreatic circulation. Such circulation in this ridge-top cave, however, would indicate a relationship of the cave either to a previous erosion cycle or to a time when the valleys on both sides of the ridge were filled temporarily. Such a situation conceivably might have arisen during Pleistocene glaciation, when there were ice-filled valleys within a few miles of Allbright Cave. However, no traces of glacial action were noted on the ridgetop, and the cave does not show the massive fill typical of the subglacial caverns of Washington, although if a cave were in proximity to the upper part of a thick glacier instead of the lower, this fill would not necessarily be present. At this time, no conclusions can be drawn about the relationship of Allbright Cave to Pleistocene glaciation. The cave appears wholly unrelated to the stream (or possibly lacustrine) terraces of the surrounding valleys, which are hundreds of feet lower than the cave.

BOY SCOUT CAVE (27)

Sec. 8, T. 34 N., R. 27 E., Omak Lake quadrangle. Elevation about 1,400 feet.

This fissure cave in the gneissic and mylonitic facies of the Colville batholith (Waters and Krauskopf, 1941) was not examined by the Survey other than through field glasses. It is visible from U.S. Highway 97 at a point about 4 miles north of Omak, and appears to be about 100 yards long. The cave is often visited by local Boy Scouts, and local informants report that it consists of a deep, narrow passage with several successive vertical pitches and at least one larger chamber, entry into which requires a rope ladder. The cave is probably the result of block slumping and (or) creep.

McLAUGHLIN CANYON CAVES (28)

Approximately sec. 33, T. 36 N., R. 27 E., Tonasket quadrangle. Elevation about 1,800 feet.

A number of partly roofed fissures of unusual extent are in the ridge just north of the mouth of McLaughlin Canyon. The bedrock is a schistose facies of the Colville batholith, and the fissures appear to have formed parallel to the dip and strike of the indistinct bedding, which appears to dip gently to the west. Some of the fissures are offset several feet along oblique fracture lines. Slickenslides are exposed on several faces, and possible fault gouge was observed at one place. Nevertheless, the passages appear to be primarily of fracture origin rather than due to faulting. Block creep and frost wedging may have been important in their origin, which basically is a geological rather than speleological problem. Local explanations of the origin of these fissures are varied (Anon., 1957).

The fissures and their caves vary in width from a few inches to many feet. Generally, those more than 8 feet wide have lost their roofing. Vertical pitches of 20 feet are common, and some exceed 40 feet. In at least one area the fissures have formed a rectangular maze.

Small deposits of ice were noted in some of the fissures in July 1957. Most of the ice was in talus. A few small coralloids were the only calcareous speleothems noted. Several of the fissures have small streamcourses, and one that was not visited by the Survey is locally said to contain a small lake.

MOUNT OLIVE CAVE (29) (Riverside Cave)

Sec. 36, T. 35 N., R. 26 E., Okanogan quadrangle. Elevation about 1,450 feet.

This tiny solution cavern is at the base of the low summit cliffs on the east side of Mount Olive, just west of Riverside. It is in a Triassic dolomite (Bennett, 1944). Its double-barreled crawlway entrance leads to a narrow chamber 15 feet high, 3 feet wide, and 15 feet long. This chamber contains a single rough stalactite. The cave has been formed on a dip joint, and has the contour of a phreatic joint passage.

RIVERSIDE CAVE (See Mount Olive Cave.)

OTHER CAVES

There are local reports of a small cave in Shale Rock Point, near Omak. It was not found during field work.

PACIFIC COUNTY

A littoral cave about 40 feet long and 15 feet in diameter at its entrance is near the Cape Disappointment lighthouse. The Washington State Division of Mines and Geology reports that it is in agglomerate (written communication, 1959).

PEND OREILLE COUNTY

The limestone deposits of Pend Oreille County are extensive, but contain relatively few known caves. However, among limestone caves of the Pacific Northwest only the extensive Nakimu Caves of British Columbia, 120 miles to the north, and Oregon Cave, near the Oregon-California border, exceed the size of Gardner Cave. In this county other caves have been intersected in mines near Metaline Falls.

CRAWFORD CAVE (See Gardner Cave.)

GARDNER CAVE (30) (Crawford Cave, Lost Cave)

Sec. 4, T. 40 N., R. 43 E., Metaline quadrangle. Elevation about 2,900 feet.

With a total slope length of about 1,050 feet, Gardner Cave (pl. 1) is the largest limestone cave in Washington. If the extreme southwest and southeast, respectively, of Oregon and Idaho are excluded, this cave is the largest in the entire area of these three states. Since it is about half a mile from the Canadian border, it is probably the northernmost limestone cave in the contiguous part of the United States. The cave is the feature of Crawford State Park, and was partially developed as a tourist attraction in 1959. It is easily accessible, and has undergone considerable vandalism.

Gardner Cave is entered through a collapse sink atop a small hill in a densely forested area northwest of Z Canyon. The cave is reached by a dirt road that leaves State Highway 6 at the northern town limits of Metaline. About 10 miles to the north, a side road leads north for 0.4 mile to a parking area. A good trail continues north up the hill for about 200 yards to the main entrance of the cave.

The cave is in the Metaline Limestone, a thick-bedded formation of Cambrian age. Geologic maps of the area indicate that the bedding dips about 21° SW. (Park and Cannon, 1943), but in the entrance passage the dip appears to be slightly greater. The entrance passage parallels the strike, and has a hanging wall ceiling. Argillaceous impurities are exposed in several places in this section of the cave.

No other karstic phenomena have been observed in the cave area, perhaps in part because of the dense forest. The cave is at a relatively low altitude, and the climate is generally mild despite rather

severe winters. It is in foothills that have been subjected to much glacial activity, as discussed on page 48.

The history of Gardner Cave is not known satisfactorily. Contemporary accounts indicate that the cave was discovered in the summer of 1903 by Ed Gardner, who homesteaded a quarter section near the cave (Steele, 1904; Anon., 1918a, 1918b). About 200 feet from the entrance, however, are two nearly illegible inscriptions with dates 1883 and 1888. The quarter section around the cave was later acquired by W. H. Crawford, a Metaline merchant. In October 1921, he deeded the 40 acres surrounding the cave to the State for a State Park (Dingee, 1930).

Gardner Cave is of geological rather than biological importance. In contrast with the teeming life of warmer Allbright Cave, in Okanogan County, Gardner Cave seems almost sterile. Aside from the entrance zone, where moss, small-leafed plants, and a porcupine were observed, the only features of biological interest noted in the cave were some tiny diptera, mold on rotting wooden steps, and a different type of mold on rat droppings in the first 300 feet of the cave.

The main entrance of Gardner Cave is a vertical collapse sink about 10 feet wide and 12 feet deep. A wooden ladder extends to the floor of the broad passage below. About 50 feet to the north is a smaller, partially blocked second entrance, also in a collapse sink. The entire 820-foot length of the main passage slopes downward at a surprisingly uniform angle of about 25°, although small local variations make this less evident in the cave than on the map.

The high, broad section of the cave immediately downslope from the main entrance terminates at a flowstone-splashed cliff about 50 feet south of the entrance. The rock cover over this part of the cave is very thin, and a section of trail crossing it is resonant underfoot.

The next 120 feet of cavern consists of a high, fairly broad passage that is aligned from north to south. Its walls are richly decorated with flowstone, which appears to consist of both calcite and moonmilk. The latter is particularly prominent at the upper end of this section.

Several small stream channels open into this passage. The largest enters from the east at the bend at the lower end of this section. Near this junction, several wide-based stalactites on a low overhang have been truncated at an old water level. Prominent on the ceiling is an incised channel, which can be traced to The Narrows, 200 feet beyond the end of this section of the cave. At The Narrows, this ceiling channel forms the entire upper half of the passage. It is one of the most prominent features of the cave, and is not limited to horizontal and near-horizontal sections of the ceiling; in several places it is inclined quite steeply. The channel was carved by the flow of a stream atop fill that almost completely filled the cave. The stream must have completely filled the tube that it occupied and enlarged.

Beyond the bend mentioned in the previous paragraph, the next 120 feet of the cave extends southwest, and is similar in dimensions to the passage just described. It is featured by the presence of enormous gours (rimstone pools), and large dripstone and flowstone accumulations (fig. 30) that narrow the passage in several places. A large column (fig. 31) in the center of the passage near the lower end of this section is the most spectacular single speleothem in the Pacific Northwest. Unfortunately, it has

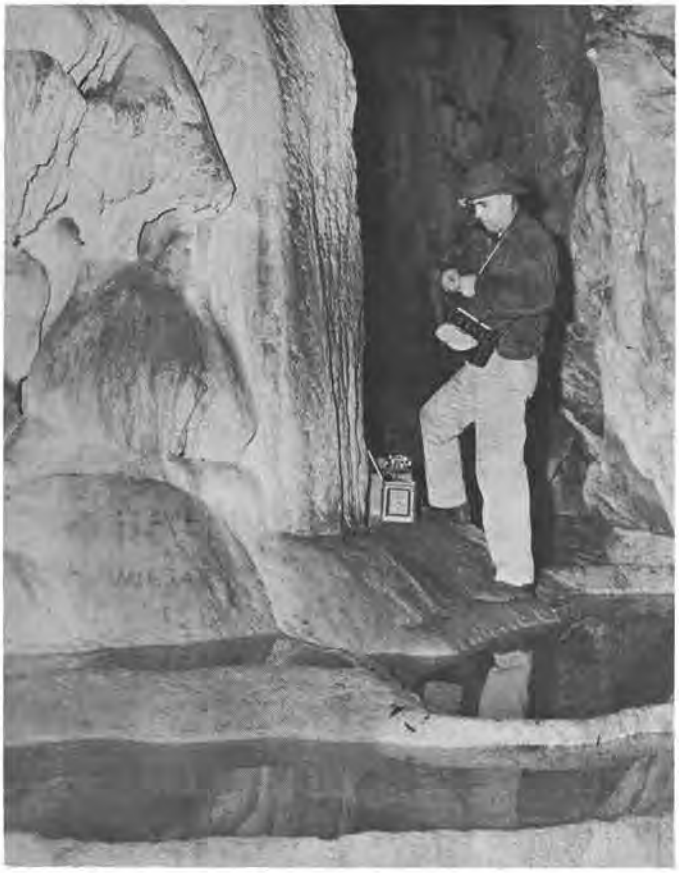


Figure 30.—Large gours, and flowstone covered with moonmilk, Gardner Cave, Pend Oreille County. Photo by Bill Lancaster.

Figure 31.—Large column in Gardner Cave, Pend Oreille County.

been subjected to much vandalism in the form of smoked inscriptions. In July 1958, however, the writer was delighted to discover that in a period of 12 months an opaque, milky flowstone deposit had obliterated most of the writing and restored much of the pristine beauty of this column.

A small chamber just below this column contains a deposit of stratified clay, and stains of an old water level are apparent on the walls. This chamber tapers downward to the entrance of The Narrows, a low, constricted, sinuous passage about 80 feet long. There are additional large gours above the entrance to The Narrows. A broken calcite speleothem here shows a jade-green afterglow lasting $4\frac{1}{2}$ seconds after discharge of a strobe flash.

The typical cross section of The Narrows passage consists of two superimposed tubes, forming a rough figure 8. The ceiling channel previously mentioned continues as the upper half of this passage. In addition to delineation by prominent ledges, flowstone false floors projecting from these ledges are indicative of an originally underlying fill, of which only traces now remain. The floor of the original passage is exposed at one place and appears to consist of flowstone originally covered with very small gours, but later subjected to moderate re-solution.

Below The Narrows there is a short length of sinuous, broader passage, then a succession of small, low chambers. They contain a large quantity of massive flowstone, a lesser amount of dripstone, a few

small helictites, and some small gours. Finally, 180 feet of broad muddy passage leads to the impassable exit of a seasonal stream at the termination of the main passage of the cave, about 790 feet along the slope from the entrance. This stream appears about 150 feet from the lower end of this passage, and is visible in many places as it courses in and out of breakdown, impenetrable fissures, slumped mud, and false floors. It has modified the bedrock with which it has come in contact, but the changes are very small.

About 70 feet from the lower end of the main passage, a low opening is present on the southeast side of the passage. Beyond is the small Junction Chamber, from which may be entered the two principal side passages of the cave.

At the southeast end of this chamber is a small opening. Beyond is a narrow passage that descends sharply from the northeast. This narrow passage contains phreatic speleogens; however, it also contains considerable accumulations of stream cobbles and gravels, and it shows the jagged residuals of vadose solution much more prominently than does the main passage. It is almost free of speleothems. Its total length, including both forks of its terminal chamber, is about 115 feet.

Leading downward and southwest from the Junction Chamber is a tapering passage about 50 feet long. A flowstone false floor (fig. 32) is a prominent feature. The false floor is continued through the small aperture at the lower end of this passage. Beneath are moderately coarse stream deposits. Beyond this aperture, this part of the cave is subject to seasonal flooding.

Figure 32.—False floor with gravel and cobbles cemented to its under surface. Terminal section, Gardner Cave, Pend Oreille County. Photo by Bill Lancaster.

This lowermost part of the cave is also the most complex. Four feet up the south wall of the small chamber beyond the aperture just mentioned, a small tube leads to a ledge 4 feet above the floor of the Mud Room, which is the part of the cave farthest from the entrance. The Mud Room can also be reached by a tighter, muddy, angled crawlway at floor level. On the southwest side of the small chamber just mentioned, a sloping pit, which is nearly choked with breakdown, extends downward for about 20 feet. This is the deepe point in the cave, about 275 feet below the entrance.

The Mud Room has few features visible through its coating. When not flooded completely, the room usually contains a seasonal lake. On July 26, 1958, this lake was noted to consist mostly of mud, in which slumping, presumably into a deeper part of the cave system, was evident. Two small stream passages enter this chamber, but neither is passable.

Phreatic speleogens are common throughout Gardner Cave. Specific vadose modifications have been mentioned. No stream fluting has been recognized. There is evidence that both phreatic and vadose phases of speleogenesis have been complex. The main passage is developed mostly on dip joints, and it trends southwest, parallel to the dip, beyond the initial series of passages. Near the entrance there has been considerable development on oblique joints as well as parallel to the strike of the bedrock. Small side passages along the main passage, and also the complex of larger side passages near the lower end of the cave, indicate that a primitive cavernous network originally existed here. The main passage was selectively enlarged along the route affording the least resistance to phreatic flow under hydrostatic pressure, but, in order to maintain its constant slope of about 20°, selection of the route must have been influenced by some factor not yet understood. This may represent bedding control, but if so, it could not be determined within the cave. The route does not appear to be related to present or past topography.

After this period of phreatic integration the cave was drained, presumably by downcutting subsequent to regional uplift, and the flowstone on the floor at The Narrows was deposited. Then came a period during which the entire main passage was filled with sediments. Probably due to compaction, a small space developed atop this fill, permitting entry of water that completely filled the space and dissolved a channel upward into the ceiling. This event could have occurred either above or below the general water table of the area, but within the incised channel the effects were phreatic.

Subsequently, flow in this ceiling channel ceased, and the channel was drained. Locally, flowstone was deposited in it and atop the underlying fill. The same stream, now under vadose conditions, or a new cave stream began to remove the fill, and in turn left some coarser deposits. The water-level stain and the stratified clay in the chamber just downslope from the great column suggest that this was an intermittent process. The sequential position of a coarse stream deposit overlain by flowstone in the tapering side passage near the lower end of the cave is not clear. Flushing of the fill, and speleothem deposition are still in progress in the cave.

The geomorphic history of the region around Gardner Cave is complex, and is not yet fully known. No mature upland surfaces have been recognized in this area. The cave is in a small foothill knoll in a broad, rolling valley surface of moderate geomorphic age, below which the Pend Oreille River has re-excavated a youthful gorge (Park and Cannon, 1943).

The cave has been covered deeply by the ice of at least two glacial advances (Park and Cannon, 1943). There are many stream terraces on the flanks of tributaries of the Pend Oreille River, and a prominent terrace at an altitude of about 2,500 feet appears to be of lacustrine origin (Park and Cannon, 1943). Because the Pend Oreille River flows northward in a deep gorge, one's natural initial reaction would be to explain this deposit of silt and fine sand as the residual of a lake dammed against retreating ice. However, there is satisfactory evidence that the preglacial flow of the river was southward, not northward as at present (Park and Cannon, 1943), and a presumed lake cannot be explained so easily.

Although the advancing glacial ice seems to have had a thickness of about 4,000 feet at Gardner Cave, it was in the waning stage of each advance, and seems to have deposited much more than it

removed (Park and Cannon, 1943). The local drainage of the cave area flows southeast, following the preglacial drainage pattern, and also following the dip of the bedding. There are no permanent surface streams adjacent to the knoll in which the cave is located.

Probably, not all of the speleogenetic sequence of the cave has been recognized during this short survey. Because of this, and also because of the complexity of the geomorphic history of the area, it appears premature to attempt to correlate the details of the history of the cave with those of the surface history. The massive speleothems are postflushing in age, and hence postglacial. The latest flushing of the cave is a feature of local runoff accompanying and following retreat of the last glaciation. It is a reasonable working hypothesis that the massive cave fill was the result of the deposits of the last glacial advance, but this is supported only by indirect evidence.

As the original gorge of the Pend Oreille River probably resulted from downcutting subsequent to Pleistocene or late Tertiary uplift, the cave was probably drained at that time, and the major part of its phreatic phase may have occurred just prior to that episode. As yet, however, one can only say that Gardner Cave merits detailed study.

INDIAN ROCK CAVES (31) (Indian Caves)

Sec. 32, T. 34 N., R. 44 E., Newport quadrangle. Elevation about 2,100 feet.

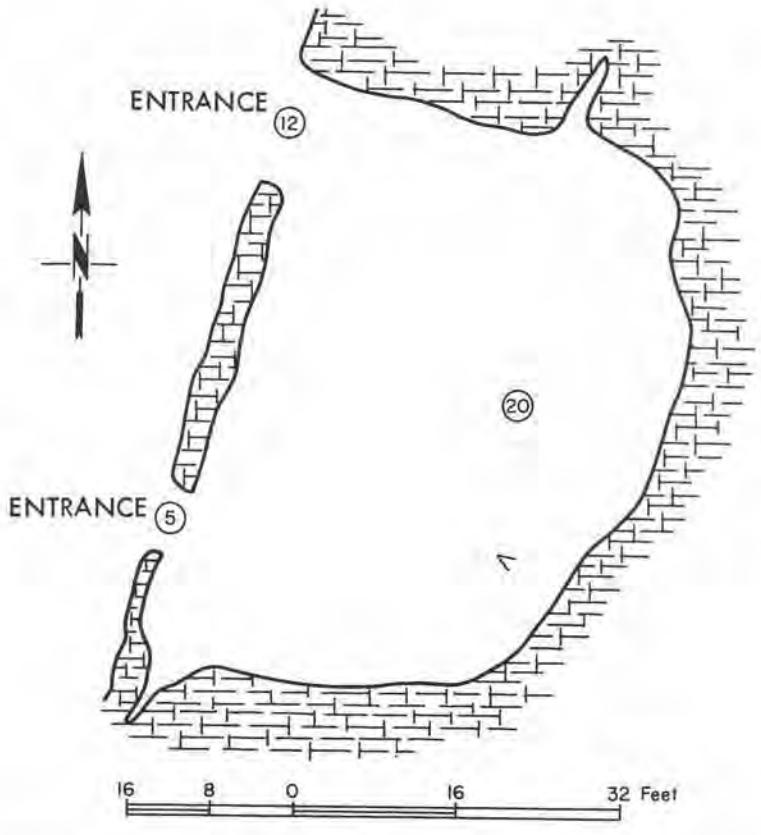


Figure 33.—Indian Rock Cave, Pend Oreille County. Survey by Washington Speleological Survey.

Two of these three caves north of the mouth of Seseah Creek on the east side of the Pend Oreille River are merely overhangs in the sandy Tiger Formation of Tertiary (?) age (Schroeder, 1952). The third is a larger cavern (fig. 33) in the same rock. It consists of a single chamber 67 feet wide and 46 feet long, with a maximum ceiling height of 20 feet. It has two small entrances facing west. The south entrance is 4 feet wide and 5 feet high. That to the north is 12 feet high, and is more irregular in shape, averaging perhaps 6 feet in width (fig. 34). Linear prolongations of the cavern follow a prominent joint that crosses the long axis of the cave rather obliquely. They have the appearance of phreatic joint pockets, and the north entrance has the cross section of a phreatic joint passage intersected by a horizon. It is difficult to explain the contour of this as being a

result of vadose processes, and if the cave were in limestone, its phreatic origin would be accepted unequivocally.

It is said locally that in 1844 Father DeSmet held services in this cave for the Indians.

Figure 34.—Main entrance of largest Indian Rock Cave, Pend Oreille County. Photo by Charles I. Barker.

LOST CAVE (See Gardner Cave.)

OTHER CAVES

The caves in the Metaline mines were not examined during the survey. The following have been reported to date (1960):

Small caves have been discovered in operating the Pend Oreille Mines and Metals mine, in sec. 16, T. 39 N., R. 43 E. Many of these caves contained sphalerite and galena in fragments on the floors and as crystals lining the walls. One cave above the 500-foot level was said to be 8 feet wide, 4 feet high, and more than 20 feet long. Others were said to have been larger. The mine is in brecciated Metaline Limestone of Cambrian age. All the caves were reported to show faulting, with smooth, slickensided walls. They were said to be most common above the 500-foot level (altitude 2,124 feet), and to decrease in size and number at depth. All those on the 700-foot level (altitude 1,900 feet) were less than 3 feet in greatest dimension. Many of the caves in this mine contained paligorskite, which has not been discovered in other Washington caves (Park and Cannon, 1943).

Several caves filled with clay, silt, and sand were intersected by the long adit of the Bella May mine, in sec. 32, T. 39 N., R. 43 E. (Park and Cannon, 1943).

Caves similar to those in the Bella May mine are in Washington Rock, west of Metaline Falls, in sec. 21, T. 39 N., R. 43 E. One such cave, filled with brown clayey iron oxide, was mined by the Lehigh Portland Cement Company (Park and Cannon, 1943).

Caves have been discovered also in the Grandview mine, in sec. 15, T. 39 N., R. 43 E. One cave contained fragments of galena-bearing rock (Jenkins, 1924).

PIERCE COUNTY

Little limestone is found in Pierce County. The county's only known caves are related to the glaciers of Mount Rainier. Some of these glacier caves are extensive, but most are small. The Paradise Ice Cave (fig. 35) in the Stevens Glacier is the best known and most extensive, but others underlie the Kautz, Carbon, Nisqually, and other glaciers (Matthes, 1938; Potts, 1950; Halliday, 1954).

At the altitude of 14,200 to 14,400 feet in the crater of Mount Rainier there are several openings between the bedrock and accumulated snow and ice. They have been formed as a result of melting by

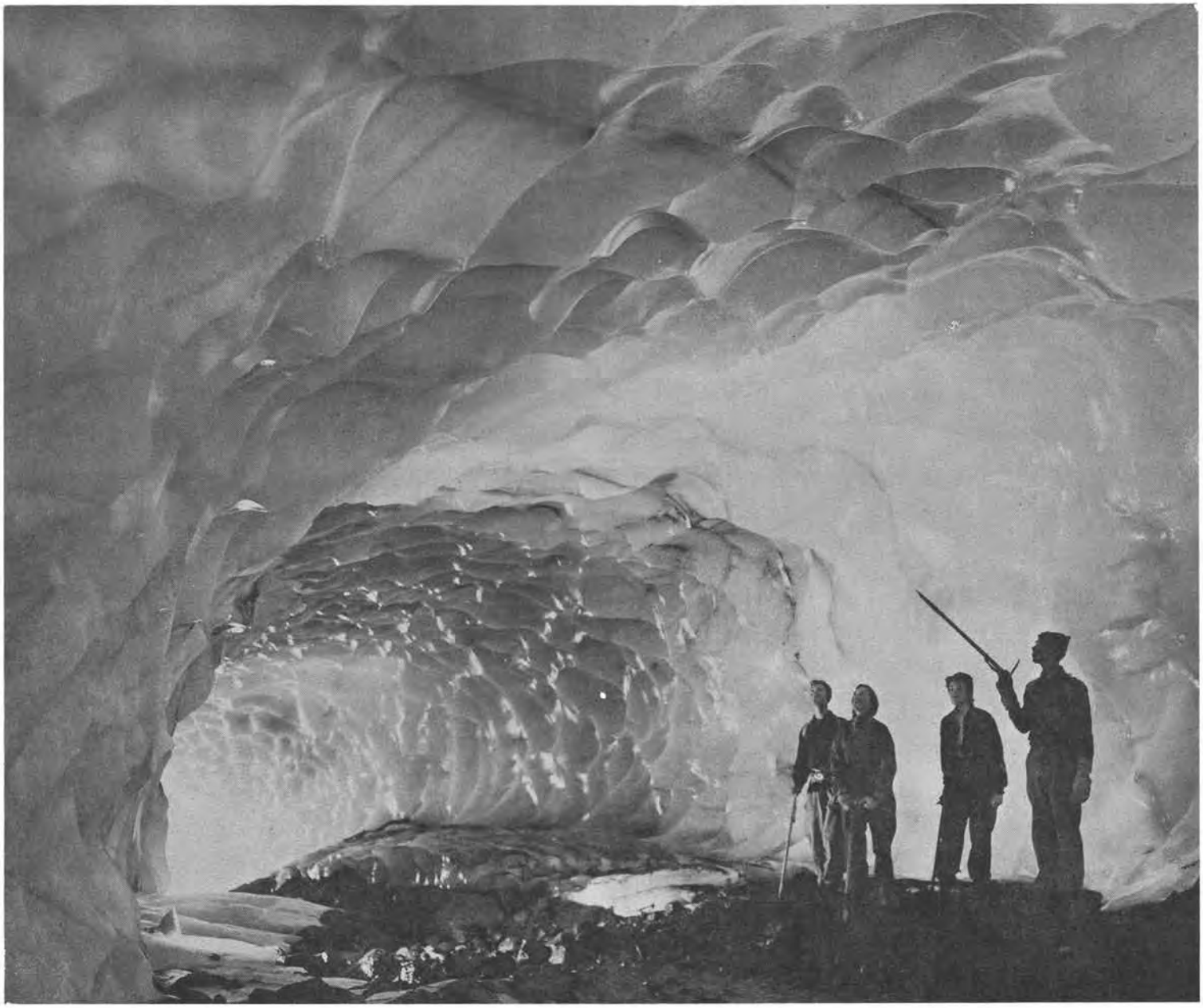


Figure 35.—Paradise Ice Cave, Stevens Glacier, Mount Rainier. Photo by Bob and Ira Spring.

the steam and volcanic gases that escape through small vents in the crater. They are variously referred to as Summit Caves, Steam Caves, or Thermal Caves, and are described as "passageways for several hundred feet from one large dome-shaped chamber to another" (McLellan, 1953). They are the highest sizable caves in the United States, possibly excluding Alaska.

SAN JUAN COUNTY

Several types of caves, including littoral caves in various rocks, and solution caves in the numerous small limestone lenses of the islands, have been discovered in San Juan County. These limestones are believed to be of Devonian, Carboniferous, and Triassic age (McLellan, 1927), and have been subjected to so much metamorphism that the dip and strike of the original beds can be determined only rarely. The limestone caves of these islands are the lowest known in the western United States, possibly exclusive of Hawaii (Halliday, 1958) and Alaska (Hackman, 1949). Local stratigraphy and geomorphology are complex. Multiple periods of glaciation and marine erosion have occurred. Although these caves are relatively small, their features include indications of early random tridimensional joint-controlled solution with subsequent shallow sub-water-table integration by selective flow. In this report each island will be listed separately for geographic reasons. To date, it has not been possible to locate the "narrow cave of fault origin, several hundred feet long" mentioned by Junius Henderson (1932) as being somewhere in the San Juan Islands. Neither Henderson's published works nor his field notes at the University of Colorado (Hugo Rodeck, written communication, 1951) indicate its location more exactly, and no cave resembling this description has been located by the Survey.

Guemes Island

There is at least one littoral cave on the east coast of Guemes Island (W. R. Danner, oral communication).

Henry Island

Littoral caves 20 to 40 feet long on the two south ends of Henry Island have been visited by members of the Washington Foldboat Club.

Jones Island

In a deposit of limestone at tide level on the north side of the isthmus of Jones Island, water gurgling in an inner chamber may be heard through cracks that show solutional features (W. R. Danner, oral communication).

Lopez Island

Members of the Washington Foldboat Club have noted the presence of littoral caves on the south end of Lopez Island.

Orcas Island

Lenses of limestone occur in considerable numbers on Orcas Island, particularly in its west central part. Originally, these lenses were considered as being in the Orcas Group of the San Juan Series

(McLellan, 1927), but it is now believed that limestones of Devonian, Early Pennsylvanian, Permian, and Triassic age are all present (W. R. Danner, oral communication). Major littoral caves have been found in other rocks also.

DOUBLE HILL CAVE (See Langell Quarry Cave.)

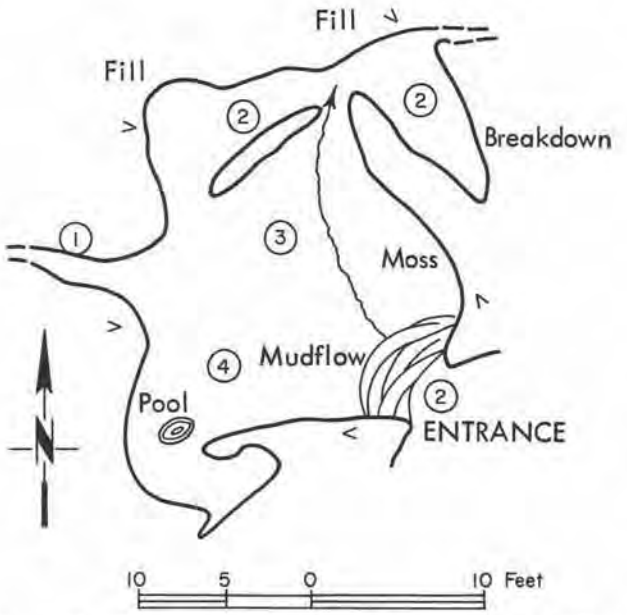


Figure 36.—Fowler's Cave, San Juan County. Survey by Washington Speleological Survey, December 1960.

Figure 37.—Entrance of Fowler's Cave, Orcas Island.

FOWLER'S CAVE (32)

Sec. 22, T. 37 N., R. 2 W.,
Orcas Island quadrangle. Elevation about 175 feet.

This small solution cave (fig. 36) in Permian limestone is about 300 yards west of the farmhouse of Mr. Harry E. Fowler. Its low entrance (fig. 37) is in a clump of brush in a cleared pasture. No definite terraces are in the vicinity.

Just inside the stoopway entrance is a short slope of surface inwash at the southeast side of a low, irregular chamber about 15 feet in diameter. Several short extensions of the cave are blocked by earthy deposits. Excavation might reveal a considerably larger and more complex cave than is now known.

This small cave includes rounded joint pockets typical of sub-water-table solution, apparently integrated by selective shallow sub-water-table flow. At the southwestern part of the chamber, near a shallow pond, there is a flat expanse of ceiling that appears to be of solutional rather than joint- or bedding-controlled origin. A single small vadose rivulet channel extends northwestward from the entrance slope to a short side passage.

Fowler's Cave shelters much life. On the northeastern wall of the main chamber, moss grows where sunlight shines through the entrance. Wool is caught on projections from the ceiling, indicating use of the cave and perhaps its pool by sheep. Many snail shells were observed on December 3, 1960, as were spiders, gnats, and a small green frog.

IMPERIAL QUARRY CAVE (33)

Sec. 31, T. 37 N., R. 2 W., Orcas Island quadrangle. Elevation about 130 feet.

This small, moderately complex cavern (fig. 38) is about 100 yards north of the old Imperial Lime Quarry. Part of the cave system underlies a small limestone spur about 10 feet high, but the sinkhole entrance is on the east side of the south end of this deeply mantled ridgelet. On the opposite side is a cavernous grotto consisting of a north-south-trending tridimensional complex of small phreatic solution cavities, largely on oblique joints, with considerable horizontal integration, much like that of Imperial Quarry Cave itself. The maximum length of this grotto passage is about 25 feet. Its irregular entrance is about 8 feet wide and 3 feet high. The grotto and cave are only a few feet apart, and the two are part of the same original system. Small solutional cavities exposed in the walls of the Imperial Quarry do not show the same configuration by shallow sub-water-table flow, and probably are not a part of this system.

The vertical entrance of Imperial Quarry Cave is an opening about 7 feet long, 4 feet wide, and 4 feet deep. From the bottom, a passage 3 to 4 feet high extends northeastward about 40 feet to a junction. The floor of this passage slopes sideways from east to west; and at two points along its length, downward extensions end in small pools. The extension nearest the entrance of the cave is connected through an impassable hole to the terminal complex of the main side passage.

Beyond the junction mentioned above, the main passage, here about 2 feet in diameter, continues northward about 45 feet to a small breakdown area. On the surface approximately above this point is a shallow sink. Along the course of the main passage are several short joint-controlled side passages, only one of which is important, and is termed the "Side Passage." The latter extends about 25 feet southwestward from the junction. Near its end is the pool that can also be seen at the bottom of the pit just inside the entrance. Like the entrance passage, this side passage is inclined sideways from east to west, following a prominent joint. The lower (terminal) end of this side passage is the only part of the cave in which it is possible to stand erect. Marked thermostratification occurs in this section of the cave.

Although the main passage of the cave and the higher part of the side passage are essentially horizontal, and developed largely through shallow sub-water-table flow, there are many features of an earlier stage of more random phreatic solution along joints in all planes. Vadose modification is minimal. At the extreme northern end of the cave, a small vadose rivulet channel runs south and west into an impenetrable side passage. A few feet farther south, a similar channel runs south along the main passage and into the main side passage. A third, similar channel is on the floor between the two pits in the entrance section, but as this channel curves over the hump between the pits, it must have been of sub-water-table origin.

To the north and east of the cave is a flat that slopes gently seaward. The main passage of the cave is only a few feet below the surface of this flat, which may be an old marine terrace, and the horizontal integration of the cavern probably developed in relation to this erosion surface. Because of

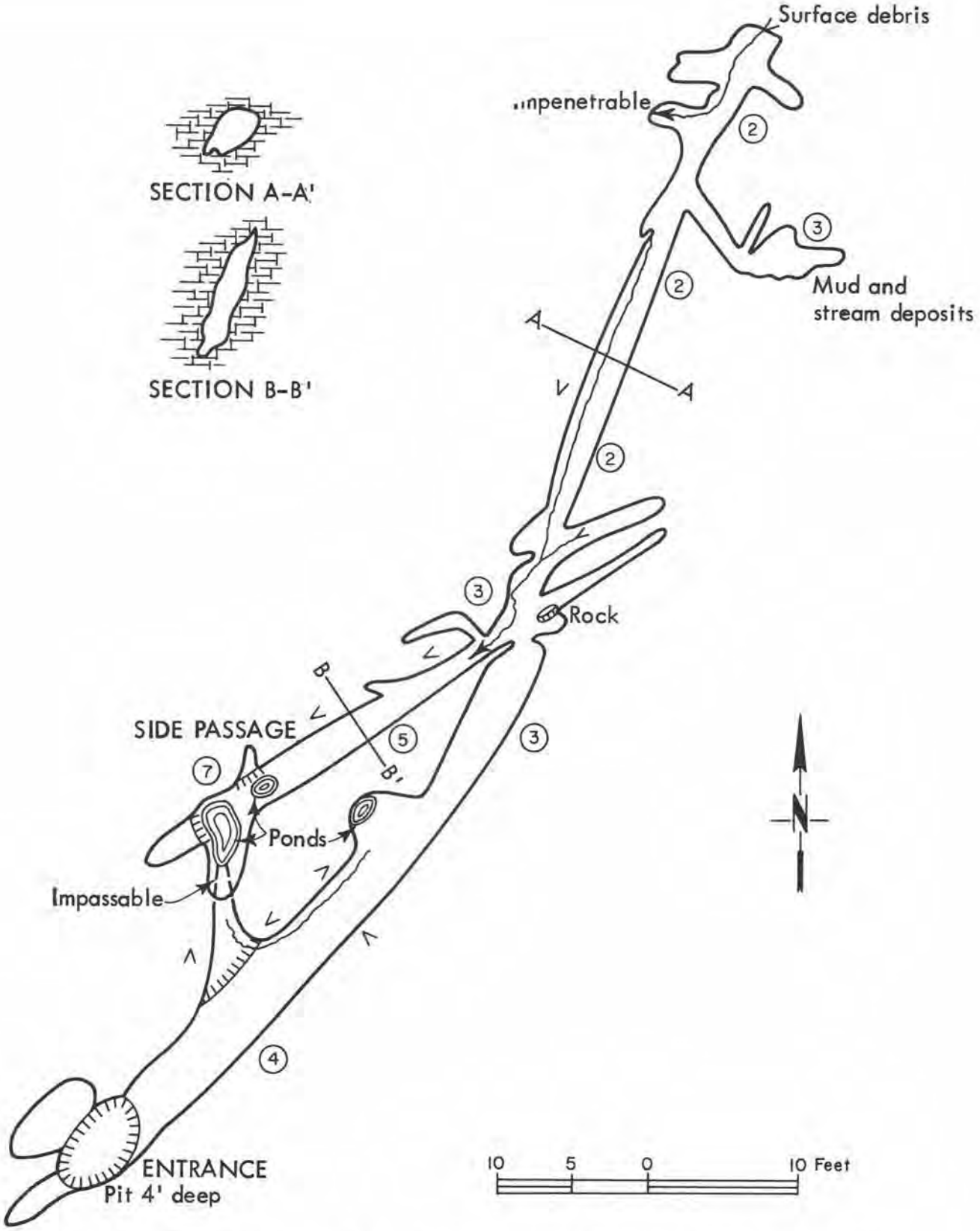


Figure 38.—Imperial Quarry Cave, San Juan County. Survey by Washington Speleological Survey, December 1960.

accumulated fill in both the cave and the nearby grotto, it is not possible to determine the total depth of sub-water-table solution at this locality.

On December 3, 1960, a considerable biota was noted, including many mosquitoes and spiders. Speleothems were almost nil, although a few patches of what appeared to be dry moonmilk were noted.

LANGELL QUARRY CAVE (34) (Double Hill Cave)

Sec. 15, T. 37 N., R. 2 W., Orcas Island quadrangle. Elevation about 475 feet.

This small solution cavern (fig. 39) was intersected by minor quarrying in the saddle between Lookout Mountain and Double Hill. Because of very dense brush, the little quarry is almost impossible to find without a guide.

Most of the cave consists of a fairly broad crawlway leading westward from the partially blocked entrance. There is a gentle upward slope from the entrance to the rear of the cave except at about the midpoint, where there is a 2-foot shelf. At about this same place, the ceiling contour changes from a flat water-table-determined pattern in the entrance section to a rounded phreatic pattern seen toward the rear of the cave.

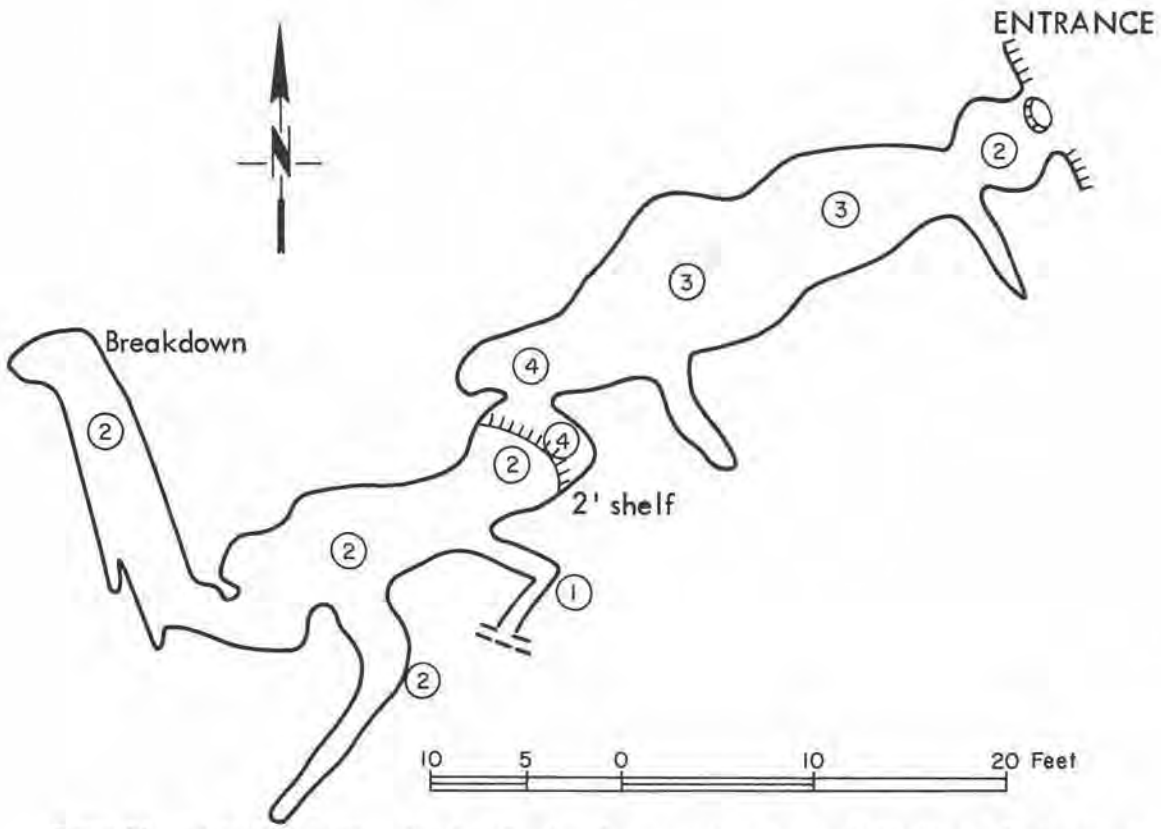


Figure 39.—Langell Quarry Cave, San Juan County. Compass and tape survey by Washington Speleological Survey, 1961.

Joint control is marked, and there are several side crawlways. Most of the ceiling and wall surfaces are covered with small flutes. No speleothems are present, but thin veinlets and larger masses of noncalcareous impurities are prominent. In one side passage a steeply inclined vadose stream channel enters through a pre-existing vertical solution tube. Most of the main passage is floored by silt that has dried, leaving mud cracks on its surface. In the center is a channel in the silt, but this may have been produced by earlier explorers rather than by currents. Many roots and a moderate biota were observed. There is some evidence that the cave fills to the level of the horizontal ceiling with the seasonal rise of the local water table. The cave was studied during a time of unusual drouth.

The cave is near the base of a low knoll, which rises about 25 feet from a small area of gentle topography perched above the steep slopes leading down to Fishing Bay. Development of the cave appears to have been related to local ground-water conditions, with initial semirandom solution along joints, followed by shallow sub-water-table integration, and current or very recent modification in the zone of fluctuation of the water table.

ORKILA CAVE (See Point Doughty Cave.)

POINT DOUGHTY CAVE (35) (Orkila Cave)

This small but well-known littoral cave is on the first small point southeast of Point Doughty, at the northwest end of Orcas Island. It was developed by differential erosion along the strike of a formation of thin-bedded shale and conglomerate that dips about 60° southward. Slumping of the hanging wall has occurred at several places.

The cave is basically an angled slot 2 to 4 feet wide, having seaward and landward entrances. The lowest part of the slot is within the tidal zone. Although the seaward entrance is blocked with breakdown, it permits entry of considerable illumination. The lower part of the cave slopes upward for about 30 feet, to a point where a vertical pitch of about 10 feet separates the 20-foot landward part from the seaward part of the cave. The clifftop (main) entrance is about 20 feet long, although partially blocked by a large rock. Only a small part of the cave is in total darkness. Spiders and insects were noted in July 1959, but no marine life was found. Tiny gours are present on the sloping lower wall of the cave.

OTHER CAVES

Other littoral caves occur southwest of West Beach (W. R. Danner, oral communication), and reportedly elsewhere on the island. Quarry personnel state that solution caverns were encountered on the shale-limestone contact at the Flaherty quarry, but no longer are present, and that a cave was encountered at the south end of Dolphin Bay Quarry No. 3, but is now blocked.

A small vertical pit is in limestone near the new north shore road in sec. 17, T. 37 N., R. 1 W. (W. R. Danner, oral communication). There are local reports of limestone caves elsewhere on Orcas Island, but no authentic information has been obtained about them.

San Juan Island

On San Juan Island there are at least three small solution caves in lenses of limestone of the Orcas Group of the San Juan Series (McLellan, 1927), which here may be of Permian age (W. R. Danner, oral communication). One of these, English Camp Cave, because of its potential correlation with littoral features, is of unusual speleogenetic interest despite its small size. Littoral caves are present in various parts of the island.

CROOK PROPERTY CAVE (See English Camp Cave.)

ENGLISH CAMP CAVE (36) (Crook Property Cave)

Sec. 25, T. 36 N., R. 4 W., Roche Harbor quadrangle. Elevation about 170 feet.

The entrance of this small cave (fig. 40) is in an abandoned limestone quarry east of English Camp, 2 feet below a gently sloping terrace that is presumably of marine origin. Several phreatic tubes about 6 inches in diameter and one long phreatic joint cavity on a main speleogenetic joint extend upward to the flat surface of the limestone deposit (fig. 41), so that much of the cave's length of about 70 feet is within the twilight zone. There are several other small vertical phreatic tubes near the cave, indicating that a more extensive system is present.

The entrance of the cave (fig. 42) is about 4 feet high and 2 feet wide. It is in the low south wall of the small abandoned quarry. Although the main part of the cave extends southward as an integrated horizontal passage, the entrance section consists of a typical phreatic joint pocket about 12 feet long and 9 feet high as measured from a point about 5 feet lower than the main passage level. Its orientation is along a joint that is at an angle of about 40° to that along which the main passage is aligned. At its bottom is a pool about 1 foot deep. At the south end of this small cavity-chamber is the first of the vertical phreatic tubes that connect with the surface.

Beyond the southern lip of the joint pocket chamber is another, less fully developed joint cavity. Beyond this cavity the passage extends about 15 feet as a tube about 4 feet high and 2 feet wide. On the east side of the ceiling is another vertical phreatic tube connecting with the surface. On the west is a similar vertical opening, which does not permit the entry of light, but, unlike the other vertical tubes, its surface is pitted and jagged. This hackling is also present in one tiny ceiling joint cavity elsewhere in the cave.

About 28 feet from the entrance the passage bends slightly to the east to follow a joint that parallels the joint cavities at the entrance. The next 25 feet of the cave is characterized by a slightly sinuous tubular course 3 to 4 feet in diameter with one elongated and several small openings to the surface; irregularly rounded phreatic joint pockets; and broad, low extensions of the upper section of the passage. Part of the ceiling is horizontal, as if water-table controlled. At another point are traces of a small ceiling meander.

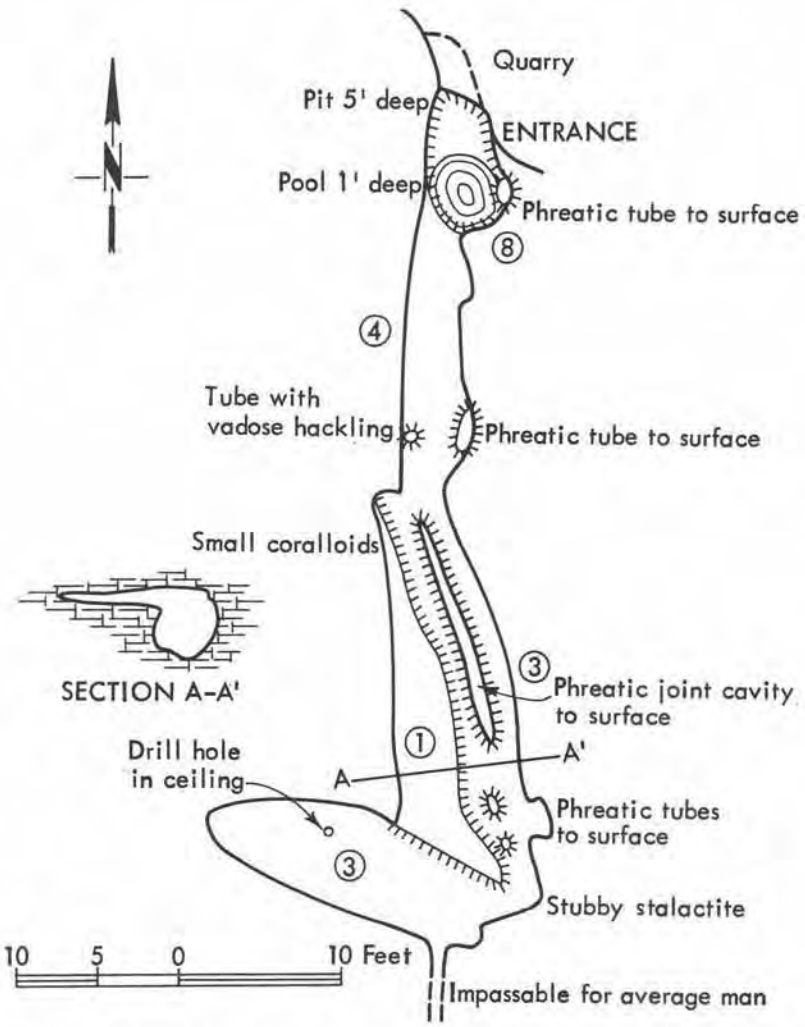


Figure 40.—English Camp Cave, San Juan County. Survey by Washington Speleological Survey, December 1960.

Figure 41.—Joint cavity extending to surface, English Camp Cave, San Juan Island.

Figure 42.—Entrance of English Camp Cave, San Juan Island. Photo by W. R. Danner.

At the end of this part of the cave, a low side chamber 16 feet long, 3 feet high, and about 5 feet in maximum width extends northwest. On its south wall is an offset continuation of the main route about 9 inches wide and of undetermined length. Excavation of earthy fill at the rear of the cave may reveal beach sands.

A few coralloids and two stubby stalactites are in English Camp Cave. The beauty of the cave is its display of speleogens. At the time of its examination a plentiful biota was present, including several types of moths, snails, a large pale green slug with a large black spot, spiders and mosquitoes, and a small green frog. Reportedly, bats are in the cave in summer.

FERN CAVE

This botanical site (Wylie, 1949) is a sandstone rockshelter just north of the Oceanographic Laboratories of the University of Washington at Friday Harbor (Peter McLellan, oral communication).

HAFFNER'S QUARRY CAVE (37)

Sec. 29, T. 36 N., R. 3 W., Friday Harbor quadrangle. Elevation about 220 feet.

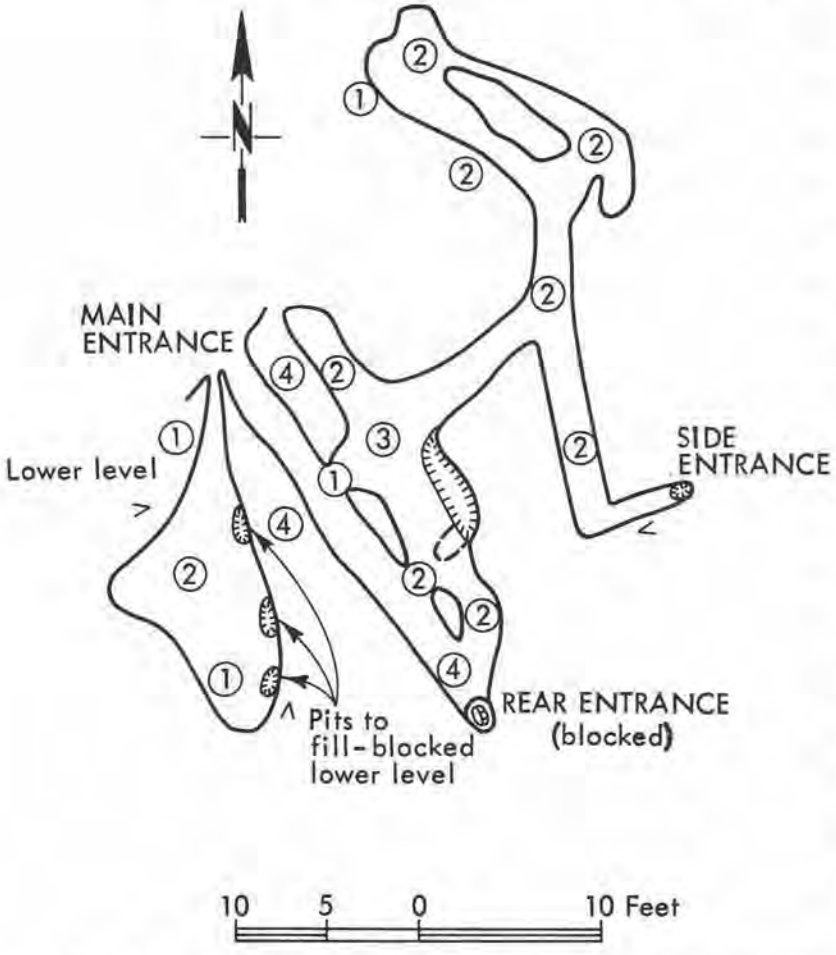


Figure 43.—Haffner's Quarry Cave, San Juan County. Survey by Washington Speleological Survey, December 1960.

This surprisingly complex little solution cave (fig. 43) is in a small limestone hillock about 15 feet high, at the south end of a small abandoned limestone quarry. Quarry operations opened the cave's main entrance, which is about 4 feet high and 2 feet wide, but the other two entrances are natural. Total length of all the cave's passages is about 125 feet, but the entire cave is within an area 30 by 40 feet. Most of the cave consists of narrow crawlways on phreatically dissolved joint passages averaging 2 feet in height, with some lower areas, but the entrance passage maintains its 4-foot height throughout its length of 24 feet. At its southeast end is the partially slab-blocked rear entrance. Beneath the west margin of the main entrance is the small oval entrance to a separate section of the cave that is at a lower level than the main part. In this small chamber the ceiling is mostly horizontal. Along the chamber's eastern wall, three earth-blocked pits extend

downward into an impenetrable, still lower level, which may connect with similar small pits in the main section.

With the exception of these small pits, the separate western section, and the slope downward from the side entrance, the cave is remarkably horizontal. In part, at least, this is due to accumulation of fill, but there appears to have been some shallow sub-water-table integration of joint cavities in the development of the present form of this cave, which today is only a few feet above the local water table.

When the cave was examined, a plentiful biota was present, including mosquitoes, gnats, spiders, and a rabbit carcass probably dragged into the side entrance by a predator.

LAWSON PROPERTY CAVE (See Roadside Cave.)

MOONSHINER'S CAVE

There are vague but persistent local reports that a cave in approximately the location of Haffner's Quarry Cave sheltered a still during prohibition days. Its identity is not known at this time (1962).

ROADSIDE CAVE (38) (Lawson Property Cave)

Sec. 14, T. 35 N., R. 4 W., Roche Harbor quadrangle. Elevation about 300 feet.

This small, joint-controlled solution cave (fig. 44) in limestone is about 10 feet southwest of the West Side Road about a mile southeast of Smallpox Bay. It is at the foot of a slope about 25 feet high and is separated from a swamp only by the road fill. This swamp apparently is on the local water table, and most of the cave is within the zone of fluctuation of the water table. During periods of high water, only the small eastern section of the cave can be entered, and even that part has at least 1 foot of standing water. There are some expanses of flat ceiling in the western section that apparently correlate with that water level.

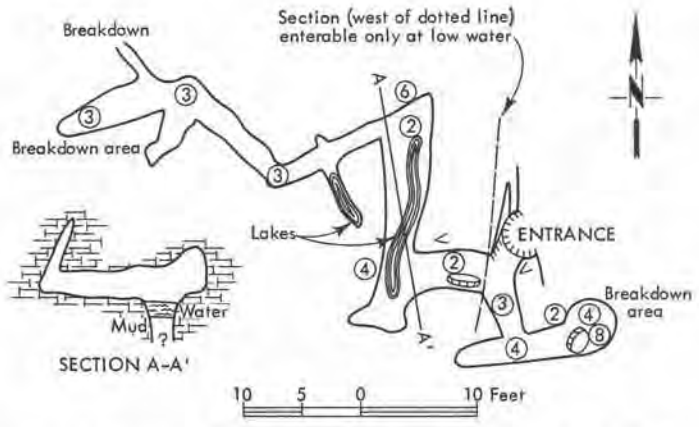


Figure 44.—Roadside Cave, San Juan County. Compass and tape survey by Washington Speleological Survey.

The entrance of the cave (fig. 45) is about 4 feet wide and 2 feet high. A steep descent of 4 feet past a grottolike westward extension leads to the main cavern level. To the south is a low passage about 8 feet long, which ends in a small complex of breakdown at each end of a small phreatic passage.

The western section of the cave is entered through a crawlway that is filled with water seasonally. Beyond is a broad, low passage leading north, with a curious narrow meander in its central part but not at either end. On September 30, 1961, there was about

1 foot of water in this meander, above tenacious mud more than 2 feet deep (the total depth was not plumbed). At the north end of this chamber is a sloping "fissure" passage of very different nature, and farther to the west is a small complex of passages with sub-water-table characteristics and with moderate breakdown at the far end. There are no speleothems, but veinlets and larger masses of noncalcareous material are exposed in several locations. A moderate biota was observed. Total length of passages is about 100 feet.

Figure 45.—Entrance of Roadside Cave, San Juan Island.

Like other San Juan Island caves, Roadside Cave appears to have been formed by shallow sub-water-table integration of a pre-existing network of solution along various joints, and to be undergoing modification at the present time in the zone of fluctuation of the water table.

OTHER CAVES

A large littoral cave is on Turk Point, north of Merrifield Cove, and a small, very narrow one has been found just south of the first beach north of Lime Kiln Light. There is locally rumored to bea larger one in that area. Others have been reported on the north shore of Smuggler's Cove, and north and south of that cove, at Delacombe Point, and near Bellevue Point. The Survey has not confirmed local reports of limestone caves on or near Cady Mountain, east and south of Sportsman's Lake, and near Quarry 5 at Roche Harbor. In a road cut on the Roche Harbor road, north of Sportsman's Lake, there are two small solution pockets on the contact between shale and very small deposits of limestone.

Shaw Island

YANSEN'S CAVE (39)

Sec. 29, T. 36 N., R.2 W., Orcas Island quadrangle. Elevation about 225 feet.

With a total of about 200 feet of passages, this small solution cavern in limestone (fig. 46) is the largest known in the San Juan Islands. It is in a spur of limestone, about 10 feet high and 100 feet in diameter, extending eastward from the northeast side of a low hill and on the south end of a small flat that is a few acres in size. The cave is almost entirely within the zone of fluctuation of the local water table, seasonally filling almost completely. Horizontal ceilings in several parts of the cave appear to correspond with the maximum water level.

Yansen's Cave has two entrances and extends completely through the low limestone spur. Almost every part of the cave is a crawlway, and it is developed on two (perhaps three) levels, about 3 feet apart.

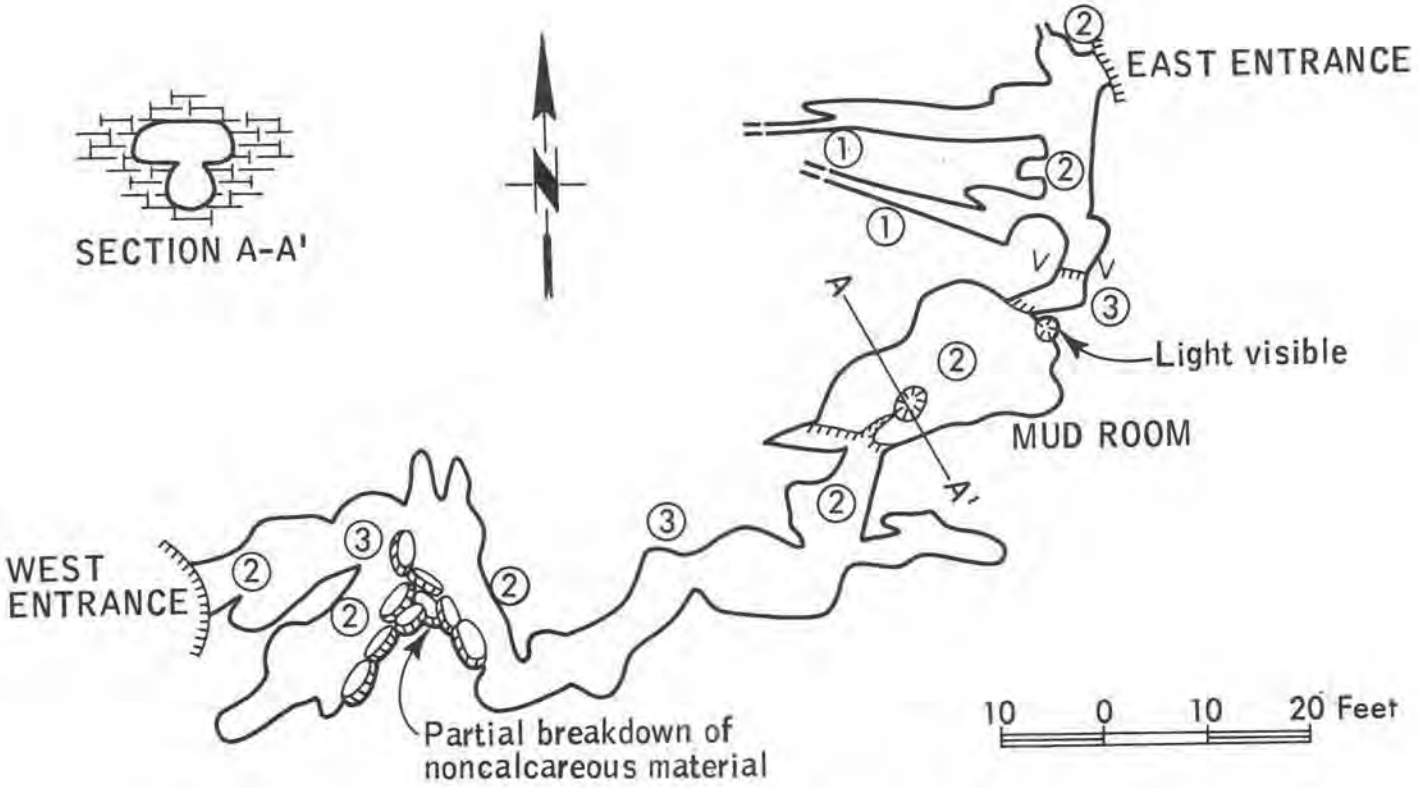


Figure 46.—Yansen's Cave, San Juan County. Compass and tape survey by Washington Speleological Survey, 1961.

The main (eastern) entrance is near the northeastern tip of the limestone spur. Inside is a low but roomy crawlway leading south for about 20 feet. Along its west side are two large and some small joint-controlled side passages, in which offsetting from one joint to another is displayed. All slope down toward the main passage. At the end of this area is a sloping pit about 3 feet deep; at its base is a crawlway that leads to the Mud Room.

The western entrance and the passage beyond are somewhat lower than the eastern entrance, but are more spacious. Also in this area are side passages on prominent joints. About 20 feet from the entrance there is a very large mass of noncalcareous material, in which there has been much breakdown. The next 20 feet of the cave has formed along the edge of this noncalcareous rock. Smaller masses of such rock are present elsewhere in the cave. Beyond this large mass is a more spacious, 40-foot sinuous passage that leads to the Mud Room.

The Mud Room is a curious cavity. It is irregular in shape and contour, and contains many wall pockets and joint cavities. On its northeast wall is an area of breakdown in which daylight is visible. Both crawlway entrances to the chamber are at a level about 3 feet below the main section of the room, which has a flat floor, about 2 feet above which is a flat ceiling. Near the center of the room is a

potholelike cavity about 3 feet in diameter, and roughly spherical, although a narrow fissure leads southwest to the entering passage. Many roots project into this room, and elsewhere in the cave. A moderate biota was observed. There are no speleothems.

Although the speleogenesis of Yansen's Cave may have been slightly more complex than that of other San Juan County caves, this cave appears to have developed largely through shallow sub-water-table integration of a pre-existing solution network, and to be presently undergoing modification by solution in the zone of fluctuation of the local water table.

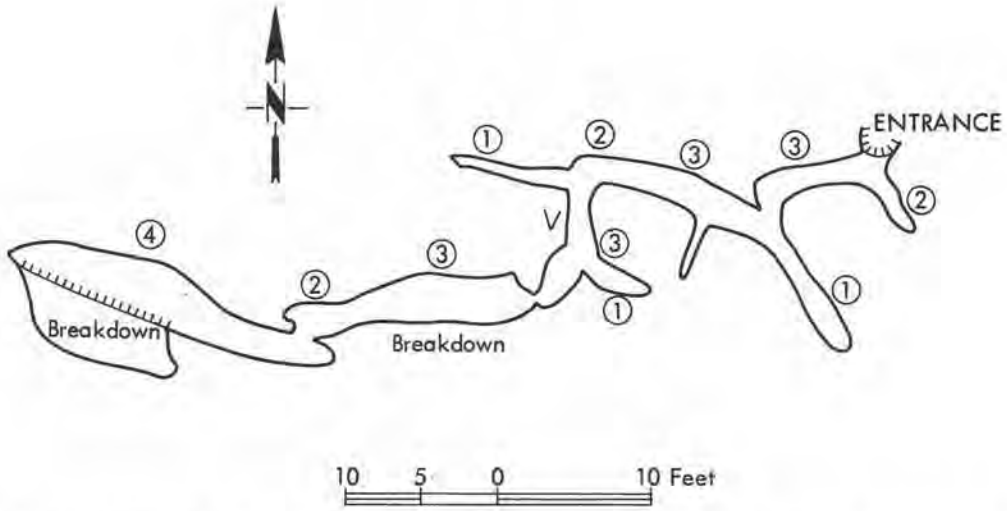


Figure 47.—Yansen's Little Cave, San Juan County. Compass and tape survey by Washington Speleological Survey.

YANSEN'S LITTLE CAVE (40)

Sec. 29, T. 36 N., R. 2 W., Orcas Island quadrangle. Elevation about 230 feet.

This cave (fig. 47) is about 30 feet south and 80 feet west of the west entrance of Yansen's Cave, and a few feet up the slope of the main part of the low hill mentioned previously. It is entered through a pit about 3 feet in diameter and 6 feet deep. Total length of passages is less than 100 feet, and almost the entire cave is crawlway. Breakdown in noncalcareous material on the south side of the terminal chamber permits an explorer to stand erect precariously. Veins and masses of noncalcareous material are prominent in other sections, and, in general, the appearance and speleogenesis of this cave are much like those of Yansen's Cave, even to the development on two levels about 3 feet apart. The rear sections of Yansen's Little Cave, however, slope gently downward toward the entrance, and the horizontal ceiling is found only in part of the entrance area. Three incipient tubular stalactites were the only speleothems noted.

OTHER CAVES

A pit 8 feet deep, about 25 feet southwest of the west entrance of Yansen's Cave, leads to a breakdown passage in shale (?) about 15 feet long, terminating close to the main passage of Yansen's Cave. There are other small sinks in this same area.

Stewart Island

There are local reports of a cave on Stewart Island, but authentic information about it has not been obtained.

Sucia Island

Rockshelters, locally termed "wind caves" are on Sucia Island near the isthmus near Fossil Bay, and also, reportedly, on the Finger Islands.

Woody Island

There are local reports of a littoral cave on the north side of a narrow inlet on the west side of Woody Island.

SKAGIT COUNTY

Skagit County has scattered deposits of limestone. Only in the Concrete area, however, are solution caves known, and these are very small. Other places where solution caves may be found eventually are the limestone cliffs along the east and south sides of Washington Monument Peak; in the alpine meadows along the trails to Dock Butte Lookout; and northeast of Blue Lake, where some sinks have been noted (W. R. Danner, oral communication). The county also has littoral caverns, both Recent and ancient. The Recent ones, between Deception Pass and Bizz Point, have been explored in the past 5 years by the San Juan Reef Raiders, under the leadership of Jan Utterstrom and Dale Wood.

BAT CAVE

Sec. 22 (?), T. 36 N., R. 3 E., Bow quadrangle.

There is locally reported to be a small talus cave northeast of Edison in which bats often congregate. About 1940, a boy was fatally injured by a rockfall in this cave.

BECKLEY'S CAVE (41) (Old Miller Place Cave, Pleasant Ridge Cave)

Sec. 9, T. 33 N., R. 3 E., Mount Vernon quadrangle.

This cavern, which was formed by collapse of part of the roof of a shallow littoral rockshelter about 150 feet long, is at the foot of a sea cliff about a quarter of a mile northwest of the Beckley farm

on the north side of the delta of the North Fork of the Skagit River. The cave is separated from the river mouth by a marine terrace now in agricultural use, and is about 50 feet south of Beckley's Shelter Cave.

The inconspicuous entrance of the cave is in a little recess below some small fractures in the conglomerate cliff. A straight passage of 40 feet through small talus chambers and crawlways extends to the main room of the cave, which is about 95 feet long, paralleling the cliff, and about 30 feet wide in its central area. The chamber is irregular in width and height. The height averages about 5 feet, but is somewhat more in places. On the east wall, reaching almost to the ceiling, is a remnant of an old sandy beach level. Some small stalactitic and coralloidal deposits are in the cave, and also flowstone coatings. There are signs that the cave is the home of at least one porcupine, and other indications of an extensive biota are present.

BECKLEY'S SHELTER CAVE (42)

About 50 feet north of Beckley's Cave is a prominent rockshelter of littoral origin at the base of the sea cliff. It is about 45 feet wide, 4 to 7 feet high, and about 20 feet deep. It is the remnant of the pre-collapse shelter mentioned above.

DECEPTION CAVE

Deception Cave was the first of the Deception Pass littoral caves to be discovered and explored by the San Juan Reef Raiders. It is south of Sares Head. The main section of the cave is about 15 feet high, 15 feet wide, and 50 feet long. The entrance is about twice as high and wide. About two-thirds of the entrance and of the main part of the cave are under water. At the end of the main section there is a short, narrow, above-water passage that leads upward at a steep angle for about 15 feet.

Near the end of the cave a submerged fissure leads at two levels to an irregular side passage about 25 feet long. At a point where the two levels converge, a submerged room about 5 feet wide and 10 feet high has been formed. The remainder of the side passage area is broader but low.

JACKMAN CREEK CAVE

Sec. 4, T. 35 N., R. 9 E., Lake Shannon quadrangle.

This cave could not be found during field work. Its location and a photograph of its entrance are given in a 1913 reference (Shedd, 1913), but the cave is not known locally. A very old, unauthenticated verbal report indicates that it is in limestone on the east side of Jackman Creek, has several entrances, and contains bats.

JENSEN CAVE (43)

Sec. 1, T. 35 N., R. 8 E., Lake Shannon quadrangle. Elevation about 1,600 feet.

This small limestone cave (fig. 48) is on the south edge of an abandoned railway grade, in a sink that was certainly first viewed many years ago. Not until the autumn of 1951, however, when State

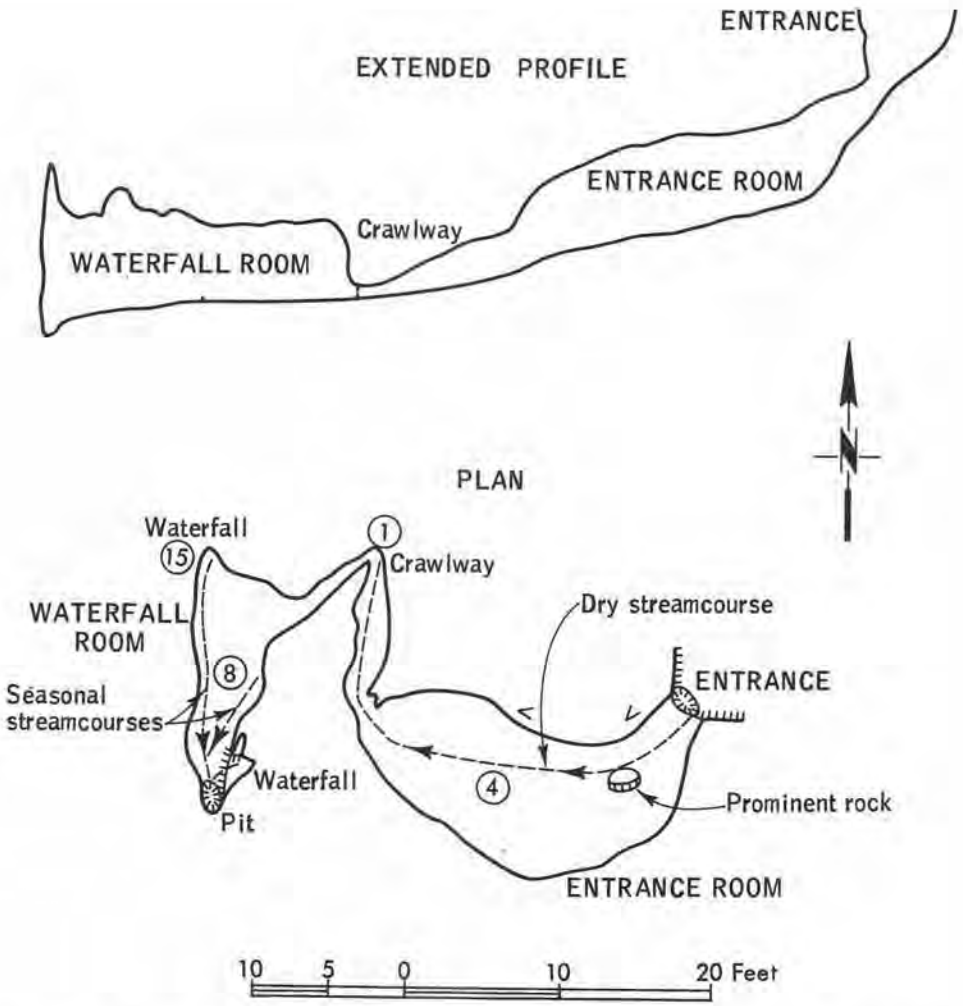


Figure 48.—Jensen Cave, Skagit County. Survey by William R. Halliday, Washington Speleological Survey, June 1956.

Forester Fred Jensen peered into the hole at its bottom, did anyone realize that it led into a cavern.

Jensen Cave is on a gently sloping bench on a heavily mantled and forested karstic hillside, 1,400 feet above the Skagit River and more than 3,000 feet below the summit of the ridge in which it is located. Seasonal surface torrents occur a few hundred feet east of the cave, but to the west, the nearest surface stream is more than a mile away. It is possible that the small stream that enters the cave flows into a fairly extensive karst drainage that wholly or partially resurges at the spring about three-eighths of a mile east of the cave, forming the small stream that parallels Franklin logging road for a few dozen yards. Between the cave and the resurgence is a vertical hillside ponor sink, 15 feet in diameter, which may also contribute to the resurgence.

The limestone bedrock at Jensen Cave is intensely fractured and partially metamorphosed, so that only a few fossils can be distinguished. It is believed to be of Permian age. At the cave, the dip and strike are difficult to measure, but the dip appears to be southwest at about 25°. If this is true, much of the ceiling of the Entrance Room is bedding-plane-determined. This room contains smooth ceiling pendants that appear to be of phreatic origin.

Jensen Cave can be entered through a hole 4 feet in diameter, at the bottom of a brush-grown conical sink 15 feet deep and 20 feet in diameter at the surface. The cave consists of two small chambers connected by a crawlway.

The Entrance Room is a low, sloping chamber 17 feet long, 3 to 10 feet wide, and 3 to 6 feet high. Along its walls are stratified clays and gravels. A projecting meander spur is near the entrance of the crawlway. A debris level that appears very recent is about 4 feet above the floor at the lower end of this room, indicating that most of the cave sometimes is filled with water. During two visits by speleologists to this cave, only a small trickling stream was flowing into the Entrance Room.

From the lower end of this room, a very tight crawlway 10 feet long passes north beneath meander niches that must have been formed atop a fill that is no longer present. The crawlway is now floored chiefly with sand, which has a tendency to reaccumulate and must be re-excavated at each visit to the cave.

At the end of this crawlway, a hole less than 1 foot in diameter opens into a short, narrow passage 8 feet high that leads southwest to the northeast corner of the Waterfall Room.

The Waterfall Room is about 17 feet long and 8 to 10 feet high. It is named for the seasonal waterfall in the northwest corner of the room, which falls from a high, narrow chimney. Elsewhere in this small room are other, irregular chimneys and jagged limestone remnants showing the vertical groovings of waterfalls. Small stream flutes are present on several minor overhangs. At the lower end of this room is a small, choked pit into which the waterfall stream disappears. A flashbulb placed in this pit in 1951 was found on a ledge a foot above the floor in 1956.

No biota and no speleothems have been observed in Jensen Cave. It appears to be a cave of phreatic origin with very marked vadose modification, and to be a functioning part of a small karstic drainage system on an otherwise typical lowland Northwest hillside.

McQUEEN'S CAVE (See Three Mile Creek Cave.)

OLD MILLER PLACE CAVE (See Beckley's Cave.)

OTTER CAVE (44)

This littoral cave north of Rock and Surge Caves was discovered and explored by members of the San Juan Reef Raiders in 1960. The name resulted from a close-range encounter with a sea otter within the cave. At low tide the floor of the 75-foot entrance section is above water. This part of the cave is

about 10 feet high and 10 feet wide. Beyond this section, excavation of beach gravels in a low part is necessary in order to crawl about 20 feet into a low terminal chamber about 10 feet long.

PLEASANT RIDGE CAVE (See Beckley's Cave.)

RAIDER CAVE (45)

At high tide the entrance of this littoral cave is almost completely submerged. The cave is on the south side of a promontory south of Bizz Point, and was named by members of the San Juan Reef Raiders for their organization. The cave is entered through a narrow passage about 2 feet high and 15 feet long, at the lower end of a fissure about 20 feet high. At the end of the narrow entrance section is a chamber about 15 feet in diameter, with two narrow terminal branches about 15 feet long.

ROCK CAVE (46)

This littoral cave just north of Sares Head has not been completely explored and is extremely dangerous because of heavy surge. About 40 feet from its half-submerged entrance, which is about 4 feet wide and 20 feet high, the narrow passage is almost blocked by a rock with a clearance of about 2 feet. The cave continues, but the only scuba diver to pass this point to date had a very difficult time with surge and spray.

SURGE CAVE (47)

This dangerous littoral cave is between Rock and Otter Caves, north of Deception Pass. It has been explored briefly on three occasions by members of the San Juan Reef Raiders, and is estimated to be about 60 feet long. Two feet of the 7-foot high entrance is above water. The cave gradually tapers. About 35 feet from the entrance, it is about $1\frac{1}{2}$ feet wide, and the ceiling descends to the water at this place, although there is an air space beyond. Wave surge in this cave is very strong, so that explorers are usually swept in with one wave and out with the next — an extremely dangerous situation.

THREE MILE CREEK CAVE (48) (Weaver's Cave, McQueen's Cave)

Sec. 30, T. 36 N., R. 9 E., Lake Shannon quadrangle. Elevation about 3,000 feet.

Three Mile Creek Cave (fig. 49) is on the steep slope east of Lake Shannon, about 2,500 feet above the lake and about 500 feet lower than the Thunder Lakes flat to the northeast. It is reached by way of the Thunder Creek and Section 19 logging roads, and is 0.7 mile from the latter on an abandoned secondary logging road. The entrance of the cave is at the edge of a small marble quarry, which extends about 100 feet into the sloping hillside in what was once typical heavily timbered upland country.

Even though partially blocked by dirt and rubble, the solution-sculptured, walk-in entrance is 6 feet high and 10 feet wide. The cave is not extensive, however. The single, roomy passage measures about 70 feet in maximum length, although local rumor indicates that originally it was much longer.

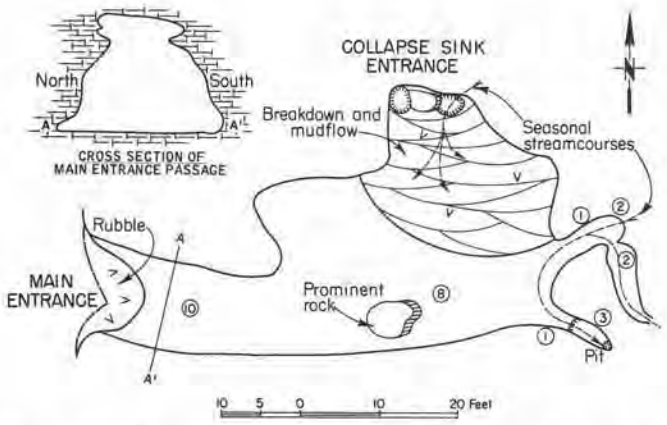


Figure 49.—Three Mile Creek Cave, Skagit County. Survey by Cascade Grotto, National Speleological Society. Additions by William R. Halliday, Washington Speleological Survey, 1956.

These reports claim that the cave was partially choked with mud and reduced to its present size within the memory of oldtimers still living.

At the rear of the cave, a small chimney entrance permits entry of a seasonal stream, which is responsible for deposition of a considerable amount of recent fill. The corresponding collapse sink is about 20 feet long, 12 feet wide, and 9 feet deep. It has enlarged perceptibly during the 5 years that the cave has been under observation.

Three Mile Creek Cave has been formed horizontally and parallel to the strike of a Paleozoic (possibly Early Pennsylvanian) limestone that dips about 20° SSE. The limestone is partially metamorphosed, moderately veined, and fractured. A little boxwork is present.

The ceiling of Three Mile Creek Cave is horizontal throughout most of the main chamber of the cave except at the southeast end of the room, where it assumes the inclination of the bedding. Bedrock is exposed on the floor only in one small area at the northern margin of the entrance, where the cone of dirt has not quite covered the floor. The bedrock exposed here is flat, but incised into it is a narrow, twisting slot about 1 foot wide and rapidly reaching a depth of 4 feet. Its upslope beginning is quite abrupt. The slot is joined by a narrower tributary slot developed along a prominent joint. Adjacent to the slot is an incised flat meander niche about 18 inches high.

About 18 inches below the flat ceiling of the entrance area there is a prominent horizon on the southern wall. On the north wall there is a smaller horizon, closer to the ceiling. Below these levels the passage section widens irregularly. Vadose channels incised in fill are present in several parts of the cave. They are particularly prominent at the east side at the rear, where such channels enter the cave through two fill-blocked passages, unite, and leave through a third such passage. Distinct variation in the fill has occurred in this section of the cave during a 5-year period of observation.

This cave contains almost no speleothems, although there are a few traces of flowstone and coralloids. About 90 percent of the cave is within the twilight zone, and animal life is fairly profuse. Insects and centipedes are particularly common. The cave traps some cold air. On May 31, 1956, following an unusually severe winter, a small patch of névé was present 30 feet inside the entrance.

A large quantity of surface debris and soil has entered the cave through the collapse sink entrance, and a lesser amount through the main entrance. As a result, only a few speleogenetic features are evident. From those already described, it appears that the present Three Mile Creek Cave is only a fragment of a larger cave that was partially destroyed by development of the canyon of the Baker River,

and partially blocked by recent fill. The small stream channels atop this fill do not appear to have had any significant role in speleogenesis except, perhaps, to distribute part of the fill. The vadose slot at the entrance is the only evidence of vadose stream exit from the cave subsequent to the development of the steep slope adjacent to the cave, and its shortness indicates that the resurgence was not of long duration. An earlier vadose stage with a gentle gradient in this part of the cave system is suggested by the entrance cross section, which is progressively wider near the floor. The flat ceiling suggests a still earlier stage of water-table control of phreatic solution. As stream flutes are not present, the flow of this phreatic water was probably not due to the sudden entry of flood waters into the water table at the cave. The known part of the cave clearly developed through shallow sub-water-table flow. Excavation of the fill at the rear of this cave might prove of unusual speleologenetic interest.

WEAVER'S CAVE (See Three Mile Creek Cave.)

OTHER CAVES

Other small littoral caves are known north of Deception Pass, on the south side of Cypress Island, and on the southwest side of the southeast branch of Fidalgo Island (W. R. Danner, oral communication). Near the spectacular north cliff of the island that bisects Deception Pass is an unusually accessible example of a small block creep cavern, a few yards east of the highway. The offset of the cliffward part is slightly more than 1 foot. The cavernous fissure is about 15 feet long, and can be entered to a depth of about 12 feet.

SKAMANIA COUNTY

Skamania County contains both a major Mount St. Helens pahoehoe lava flow and the western part of the Mount Adams pahoehoe flows. These flows contain the largest and most important lava tubes in the State of Washington. No limestone is known in this county, and the name of Marble Mountain is a misnomer (Verhoogen, 1937).

APE CAVE (49)

Secs. 5 and 8, T. 7 N., R. 5 E., Mount St. Helens quadrangle.
Elevation of upper entrance 2,450 feet.

Ape Cave (pl. 2) is the largest cave in Washington and is the longest unitary lava tube cave known in the United States. Its slope length, measured by plastic tube, is about 11,215 feet, and it has a descent of approximately 700 feet, as measured hydrostatically.

The odd name of the cave was chosen by its first explorers, a local group of young outdoorsmen who call themselves the St. Helens Apes in memory of a widely publicized incident in which two

prospectors claimed to have had rocks thrown at them by an ape-man, which has never been seen again. The cave was named for the organization rather than for the ape.

Ape Cave was discovered in 1951 by a "cat skinner" named Johnson, from Amboy, Washington. Mr. Johnson, it is reported, almost drove his tractor into the lower entrance of the cave while clearing brush. In the spring of 1952, the Apes built ladders in the cave and explored it.

Ape Cave has two entrances, both collapse sinks. They connect with short, separate upper levels, below which other drops lead to the main tube level. The south, or lower entrance is the one most often entered. It is just across a prominent abandoned logging road, about 100 yards slightly east of north from a parking area. It is about 15 feet in diameter and 20 feet deep.

The cave extends about 500 feet upslope from the upper entrance and more than 3,900 feet downslope from the main entrance. Several large breakdown domes approach the surface, and light is visible through one of them. A considerable amount of dripping water enters the cave through some of these breakdown domes. At one place the drip amounted to a heavy downpour on December 27, 1958. On this date a small stream was visible in several sections of the cave, particularly downslope from the main entrance. It is said to be seasonal. In the lower section, and to a lesser degree in some other sections of the cave, there are stream deposits as much as 2 feet thick, consisting of sand and gravel of pumice. The deposits appear to have been reworked frequently by the stream, but in protected areas, gravel overlies sand. Small rivulet channels on the surface of the deposits are not uncommon, but no channels were found incised in the bedrock. Coalescence of drip and splash holes in the stream deposits has formed unusual "badlands," (fig. 50) mimicking Cathedral Gorge, Nevada, in miniature.

Figure 50.—Drip-eroded sand deposits in Ape Cave, Skamania County.

Ape Cave is a unitary lava tube cave, but, like several of those in its area, it has some vertical complexity. There are long sections with an hour-glass cross section, and the upper section often separates into short segments of a distinct level. This upper channel is often offset a few feet, swinging more widely than the lower. At one place it forms an offset upper loop about 50 feet long before rejoining the main tube. A number of cupolas are present, but they are not as prominent as ceiling channels. As mentioned, both entrances lead to separate lengths of upper level. There are several small "lava falls" that probably represent a point of coalescence of still

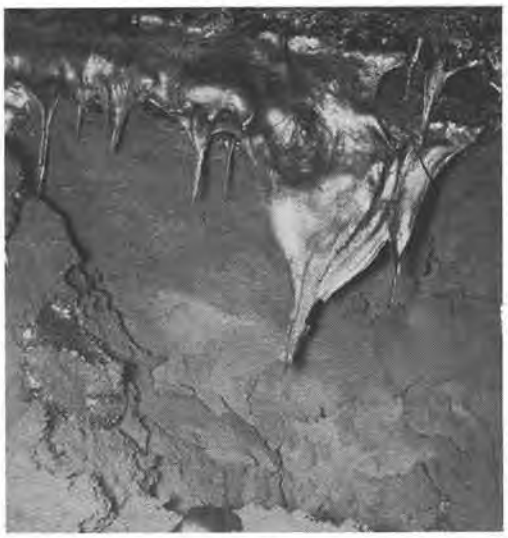


Figure 51.—One type of ribbon stalactite occurring behind the crust of lava tubes.

Figure 52.—Another type of ribbon stalactite occurring behind the crust of lava tubes.

Figure 53.—Small "lava spring" in Ape Cave, Skamania County. Note "lava dripstone."

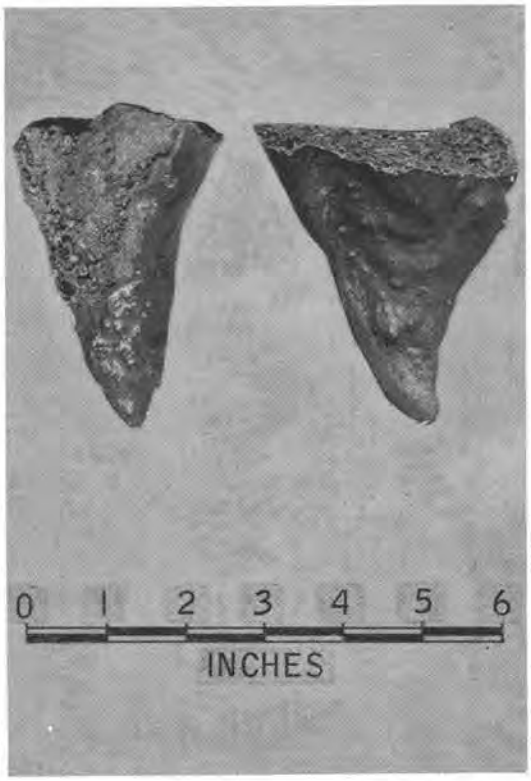


Figure 54.—Broken specimens of "tapered" lava stalactites. Their origin appears to be entirely different from those of the tubular type.

lower levels. The lower end of the cave is blocked by stream deposits, which are being excavated by the Apes.

This cave contains a number of interesting geological features. Near the upper end, the surface of much of the lava is spotted with tiny brown egglike protuberances that have not yet been identified. In this section and also near the middle of the cave there are a few calcareous speleothems — ribbons and stalactites as much as 3 inches long, and some tiny gours. They are white to red brown in color. Along the walls in this area is a row of unusual "porthole"-like round splotches in the lava. Downslope from the upper entrance the ceiling shows unusually prominent signs of remelting. Where the lateral crust has collapsed (a common occurrence throughout the cave), ribbon stalactites (figs. 51 and 52) and stalagmites of lava are revealed in the space behind the crust.

About 400 feet downslope from the upper entrance there are two lava falls. Beyond this point, breakdown increases but is intermittent. Wall flowlines and ridges are fairly well developed, and the upper level is large and well marked. On the east side of the passage is a lava spring (fig. 53).

About 1,100 feet downslope from the upper entrance is a collapse dome that is open to the surface. It is not a feasible route for human entry. The next 600 feet of the cave is not of special note except for high ledges and a smaller amount of rockfall.

The "Waterfall," a zone of heavy drip from the ceiling, is about 200 feet farther south. Large accumulations of rockfall follow, and the passage then narrows appreciably. The stream from the waterfall terminates at a small pond behind a lava dam, which is followed by a steep short slope. Shelves and upper level segments are prominent in this region.

Additional lava springs and a lavafall pit 10 feet deep are interspersed amid rather dangerous breakdown dome chambers. Autobrecciated lava is exposed behind the walls of the tube. Locally, the cave narrows again and becomes more tortuous in its course. Tapered lava stalactites (fig. 54) are locally prominent, and there are lateral flow marks.

Downslope from the main entrance, stream deposits are more prominent. There is little breakdown beyond the first 1,000 feet. Some reddish rippled lava (fig. 55) is visible on the floor, and an occasional splash ring may be seen. Lateral flow marks are prominent close to the floor. At one place the most recent flow mark is horizontal, although an older mark, which it obscures elsewhere, was rippled upward for several inches. In another area there is a remelting film over a lava tongue. An upper level is present in several sections. At one area of transition from one to two levels, large rounded chockstones (fig. 56) are supported by the boundary ledges. Lateral ridges are better developed than are flow marks.

In the lowest section, almost no breakdown has occurred other than from the walls, where additional autobrecciated lava and flat speleothems are exposed. Short tubular lava stalactites (fig. 57) and helictites are present. Some of the latter show the influence of wind currents. No multiglobular stalagmites were observed, but a few examples of unique forms that may represent imbedding of stalactites in molten lava have been found, and one pipestem stalactite (fig. 58). Slump ripples are prominent on the walls.

Figure 55.—Rippled lava floor showing differential flow in a lava tube.

Figure 57.—Tubular lava stalactite and globular lava stalagmite.

Figure 56.—"Lava ball" in Ape Cave.

Figure 58.—"Pipestem" variations of a tubular lava stalactite.

Figure 59.—Hole in "upper floor" of Ape Cave. Penetrating the horizontal division shown in figure 60 are several openings such as this.

Figure 60.—Horizontally divided passage at the lower end of Ape Cave.

Figure 61.—An unusual form of lava stalactite in Ape Cave. The lower end was in contact with the upper surface of a flow.

At the lower end of the cave, a smooth lava diaphragm (fig. 60) divides the passage horizontally. On its surface is a row of holes (fig. 59) that have the appearance of large bubble rings.

Ape Cave is of some biological importance. On December 27, 1958, about 20 hibernating brown bats (Myotis sp.) were found in the lower section, and about a dozen long-eared bats Corynorhinus rafinesqui were hibernating in dry sections elsewhere in the cave, overlapping minimally with the range of the Myotis. A large salamander, Ambystoma gracile, was found on the moss beneath the collapse dome that is open to the surface. The cave is the type locality of Grylloblatta chirurgica (Gurney, 1961). Some unidentified moldlike filaments were noted on the ceiling about 1,200 feet downslope from this opening. Lava tube slime is locally prominent in several areas.

On that date, light rain mixed with snow was falling at the main entrance, and snow was falling at the upper entrance, where 4 inches of snow was already present. At the main entrance the air temperature was 34° F. (wet bulb) and 35° (dry bulb). In the cave, below this entrance, the water temperature was 41.5°, and the air temperature was 42.0° (wet bulb) and 42.5° (dry bulb). A short distance downslope from the upper entrance, the water temperature was 42°, and the air temperature, 42° (wet bulb) and 43° (dry bulb). In narrow sections of the cave, air currents moving upslope reached a maximum of 7 m.p.h. A group, which had visited the cave three weeks previously, stated that in the interim there had been a great increase in the ceiling drip and general moisture in the cave. Perhaps because of this increase in moisture, hibernating bats (Corynorhinus sp.) had left the upper end of the cave during that time.

It is locally reported that there is a surface stream at the approximate location of "The Waterfall" in the cave.

BAT CAVE (50)

Sec. 19, T. 7 N., R. 5 E., Mount St. Helens quadrangle. Elevation about 1,200 feet.

The main part of this small but complex lava cavern (fig. 62) was discovered in 1958 by Boy Scout Troop 348, led by Harry Reese. Its upper passage was discovered November 5, 1960 by the Reese brothers, on a Washington Speleological Survey expedition. The name was given the cave because one to several dozen bats (Corynorhinus sp.) can usually be found in it, whereas relatively few bats are observed in other caves of this area.

The upper entrance of the cave (fig. 63) is in a partially collapsed bubble with a crust 10 inches thick. A descent of about 20 feet through breakdown leads to a lava tube about 12 feet wide and 12 feet high, near a lava seal at its upper end. This part of the cave is slightly less than 300 feet long, and pursues a somewhat sinuous southwestward course to an area of collapse. About midway along its course, the opening of a side passage high on the north wall of the cavern leads to a smaller, upper level tube that roughly parallels the main tube and is connected to it at the terminal breakdown of this section. At this point, daylight can be seen through an impenetrable hole in the roof of the lava flow. By crawling about 30 feet through the breakdown, one reaches the main entrance sink of Bat Cave. The upper level

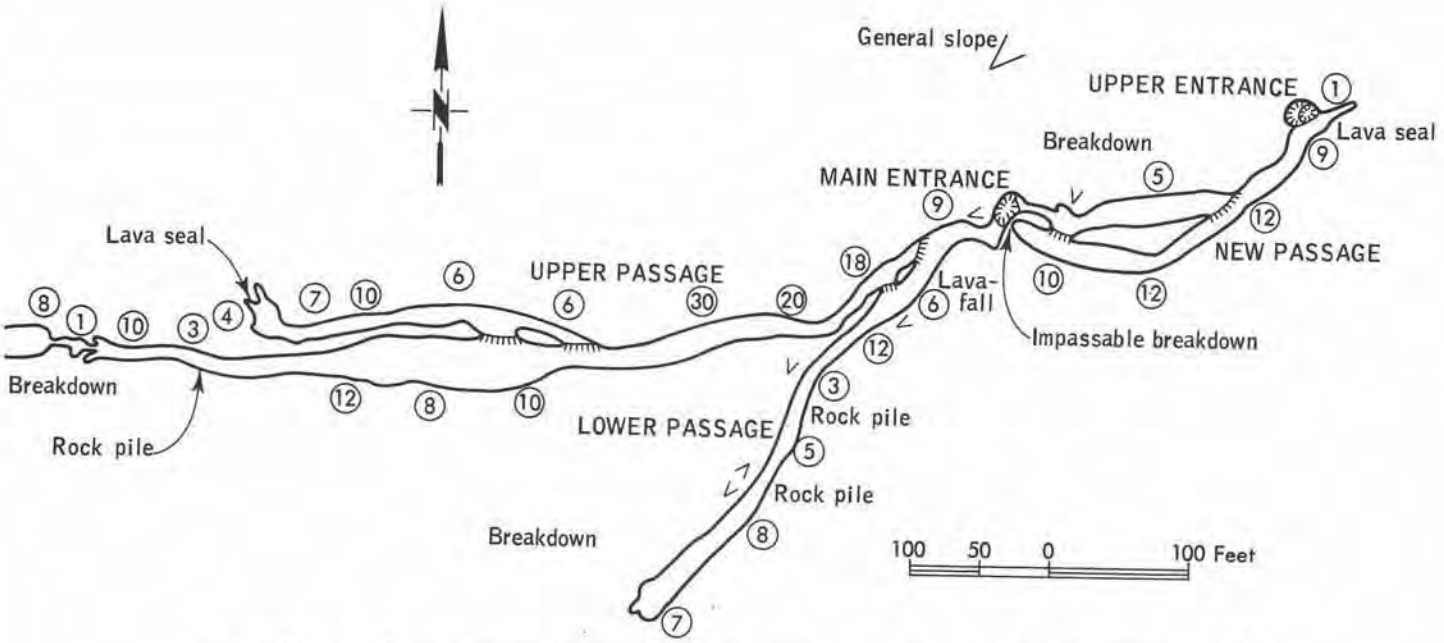


Figure 62.—Bat Cave, Skamania County. Survey by Washington Speleological Survey, November 1960.

Figure 63.—Upper entrance of Bat Cave, Skamania County, is in a thin-shelled lava dome.

tube is about 5 feet high and 18 feet wide where not obstructed by breakdown. Features of this section of the main tube include unusually complex wall grooves to a height of 3 feet, a lava falls, well-developed ceiling glaze with some flaking-off, and a group of small lava stalactites that are all deviated in the same direction as though affected by strong currents of hot gases while still molten. This deviation has not been noted in other Washington lava tube caves. A small amount of lava tube slime is present.

The main entrance of Bat Cave is a collapse sink about 12 feet in diameter, with a larger cavernous space below. In contrast with the upper entrance, which is on the edge of the lava flow area, the main entrance is about 50 yards from the margin. From the small entrance chamber, a crawlway leads northeastward through breakdown to the upper level tube just described, and the main passage extends to the south and west down a breakdown slope to a junction about 60 feet from the

entrance, where the tube bifurcates. The main passage extends south and downward. On the west wall of the passage, at a level about 4 feet higher on a prominent shelf, another passage extends southwestward at a lesser slope. It is of interest that the two passages are also connected by a smaller tube, about 3 feet in diameter, which leaves the more western passage just below the junction, to joint the lower passage, on the roof of which it can be traced for some distance.

In the lower, more southerly tube, there is a short lava falls downslope from the junction, followed by a steep, wide section. The passage then alternates between areas of extensive breakdown and unaltered sections of lava tube averaging about 10 feet in width and 6 feet in height, for a total distance of about 400 feet past the junction. It ends at a room about 25 feet wide and 7 feet high, beyond which further passage is blocked by breakdown. Where the cavern floor is exposed, clinkery and moderately granular surfaces are visible. A few lava dripstone speleothems are present. This is the section in which the bats are plentiful.

The more western branch of the cave, usually referred to as the Upper Passage, slopes more gradually than the other. Only a few bats have been observed in this area. Its mouth is broad and spacious, but a few yards downslope, the floor and the lower half of the tube narrows to a width of about 6 feet, whereas the upper part is more than twice as wide. Well-developed wall grooves are present, and ledges and gutters are prominent in its initial section. About 250 feet from the start of the Upper Passage, and again about 75 feet farther downslope, openings on the north side of the passage lead to a branch that roughly parallels the Upper Passage for about 250 feet, ending in a lava-sealed room about 30 feet in diameter. Features of this side passage are a large lava spring and some lava speleothems. Very little breakdown is present. The main Upper Passage continues past great piles of breakdown and longitudinal mounds of lava to a point about 700 feet from the junction, where breakdown blocks a small length of tube that can be reached only by crawling through about 40 feet of dangerously loose rock.

In addition to the bats, other creatures have been observed, including grylloblattids and polydesmid millipedes. Lava tube slime is scant and patchy.

BIG CAVE (51) (Nielsen's Big Cave)

Sec. 8, T. 5 N., R. 9 E., Willard quadrangle. Elevation about 3,200 feet.

The entrance of this 2,700-foot lava-tube cave (fig. 64) is about 100 yards west of the Willard-Peterson Prairie road at a point about half a mile south of the junction of that road with the Goose Lake-Peterson Prairie road. It is at the north end of a large lava trench, which is about 100 feet wide, 40 feet deep, and $\frac{1}{4}$ mile long. The cave trends north and east, upslope from the entrance, with the eastern trend predominating in its final half. The cave entrance is a crawlway through breakdown, and extensive breakdown is characteristic of the entire cave; its original floor is exposed only in one short section about 400 feet from its upper end. Consequently, Big Cave does not offer as much opportunity for speleogenetic study as do some other caves of the area. However, the ceiling and lateral breakdown have exposed

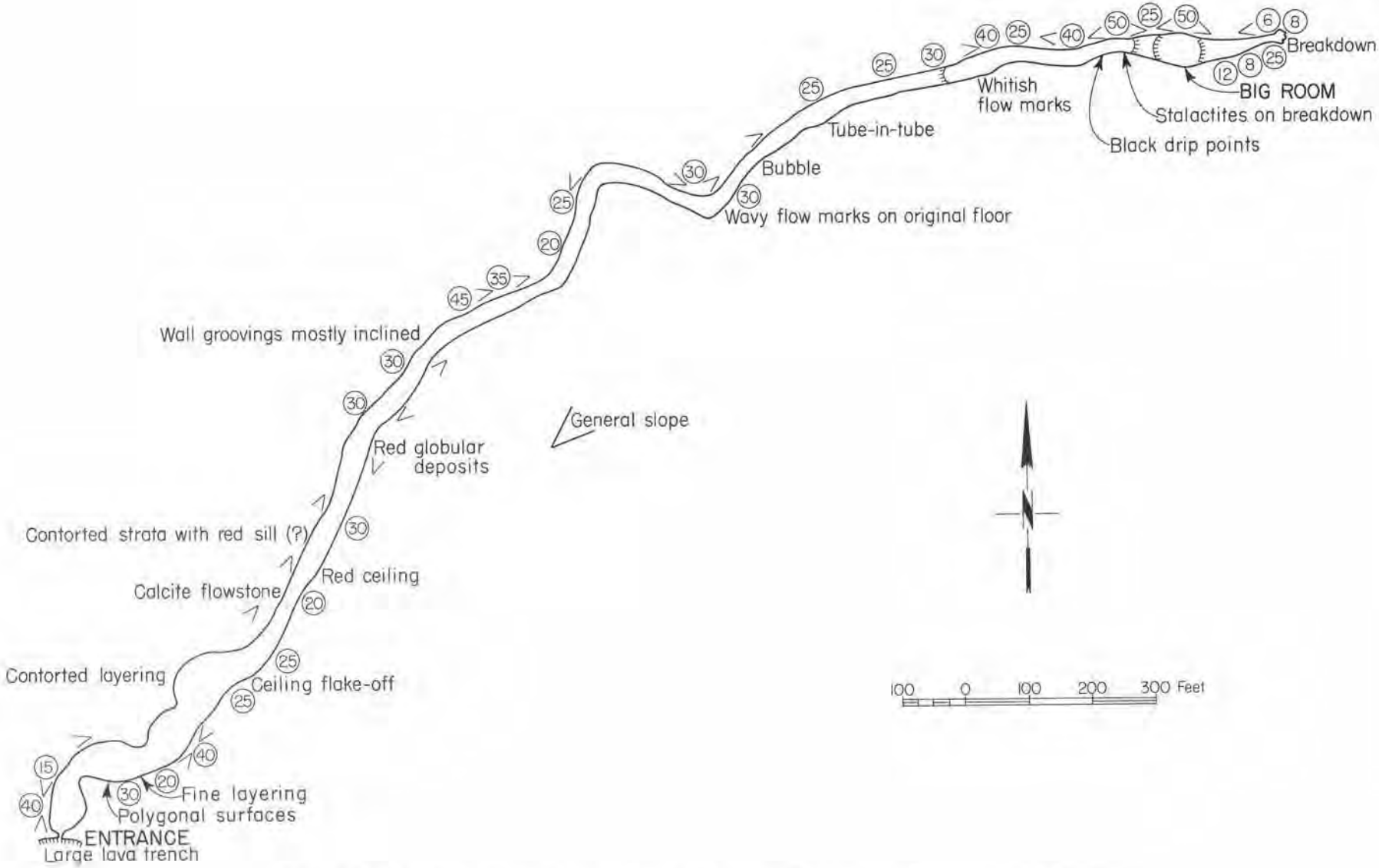


Figure 64.—Big Cave, Skamania County. Survey by Washington Speleological Survey, November 1959.

features of unusual interest, which demonstrate some of the internal mechanisms of lava flows. In some parts of the cave the exposed bedding is regular; in others, markedly distorted. At a point about 600 feet from the entrance is a phenomenon that may prove to be a sill of reddish lava. Other unexplained features of the cave include what may prove to be spatter vents and a large lava bubble.

Big Cave is believed to have been discovered by loggers about 1957. It owes its name to the impressive size of the entrance section of the tube, where ceiling heights of 25 to 40 feet and widths of 30 to 50 feet are characteristic. In one chamber the width reaches 90 feet. Beyond this section the cave maintains a characteristically high ceiling, but becomes considerably narrower, although not less than 25 feet in width, until the terminal breakdown area is reached. The course of the cave is moderately sinuous, and no branches have been found.

Steep rubble piles are present throughout Big Cave. Various lava speleothems, including clusters of tubular stalactites, have been found on fragments of breakdown. The single visible section of the original floor shows a ropy pahoehoe flow. A short length of tube-in-tube is nearby. At a point about 1,000 feet from the entrance are vertical wall groovings. Many show some deflection toward the upper end of the cave, but some are deflected toward the entrance. Lateral flow grooves are prominent in short sections where lateral breakdown has not been excessive. A sequence of at least two flow levels can be traced. One small travertine drapery about 6 inches long has been observed.

Figure 65.—Moths on a breakdown block in Big Cave, Skamania County.

Big Cave supports a moderate biota. Bats were observed in flight in November 1959, and many moths (fig. 65) were noted on the wall of sections that are in total darkness. Lava tube slime is present in moderate quantity.

BIG TRENCH CAVE SYSTEM (52)

Sec. 34, T. 6 N., R. 9 E., Willard quadrangle. Elevation about 3,000 feet.

North of Mann Butte is the largely collapsed remnant of a complex lava tube system (pl. 3), the passages of which originally had a slope length of at least 4,000 feet. Although the 6 small caves and 2 natural bridges still uncollapsed total less than 1,000 feet, the system is one of unusual interest because of its varied features.

Except for the re-entrant side passage originally about 400 feet long (the Cougar Den area), the Big Trench Cave System displays in its trench areas features of multilevel tube development elsewhere found only underground. With one exception, all the cavernous remnants of the system that now can be entered are very shallow, with overburdens of 10 to 20 feet. In one cave near the center of the system, an underground sink extends downward to a short lower level, largely choked with breakdown. The small volume and thin overburden of the remaining caves are conformable to certain sections of the trench, which appear to be the remnants of collapse of tubes of these proportions. In other sections of the trench, relatively shallow segments descend rather abruptly to depths of 40 to 50 feet and, in a few areas, considerably greater depths. At the western end of the second cavernous section from the east end of the system, the uncollapsed tube is about 15 feet high and 25 feet wide, and has an overburden of about 10 feet. In contrast, the sink just west of this entrance is more than 50 feet wide and probably more than 75 feet deep.

The Big Trench Cave System, therefore, appears to be a largely collapsed system of superimposed tubes with a single shallow re-entrant. Because of extensive breakdown, few tube features are visible except at the downslope end. In the Cougar Den Cave, breakdown has revealed glaze on several wall layers. The terminal cave and the one just upslope from it have granular walls, with local thin coatings of lava along the lower parts of the walls. The lower end of the terminal cave is blocked by billowy lava that prevents access into another small chamber visible through a little opening above the lava seal. In this area, thick slime is present. The remaining caves appear to harbor a rich biota, possibly including at least one cougar.

BLASTED CAVE (See Dynamited Cave.)

BOYLES CREEK CAVE (See Fish Hatchery Cave.)

CAMPGROUND ICE CAVE (See Ice Cave, Skamania County.)

CURLY CREEK CAVE (53) (Lava Cave)

Sec. 2, T. 6 N., R. 7 E., Steamboat Mountain quadrangle. Elevation about 3,050 feet.

Discovered in 1958, this little-known lava-tube cave (fig. 66) near the new (1961) Curly Creek road may be only one of a number of lava tubes in this area. Breakdown is present throughout nearly all of the cave and almost blocks the passage about 200 feet from the entrance. Including the single 100-foot side passage, the slope length of the cave is 1,225 feet.

The entrance of the cave is a spacious but sloping opening at the lower end of a large sink. Daylight is visible almost to the breakdown chokes 200 feet inside. This area is quite dangerous to novices. The cave has a somewhat sinuous course toward the northwest, and primarily is a single tube averaging about 25 feet in width and 20 feet in height. The downslope end of the cave is blocked by

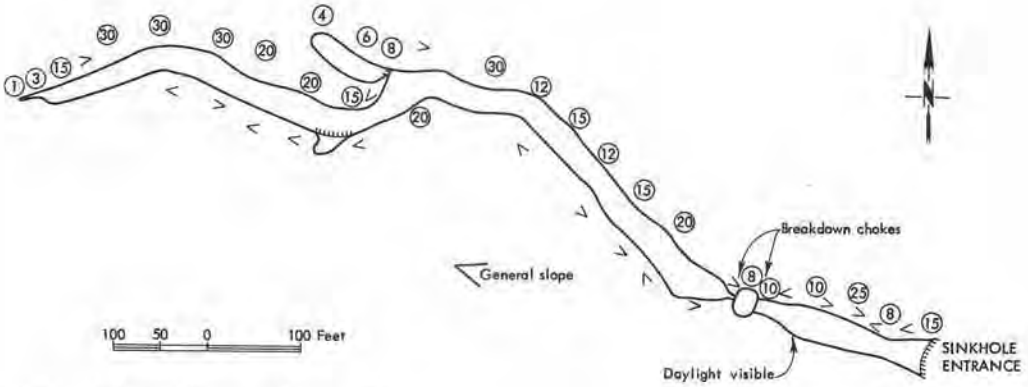


Figure 66.—Curly Creek Cave, Skamania County. Compass and tape survey by Washington Speleological Survey, August 27, 1961.

breakdown, and elsewhere most of the floor consists of great piles of rubble of reddish granular lava or dark gray massive basalt. About 1,000 feet from the entrance, a pit leads to a short side passage terminating in a lava seal, possibly with flow from west to east. A lava floor, flow grooves, and some glazed areas are near the downslope end of the main passage, as well as some pasty, granular lava coatings. Some small goured calcareous ribbon deposits are present. The entrance area appears to support a rich biota. Downslope, there are moderate quantities of an unusually compact form of lava tube slime.

DRY CREEK CAVE (54)

Sec. 27, T. 6 N., R. 9 E., Willard quadrangle. Elevation about 3,400 feet.

The main entrance of Dry Creek Cave (fig. 67) is a small collapse sink west of the Forest Service road leading north from Peterson Prairie Guard Station at a point 1½ miles north of the road junction near that station. A smaller, upper entrance about 400 feet west-northwest of the main entrance can also be used for entry.

Dry Creek Cave (pl. 4) is the most complex lava cavern known in Washington, and is potentially of exceptional scientific value. It consists of a complex of small tubes and broad, low chambers, partially filled with multiple tongues of aa and pahoehoe lava. There is very little breakdown, and the cave contains unusually fine lava speleogens, which demonstrate many features of the dynamics of subsurface lava flows. Pillars of various sizes are numerous, and the tubes repeatedly branch and rejoin. Longitudinal ceiling tubes are well developed locally, and at least one small tube-in-tube is present. Tubes are developed on at least two levels, hardly more than 3 feet apart. One small upper-level tube, circular and about 3 feet in diameter, shows the least modification by flow through it of any lava tube large enough to enter that is known to the writer. Most of its rather short length is free of flow groovings and ridges.

Stream invasion of Dry Creek Cave has left small local deposits, and at least one rivulet channel has been incised into such a deposit. In the main passage, lateral shelves project as much as one foot

Figure 67.—Main entrance of Dry Creek Cave, Skamania County.

from the wall, and there are as many as five successive lateral flow ridges on some walls. At least two floor concentrics of depositional rather than splash origin are present.

Dry Creek Cave is not yet fully explored. A total of about 1,400 feet of passages have been mapped, and about 500 feet in addition have been explored systematically. Besides the main portion of the cave, there is a long collapse sink about 100 feet west of the main entrance. At its upper end is a low lava tube crawlway over aa lava, which has filled the tube to about 18 inches from its arched roof. This 100-foot cavern, known as Dry Creek Cave Annex, together with the adjoining sink, appear to be integral parts of the Dry Creek Cave system.

The biota of the cave system is plentiful. It varies from springtails (collembola), bristle-tails (probably Plusiocampa sp.), mosquitoes, spiders, harvestmen, moths (Scoliopteryx sp.), wormlike fly larvae (perhaps fungivorids), and other insects to pika (Ochotona princeps), and perhaps hibernating bears in the smelly, denlike grotto just north of the entrance of the Annex. Bats have been observed in flight throughout the cave. Detailed biological and geological studies of this cave would be exceptionally valuable.

DYNAMITED CAVE (55) (Blasted Cave, Lemei Road Cave)

Sec. 35, T. 6 N., R. 9 E., Willard quadrangle. Elevation about 3,360 feet.

This extensive lava tube cave (pl. 5), containing dangerously deep pits, was discovered in 1958 (Nielsen, 1958), but had been explored only partly when it was dynamited by vandals (Anon., 1958). The dynamiting effectively closed the entrance (fig. 68) with many tons of tightly packed rock, and left other great rocks loosely poised at the edge of the sink. However, the exceptional scientific interest regarding this vertically complex cavern is sufficient grounds for hope of future studies of the cave.

The blasted entrance of the cave is at the base of a 30-foot cliff, which is at the south end of a shallow, greatly eroded lava trench. The known part of the cave is a vertical complex of superimposed tubes of greatly varying size and nature. Slightly more than 4,000 feet of passages have been mapped, and the total depth of the cave may exceed 300 feet. The lava tube trends slightly east of south from the entrance, in a slightly sinuous course.

The entrance section of the cave has a slope length of 680 feet. Initially, there is a rockpile descent of about 40 feet in a warm, broad, vaulted chamber containing many insects in summer. Above

Figure 68.—Entrance of Dynamited Cave, Skamania County, is beneath this rubble.

Figure 69.—Downslope end of the entrance section, Dynamited Cave. Note lateral coatings. False floor visible at rear, spanning entrance section.

its lower end (fig. 69) is an upper-level tube about 200 feet long and 6 feet in diameter, ending in breakdown. Beyond this tube, the main route continues as a roomy corridor containing large amounts of breakdown. Sand and silt deposits are present locally, and little, if any, of the original cavern floor is visible. Overhead, unusual lava speleogens are prominent. Several segments of flat ceilings represent flow-crust remnants, and there are two delicate natural bridges, and several short segments of small ceiling tubes that are roughly triangular in cross section. In other areas, vertical alignment of what appear to be remnants of crusts of 12 or more successive flows are visible on the ceiling and upper walls. These flows appear to have progressively occluded the upper part of the tube. Then the crusts collapsed when their underlying support was removed. Farther from the entrance the passage becomes progressively narrower and higher. It ends at a 15-foot ledge, below which is the intermediate section of the cave.

This intermediate section has two parts, one lying largely beneath the entrance section and extending much farther north, and the main route extending south from the junction.

The sub-entrance part is 1,670 feet long. In its southern half, breakdown is locally minimal, and deposits of fine sediments have accumulated to a maximum thickness of about 2 feet. Constant-drip points have resulted in formation of miniature "badlands" in these deposits, and there are a few small pools and rivulet channels. In another part of this southern half, an unusual blocky rectangular ridge about 10 feet in height and in width occupies the center of the tube. Elsewhere in this section, breakdown

is marked, and at one point the tube is almost occluded by rockfall. Downslope from the area of sedimentary deposits are some interesting speleogenetic features, including small upper levels; ceiling channels; a large horizontal lava spring overhead with concentric layering; multiple wall layers, each with a glazed surface; and a small pear-shaped upper-level tube in which breakdown has exposed a multilayered floor. White (calcareous?) coralloids and black dripstone are present, and at the northern end of this section are some stubby calcareous speleothems as much as 5 cm. long and 3 cm. in diameter. Surface glaze, including locally some red-brown glaze, is prominent on the walls and ceiling, and there are some slump patterns. Locally, flow grooves are marked, including some on the underside of a "hanging wall" ceiling in an area where the passage cross section is pear shaped. Near the junction with the entrance section are the disintegrating remnants of the skeleton of a large mammal (bear?).

The main route of the intermediate section of the cave extends about 950 feet south from the 15-foot ledge to a lava-walled pit 40 feet deep. Breakdown is moderate throughout this section, and there is little tube floor visible except at the lower end. Small sand deposits have accumulated. One natural bridge, multiple lateral coatings, large lateral gutters, and flow grooves up to a height of 15 feet are present. Glaze is moderate, and there are some slump patterns. A ceiling channel is visible in the area. Also present are a few stubby calcareous stalactites.

At the lower end of this intermediate section, just before the 40-foot pit, is a small chamber with a rippled floor. It is entered by descending a 10-foot lavafall, which has a central clinker tongue and smooth, glazed margins (fig. 70).

The 40-foot pit is a junction of three major levels. The upper level arises as a lava spring about 75 feet north of the pit, and at the lip of the pit is about 15 feet above the intermediate section. It is roughly keyhole shaped in the section just north of the pit, and is about 10 feet high and 6 to 8 feet wide except at floor level, where it is narrower. Beyond the pit, the upper and intermediate levels are united for a distance of about 200 feet, at which point the continuation cannot be reached without the use of climbing poles. This combined section, about 30 feet high and 10 to 15 feet wide, contains some unusual features, but crossing the pit to reach it requires special gear and skill, and has been accomplished only once. The southern lip of the pit actually is a large glazed chockstone. Beyond is a continuation of the pit, which can be skirted on a highly glazed ledge. On this ledge and on the glazed wall are many small

Figure 70.—Lavafall into chamber above 40-foot pit, Dynamited Cave.

spatter accretions. There is very little breakdown in the immediate area of the pit, but beyond it, increasing amounts are present as far as the end of the combined section. A few yards farther downslope in the intermediate level is another glazed chockstone, beneath which is a descent of about 5 feet to a sublevel about 5 feet high and 3 feet wide, which becomes smaller over a course of about 100 feet, interrupted by still another 5-foot drop to another sublevel. These sublevels contain red lava tongues. At the downslope end are numerous gray-black lava speleothems. Both of these sublevels slope downward toward the lowest sublevel.

The 40-foot pit is a curious structure worthy of detailed speleogenetic study. Only its upper part contains a typical lavafall. The overhanging lower 12 feet is part of the underlying passage, and the demarcation is sharp. Innumerable small lava stalactites hang from projecting surfaces of its midsection. Its appearance suggests that it was either a gas vent or an abandoned upward conduit that was suddenly drained.

At the base of this pit is an impressive arched chamber—"The Grand Ballroom"—which is the upper end of the lower section of the cave. The room is about 50 feet in diameter, and all its ropy floor is level except perhaps a small area of subsidence beneath the pit. Relatively little ceiling or lateral breakdown has occurred here. The lateral breakdown has exposed a variety of lavas, including some red autobrecciated lava in which several rivulet channels have developed. Large lateral ridges and gutters are prominent. From their recesses, extensive irregularly contoured masses of reddish lava have been extruded.

Over a course of about 650 feet, the lower-level tube leading from The Grand Ballroom gradually narrows en route to a 55-foot pit. There are well-developed flow patterns and relatively little breakdown. A possible tumulus, a cupola, and additional autobrecciated lava have been noted.

The 55-foot pit in some ways resembles the 40-foot pit, but a lavafall, preceded by a horseshoe-shaped "pulled" pattern in the pahoehoe floor, is present. The pit is said to lead to a short basal crawlway in breakdown. On the far side of its 10-foot mouth, the pit is separated by a narrow span from a large chamber, beyond which is a partially explored area that is several hundred feet long and is developed on at least three flow levels. To date, this section of the cave has received no speleogenetic study. A small waterfall and stream are known to be present. Crossing the 55-foot pit and descending the 50-foot cliff into this section of the cave should be attempted only by highly skilled speleologists.

The speleogenesis of Dynamited Cave is complex. The interrelationship of the various flow levels of the different parts of the cave, all seemingly following the same alignment, is the most difficult speleogenetic problem of lava tubes that the writer can recall.

Aside from the profuse biota of the entrance chamber, where insects are abundant and a number of bats have been seen, insects have been found only at the upper end of the subentrance section and no biota noted elsewhere in the cave. However, to date no extensive biological survey has been attempted here.

FALLS CREEK CAVE (56) (Panther Creek Cave, Lava Caves)

Secs. 1 and 12, T. 5 N., R. 8 E., Wind River quadrangle. Elevation about 2,875 feet.

The entrances of this extensive and moderately complex lava-tube cave (pl. 6) are about half a mile north of the end of the Falls Creek road, in a forested area in which exploring parties have repeatedly lost their way, particularly upon attempting to return to the road. Total slope length of the passages of the cave is about 6,000 feet, about 4,300 feet of which is along the main passage, which follows a sinuous course, roughly north to south from the Big Entrance to the terminal complex, although the unmapped lowermost section of the cave seems to trend more to the west.

Actually, there are three separate parts to the cave system, separated by collapse sinks. The two upper sections are very short, however.

The upper, northern end of the system consists of a grottolike chamber adjacent to, but not aligned with, an additional sink with raised margins. At the lowest part of this spacious chamber, a thick ice floor was found on July 23, 1960. The nearby additional sink just mentioned is much more eroded and filled with vegetation than the two sinks of the cave system proper, and appears much older.

This northernmost chamber is at the north end of a collapse sink about 60 feet long. Along the east wall of this sink is a smaller chamber, which is also a remnant of the original tube. At the south end of the sink is the entrance of the second section of the system. This section, which resembles a natural bridge, is about 150 feet long. At both ends, the floor is extremely steep and rough, due to breakdown. A small amount of melting ice was found at its lowest point on July 23, 1960.

At the southwest end of this second section of the cave is the larger of the two sinks of the system. At its southern end, about 450 feet from the northern end of the system, is the steep entrance of the main passage. On the southwest wall of this larger sink is the entrance of another small passage, which extends roughly southwest for about 500 feet. Because of logistic problems, the side passages off the main passage, and the final 1,200-odd feet of the main passage itself have not been surveyed, but all penetrable openings of the cave system are believed to have been explored.

Falls Creek Cave is of considerable geologic interest. Despite the occurrence of considerable breakdown in the cave, there are many speleogenetic features indicative of a complex history. Both re-entrant and non-re-entrant side tubes are present. Except at the points of re-entry, all are effluent. Their entrances occur both at floor level and at high ledge levels, the latter predominating. Within the tube are natural bridges and several superposed levels (fig. 71). The terminal complex of the cave particularly merits detailed study. In this area it appears that the main tube originally continued at its accustomed level. Subsequently, a flow broke through from this level to a lower chamber that now has a lava seal. From the main level, two chimneys lead upward to a third level of small, irregular chambers and passageways that was almost occluded in two locations by a flow of reddish lava.

The cross section of the cave, where not disrupted by breakdown, varies considerably. In the section south of the large sink the passage section is roughly rectangular and has a capping flat arch. The

Figure 71.—Lava cascade from an upper level to the main passage in Falls Creek Cave. Photo by Peter Alburas.

walls here are vertical for a distance of more than 30 feet, and show particularly fine lateral flow grooves. An area farther downslope has a cross section resembling a moorish dome pattern, but a broad, flat arch is more common. Except in the stoopway just upslope from the terminal complex and in areas with massive breakdown, the ceiling height of the main passage is rarely less than 15 feet, usually more than 25 feet, and in places 50 feet or more. Similarly, this passage is rarely less than 15 feet in width, and usually 20 to 25 feet. The side passages are lower and narrower, but in general contain less breakdown.

A dark, brick-red lava flow can be seen on much of the original floor of the cave. In some areas its surface is almost smooth; in other sections it is rippled, and locally shows buckling subsequent to crusting. A few splash concentrics are present. In some places, large lateral ridges have been formed of the same lava, and in a few areas there is a red glaze on the walls and ceiling instead of the commoner

Figure 72.—Group of lava stalagmites in a Washington cave.

blackish type. Lava stalactites are few and small, and are tubular. Lava stalagmites are larger, and a few are atop lateral ridges, indicating that they were a late development during the thermal period of the cave.

A small rivulet enters the cave about midway along the main passage, and has formed a deposit of sand and mud. Its channel is not penetrable. Similar material has also washed in through the main entrance. Lava tube slime is patchy in distribution. Slime flowstone is present in one section, and a few small calcareous dripstone deposits seemingly independent of the slime have been observed.

Falls Creek Cave is of some biological importance. Mosses and ferns grow profusely in the main entrance, and about a dozen salamanders (Ambystoma gracile) were found in that area on July 23, 1960, after a prolonged period of warm, dry weather. On that date, a distinct air current could be felt flowing down the cave at all constricted parts of the passage.

Nothing is known of the history of Falls Creek Cave. Due to its proximity to a maintained but little-used trail, it has probably been known to a few persons for many years.

FISH HATCHERY CAVE (57) (Boyles Creek Cave)

W. edge sec. 14, T. 2 N., R. 5 E., Bridal Veil quadrangle. Elevation about 750 feet.

This small cavern (fig. 73) in the Eagle Creek Formation of Miocene age (Hodge, 1938), is a hydrological curiosity, and its origin is a perplexing problem.

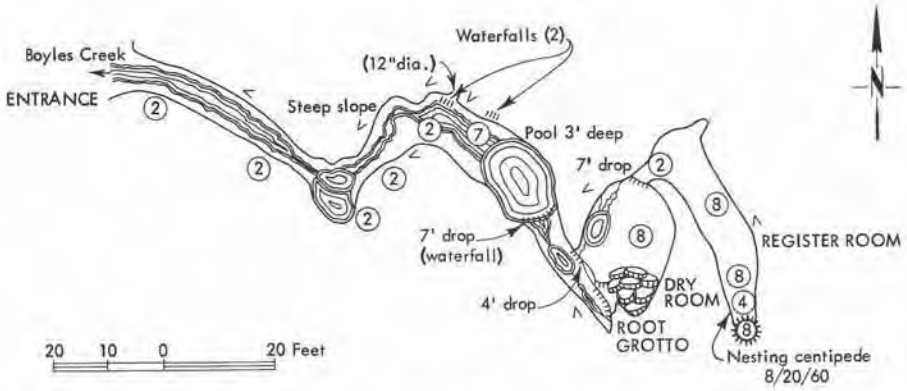


Figure 73.—Fish Hatchery Cave (Boyles Creek Cave), Skamania County. Survey by Washington Speleological Survey and Oregon Speleological Survey, August 1960.

The entrance of this cave (fig. 74) is about 2 feet high and 4 feet wide. From it emerges a sizable perennial stream. The entrance passage appears to be incised in soft pyroclastic rocks underlying a horizontal basalt flow. Nowhere in the cave have any features of lava tubes been observed.

Figure 74.—Sparkling stream emerging from the entrance of Fish Hatchery Cave, Skamania County.

The slightly sinuous entrance passage maintains approximately these dimensions over a southeastward course of about 40 feet. At its end there is a small, low chamber in which are some vadose speleogens. The cave stream cascades into this chamber from the more spacious part of the cave to the north and east. In this complex area the varied nature of the volcanic rocks in which this cave occurs is evident.

Above a short, steep pitch is the west end of the Waterfall Chamber. On its north wall is a hole about 1 foot in diameter, through which most of the perennial cave stream emerges. This hole has not been explored, although additional cavern can be seen beyond it.

The Waterfall Chamber is slightly curved. It averages 7 feet in height and 10 feet in width, and is 30 feet long. At its eastern end is a 5-foot waterfall (almost dry in August), with a deep plunge pool at its base. By ascending this waterfall one can enter an upper continuation of the Waterfall Chamber. This passage narrows rapidly, and terminates 24 feet from the waterfall. A small rivulet emerges from granular pyroclastic rocks at this point, and considerable dripping water enters this chamber in several other places.

Two openings extend upward and northward between this extension of the Waterfall Chamber and the largest chamber of the cave. Aside from a small pool at its lowest point, this large chamber was dry on August 20, 1960. It is about 20 feet in diameter and 8 feet high. Its present margins appear to be determined largely by breakdown. The bedding of several members of the Eagle Creek Formation is exposed in this chamber. A feature of especial interest is the spaghettilike mass of rootlets in a small grotto connecting this chamber with the east end of the Waterfall Chamber Extension. On the floor of the main part of the room are fragments of basalt with small tortuous channels that resemble tiny bedding-plane anastomoses.

On the northern edge of this chamber, at ceiling level, there is an opening about 2 feet in diameter. Entry into this opening is dangerous, because of the fractured and poorly consolidated rock adjacent to it. It leads to the floor level of a broad dry corridor, 40 feet long and 8 feet high, with a terminal chimney. This chimney, which is the part of the cave farthest from the entrance, serves as a seasonal ingress of water. A feature of interest in this passage is a rodent nest of moss and other organic

material, which is the locus of springtails (collembola), beetles (Quedius spelaeus), millipedes (fam. Polydesmidae), and other invertebrates.

The main passages of Fish Hatchery Cave are developed along the strike of the pyroclastic rocks and lavas of the Eagle Creek Formation, and serve as dendritic stream courses — perennial, seasonal, and perhaps abandoned. Breakdown and bedding variations have influenced part of the pattern of the cave, but its overall form resembles that of certain types of limestone solution caverns. If this cave was initiated by headward sapping by a spring located between two resistant beds, and modified, without significant solution, by the factors mentioned above, the pattern and occurrence of the cave is merely curious. If solution of these pyroclastic rocks was significant in the cave's speleogenesis, the situation is very unusual, although a somewhat similar occurrence has been noted in tuff in California (Halliday, 1960b), as has development of karst through solution of diorite, which also is a poorly soluble rock (Legrand, 1952).

GULER ICE CAVE (See Ice Cave.)

ICE CAVE (58) (Campground Ice Cave, Guler Ice Cave, Mount Adams Ice Cave, Trout Lake Ice Cave)

Sec. 35, T. 6 N., R. 9 E., Willard quadrangle. Elevation 2,820 feet.

This well-known cave (fig. 75) has 4 sections, separated by 3 collapse sinks in addition to the main entrance of the cave, which is another collapse sink about 15 feet in diameter and 14 feet deep. This entrance is within Ice Cave Forest Campground of the Gifford Pinchot National Forest. The cave has been known for almost 100 years (Raymond, 1869), and served as the ice supply for the towns of Hood River and The Dalles in pioneer years (Raymond, 1869; Condon, 1896).

The Forest Service has constructed a ladder leading to a névé cone beneath the main entrance of this lava tube glaciere. Most visitors are aware only of the 120-foot glaciere section that slopes southeastward from the ladder, but some penetrate the more constricted, sinuous 200-foot passage leading west to another collapse sink. The other three sections of the tube, sloping downward from the west, are generally overlooked. Total length of the cavern passages is about 650 feet.

The western, uppermost section of the cave is a low, rather unremarkable passage about 150 feet long. It is the widest part of the cave system (fig. 75), and is floored with smooth lava. On the north side of the sink at its lower end is a short, broad, low passage from which another flow entered the tube.

The next section, to the east, is about 100 feet long and 15 feet wide. It is the only section of the cave in which one may stroll from one sink to the next, despite the irregular breakdown on the floor.

Between the sink at the lower end of this section and that at the upper end of the "main" section, the tube divides into two smaller tubes about 60 feet long and 5 feet high. The straight southern

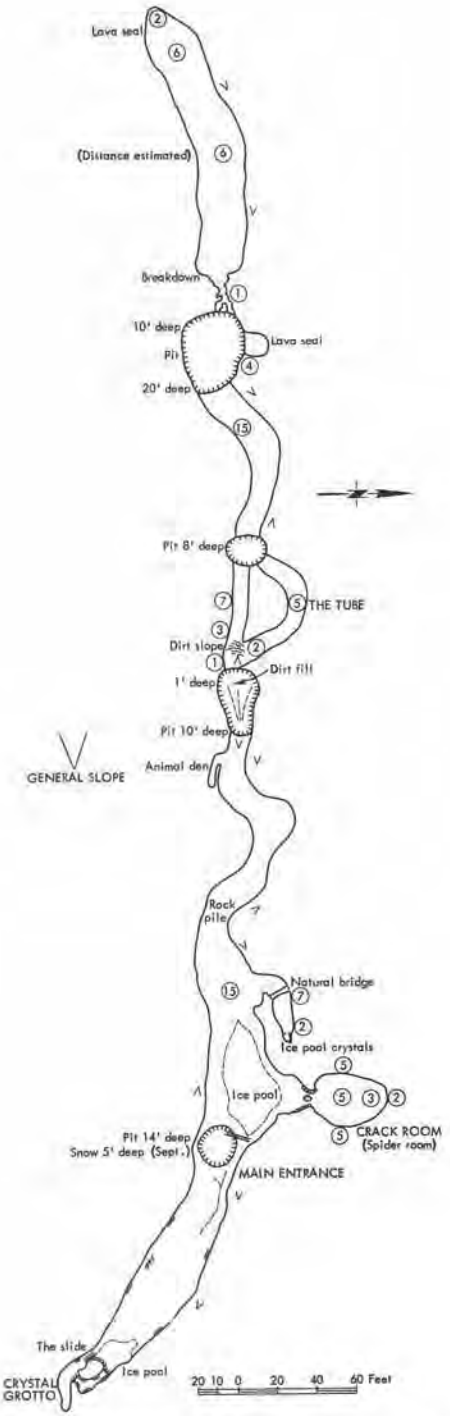


Figure 75.—Ice Cave, Skamania County. Survey by Halliday, McLellan, Sargent, and Tyler; September 1950.

branch is floored with debris and rockfall, but the curved northern branch is an almost perfect tube. After becoming lower in interior height, the tubes rejoin beneath the debris-blocked upper, western entrance sink of the "main" section.

Near the base of the ladder, at the east end of the "main" section, a small opening in lava talus leads to the low, arched, oval Crack Room. Its floor is a flat lava surface interrupted only by small contraction fissures. In a tapering recess farther up this main section of tube is a fine lava span or natural bridge.

As described elsewhere (Halliday, 1954), the lower, eastern end of this cave acts as a trap, retaining heavy cold air that settles into the cave in winter. There is no active circulation of air in this part of the cave. Much seasonal melting occurs, but an ice floor, a few stalagmites, and large drip masses of ice apparently persist throughout the year. The cave is usually snowed in until at least mid-June of each year, and refreezing begins in October or November.

LAKE CAVE (59)

Sec. 17, T. 7 N., R. 5 E., Mount St. Helens quadrangle.
Elevation about 1,900 feet.

Lake Cave (fig. 76) is primarily a unitary lava tube cavern of moderate length and vertical complexity. It is south of Ape Cave in one of the older appearing flows of the Mount St. Helens cave area. Its main tube is approximately 3,775 feet in slope length, and descends about 225 feet. It is a cave of unusual scientific importance.

The part of the cave immediately adjacent to the entrance is complex. From the collapse sink entrance, the main passage trends roughly from north to south, following the sinuous course typical of unitary tubes. Upslope, north of the entrance, the passage has two branches. The western branch is terminated by an intrusive lava seal about 50 feet from the entrance. The east fork is almost blocked in a similar manner, but in a small space above the flow an agile person can crawl for at least 50

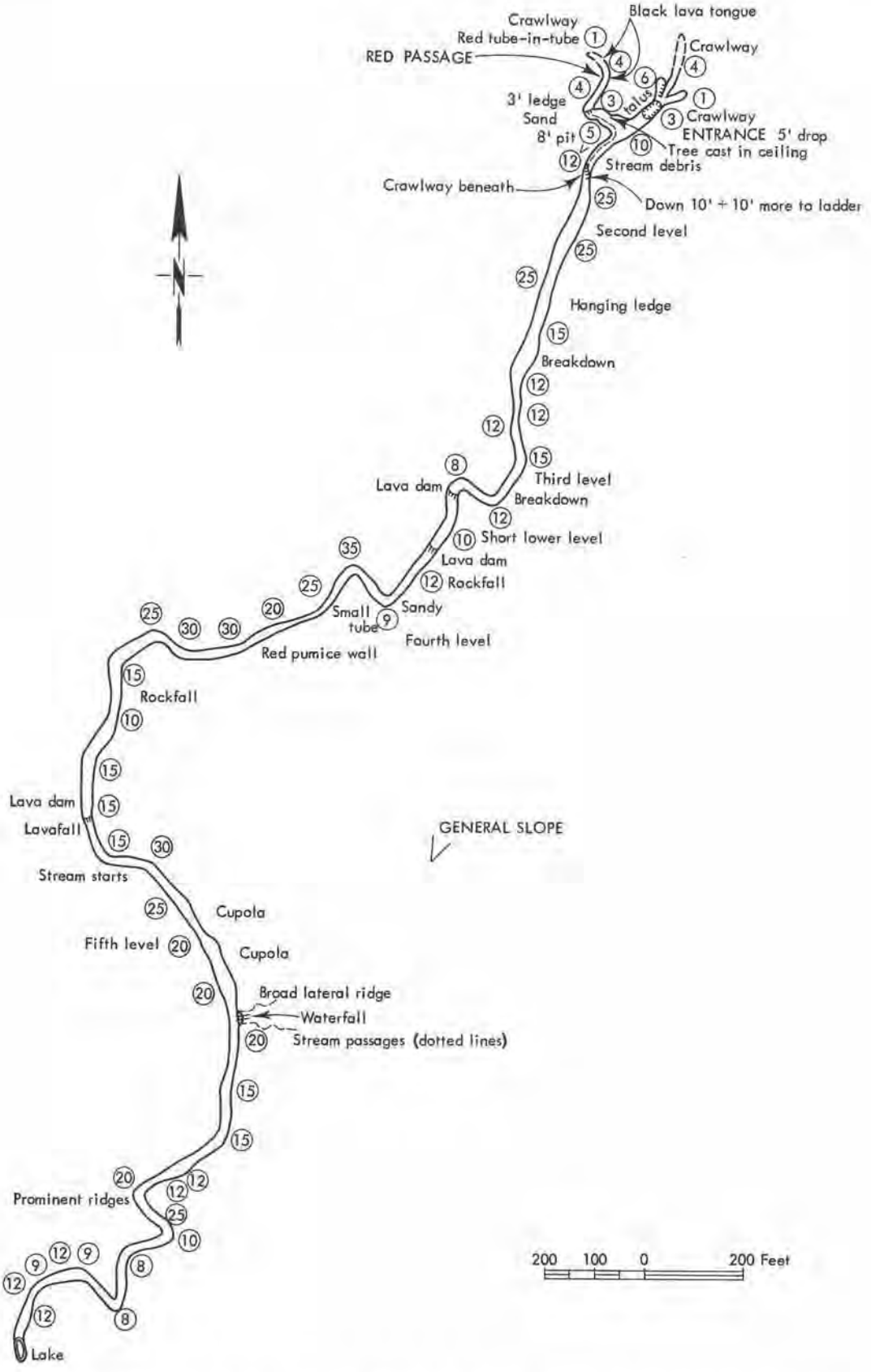


Figure 76.—Lake Cave, Skamania County. Survey by William R. Halliday, Washington Speleological Survey, December 1958. Additions by Washington Speleological Survey, June 1959.

feet farther. The flows entering through the two passages were not simultaneous. That from the west was the more recent, as it overlies and has partially remelted the margin of the flow from the east fork.

Another short side passage, the Red Passage, enters the cave from the west just south of the entrance sink. At the junction it is at right angles to the main passage, but a little farther upslope it turns to the north, paralleling the main passage for a short distance before angling northwest. At the upper end of this side passage, local explorers have succeeded in forcing the first of two intrusive lava seals, making the total penetrable length of this side passage about 100 feet. The most interesting feature of this passage is the rather smooth, brilliantly brick-red lava flow that emerged from and lines it. Some of this coloring is only a surface coating over gray-black lava, but much of it is inherent in the main flow of this area. This flow appears to be the most recent in the cave. The coloring is identical with that of the red crystalline autobrecciated lava exposed by lateral breakdown in the downslope parts of the main tube.

Other interesting features of this side passage include a small pit at the first bend. Its narrow tube descends about 10 feet, then turns upward, ascending almost to the passage level. A seasonal stream drips through the roof in this area, carrying gravel. Its channel disappears in the main tube. Small roots emerge from part of the roof of the passage, and a reddish mold and an unidentified fungus were observed on the ceiling on December 28, 1958.

About 100 feet south from the entrance of the cave, the broad but fairly low main passage descends from the entrance level to a lower tube level. This lower tube extends back north beneath the entrance passage for some distance, but it is almost occluded by a flow of rough lava that makes crawling difficult.

A seasonal stream emerges from this low opening, carrying more water and sediments than that of the Red Passage. This stream is visible intermittently as far as The Waterfall, about 2,500 feet from the entrance, where it joins the larger seasonal stream that enters the cave at that point. The combined stream then continues to a sediment- and gravel-impounded lake at the lower end of the cave. Sand and gravel deposits occur along much of the length of the cave, but are not as common as in the lower section of nearby Ape Cave. Breakdown is widespread in the upper 2,000 feet of the cave, but is relatively sparse below The Waterfall.

The upslope part of the second level of the cave consists of an impressive passage about 25 feet high and 20 feet wide near the ceiling, although quite narrow at floor level. About 500 feet from the entrance, beyond a massive overhang on the east, there is a descent of 8 feet to a third tube level. Its upslope part is almost blocked by breakdown. In this area, several small chambers have formed where the lateral crust of the tube has partly broken away. At least three layers of this crust can be distinguished in some places.

About 250 feet from the beginning of this third level, an upper-level tube can be seen over the main passage. Beyond an area of dangerous breakdown are three lava dams; between the first and second, a pit leads down to a crawlway on the fourth level, but there is an easier descent on the far side of the third dam.

Beyond this descent, red autobrecciated lava is locally exposed by lateral breakdown. An interesting feature of this section is a miniature flow containing a tube about 8 inches in diameter, aligned transversely to the axis of the passage.

There are many small lava springs along the lower wall of this part of the cave, and ribbon stalactites occur behind the crust. Tubular stalactites are common, but puddles are present rather than multiglobular stalagmites. In this area the ceiling height is approximately 30 feet — the greatest height in the cave.

About 2,100 feet from the entrance, a lava dam and a 6-foot lava falls lead down to the fifth tube level. The cave stream is augmented by dripping water at this point. Two small cupolas are present. About 400 feet beyond the lava falls, a large opening in the east wall of the cave permits entry of a seasonal 6-foot waterfall, which emerges from two confluent dendritic stream passages. These are vadose stream passages, which have cut into partially weathered autobrecciated lava that underlies a compact basalt flow. The undersurface of this flow is exposed along much of the 200-foot length of these crawlways. Horizontal and vertical tree casts are visible on this undersurface. In the walls of the vadose passages is considerable charcoal in the shape of roots of plants that were growing on the surface at the time the basalt flowed over it. The root stump of a large tree, exposed by the stream channel, shows a gradation from uncharred wood to very hard, dense charcoal resembling bituminous coal. Samples submitted to Dr. Arthur Fairhall of the University of Washington for radiocarbon study were found in preliminary studies to be about 2,250 ±150 years old (Arthur Fairhall, oral communication).

Beyond The Waterfall, the sinuous passage is rather regular in outline. Wall ridges are prominent, and little breakdown has occurred. Despite the seasonally sizable stream, no channel has been incised in the floor. Under ordinary conditions the lake at the end of the cave has a maximum depth of 4 feet, but a high-water mark 10 feet higher than the surface is present. The lake is about 50 feet long and averages about 9 feet in width, filling the entire width of the tube at this point. The end of the cave is not a siphon, being blocked with stream deposits.

Lake Cave was discovered and first explored in April 1958, by a scouting party of the St. Helens Apes (see Ape Cave). It is in a densely forested region in which there are many vertical tree casts as much as 5 feet in diameter and 10 feet deep. The cave contains a considerable biota, including salamanders (Ambystoma gracile and Ensatina escholtzii oregonensis), larvae of fungus gnats (fam. Fungivoridae), and Grylloblatta chirurgica (Gurney, 1961).

LAVA CAVE (See Ole's Cave and Curly Creek Cave.)

LAVA CAVES (See Falls Creek Cave.)

LEMEI ROAD CAVE (Lemei Cave) (See Dynamited Cave.)

LITTLE RED RIVER CAVE (60)

Sec. 32, T. 8 N., R. 5 E., Mount St. Helens quadrangle.
Elevation of entrance about 2,800 feet.

This northernmost of the Mount St. Helens group of lava-tube caves (pl. 7) was discovered September 15, 1960, by Bill Reese, Bob Kitch, and Gene McCune, while cave-hunting. Its total slope length is about 3,865 feet, most of which is a unitary lava tube, and it terminates in a lake that, although shallower, is larger than that of Lake Cave. The unusual name of this cave is due to a reddish discoloration on the floor of the channel of the rivulet that forms the lake.

The entrance of the cave is a collapse sink about 10 feet in diameter and 8 feet deep, at the foot of a Douglas fir about 44 inches in diameter. A 15-foot snag projects upward from the bottom of the small sink. The actual opening of the cave is a triangular space about 3 feet high and 10 feet wide, below the north wall of the sink. Beyond is an irregular, spacious chamber, which is a junction of three levels and several tubes. Just below and to the east of the triangular opening are remnants of a tube about 4 feet in diameter leading south, including a fine span. To the north is the orifice of a larger tube, from which flowed a lava that left a red glaze on walls and floor. To the northeast, in the most spacious part of the chamber, is a drop of about 20 feet to another tube level, which is the main route. It is reached most conveniently by way of the tube with the red glaze mentioned above, at a point about 190 feet northeast of the entrance. Almost exactly beneath the lip of the 20-foot dropoff at the lower, southern end of the main passage level is a short crack about 1 foot wide, through which an overhanging descent of 10 feet conducts the explorer downward into a stream-eroded section of short passages and a steeply sloping large breakdown chamber in what appears to be autobrecciated lava. The transition from the short lava tube complex at the entrance is dramatic. One feature of interest is the exposure of vertically laminated lava in the ceiling.

At the lower end of this breakdown area, a lower-level tube is encountered. For several hundred feet it averages about 15 feet in width and 12 feet in height, following a sinuous course roughly southward. The floor of its upslope part is covered with a thin coating of stream deposits, and little breakdown has occurred. Slumping of its lateral glaze is apparent about 200 feet from the beginning of this section. Farther along its course, lateral flow grooves are present to a height of 6, 7, and finally 9 feet above the floor. Two large lava springs open into the passage at prominent shelves, and a short segment of an upper tube opens in the ceiling along its course. Near the lower end of this section, the lava floor has been markedly rippled, as if the flow had been partially obstructed by the narrowing of the passage that precedes the descent to the lower level beyond.

At the end of this broad, pleasant passage, the character of the cave changes abruptly. Two steep descents, separated by a short horizontal landing, extend downward at an angle of about 45° in a narrow tube. The overall descent is about 50 feet. The lower "slide" is the longer, measuring more than 75 feet in length. A number of features of interest are in the slide area. A small upper level complex,

largely overlying the main tube but floored with a smooth, glazed flow, is present. The granular flow of the floor of the main tube narrows to form a thin central tongue on the upper slide. At its base is a surprisingly small "clinker pile" of the same material. The lateral glaze of the main tube is smooth and ropy. Locally, large patches of this glaze peeled off while still molten. There are some small lava stalactites.

Beyond this descent is massive breakdown over a length of about 400 feet of broad, spacious, but dangerous passage. Then the general trend of the cave turns from southeast to southwest, and only local breakdown is present in the cave's final 1,200 feet. This section is marked by the presence of fine depositional features, including prominent lateral gutters, local glazed ribbon flow deposits in the gutters, pronounced lateral glaze that locally has been flaked off by subsequent floor flows, wall grooves to heights of 3 to 5 feet, and a prominent lava tongue near the lower end of the cave. About 100 feet beyond the turn to a southwest trend, small cracks in the east wall of the passage permit entry of coalescing rivulets. Along their channels, over a course of about 600 feet, these rivulets appear to have deposited the red coloring matter that gave the cave its name. The width of this section averages about 15 feet, although the cave narrows toward its lower end. The height is more variable, and there are occasional duck-unders. The end of the cave is occupied by a shallow permanent lake, above which the ceiling height descends from 10 to 2 feet, then rises to about 8 feet at the downslope end.

Little Red River Cave is of especial geologic interest because of its features of flow phenomena. It is of minor biological importance; a few bats (Corynorhinus sp.) and millipedes have been noted. Lava tube slime is fairly well developed locally.

MOUNT ADAMS ICE CAVE (See Ice Cave, Skamania County.)

MOUNT ST. HELENS CAVE (See Ole's Cave.)

NEW CAVE (61)

Sec. 36, T. 6 N., R. 9 E., Willard quadrangle. Elevation about 2,775 feet.

This interesting lava-tube cave (pl. 8) was discovered in 1954 by a logging crew that was constructing the East Peterson Ridge road. The main entrance of the cave (fig. 77) is a collapse sink about 15 feet wide, 20 feet long, and 8 feet deep. The sink is about 30 feet east of the East Peterson Ridge road, about $\frac{1}{4}$ mile north of its junction with the Trout Lake-Peterson Prairie road.

If the writer's interpretation of the billowy mounds of aa lava at the upper end of the tube is correct, New Cave is a sinuous, spacious, 6,000-foot unitary lava-tube cavern trending roughly from west to east, partially interrupted by four collapse sinks, and characterized by much breakdown elsewhere, but traversable from initial tumulus to terminal lava seal. However, a few small side passages, chambers, and ledges at a level well above the cavern floor are indications of complexity in speleogenesis.

The slope length of the newly discovered (1961), western section of New Cave is about 2,140 feet. Much breakdown is present, and only a little pahoehoe floor is visible. A considerable variety of

Figure 77.—Entrance of New Cave, Skamania County.

lavas are exposed in the walls, including some red autobrecciated lava. Travel in this section requires clambering over piles of breakdown and over great billowy mounds of aa lava, which blocks the upper end of the cave and has the semblance of a modified tumulus. In many areas, flow lines and shelves are well developed, and short side passages and level-floored chambers are present in three areas. Six to eight bats were observed flying in its entrance area on June 18, 1961. At approximately midpoint of the passage, there is a steep ascent of 30 feet at a sharp bend in the passage, but rockfall is so heavy in this area that the reason for this rise is not clear.

At the eastern end of this extensive upper section is a compound lava sink about 100 feet long. An uncollapsed section of tube about 40 feet long separates this sink from another, smaller sink, from which a 175-foot segment of tube extends to a point beneath breakdown in the largest sink in the system, about 150 feet long and 50 feet wide. At the east end of this sink is the upper end of the "main" section of the cave.

The "main," or lower, part of New Cave consists of a single sinuous tube about 3,850 feet long, leading roughly from east to west, although about 750 feet of it trends more nearly from south to north. The western section of this "main" part crosses beneath the road and continues for about 1,100 feet to the large collapse sink just mentioned. This part of the cave is very rough, and barriers of aa lava and of breakdown are almost continuous. Near its western end, a relatively undisturbed section of tube has an arched roof, and on each shoulder of the passage are very broad, flat ledges. The basalt bedrock revealed by breakdown along much of this passage is unusually nonvesicular and uniform. Along the walls and ceiling of this passage are extensive deposits of lava tube slime.

The eastern part of the "main" section of New Cave is about 2,725 feet long. In contrast to the western part, it is almost free from breakdown, and its varying cross section and its speleogens are of considerable potential importance in speleogenetic studies. Although it is basically a unitary tube with a gentle slope throughout, rudimentary sections of an upper level are present in several areas. These vary from small ledges to ceiling channels, figure-8 passage cross sections, natural bridges, short lengths of upper passage, and one or two small chambers above the main tube.

The floor of most of this part of the cave consists of pahoehoe lava with a slightly clinkery surface which is gently rippled in some areas (fig. 78). Longitudinal ceiling grooves are locally prominent.

Contraction fissures, lateral ridges, and small cupolas are present. In several areas are tubular lava stalactites. One 5-inch lava stalagmite has been observed, and there is a single 3-inch tubular travertine stalactite, with a thin film of the same material deposited beneath it. The cave ends at a lava seal in a narrowing crawlway.

Figure 78.—Crawlway floored with granular lava, New Cave, Skamania County.

New Cave is of some biological importance. Bats have been observed flying in the cave. Unidentified moths, fly larvae, and cocoons have been found near its eastern end. The main entrance supports an extensive growth of mosses. It is probable that the cave is undergoing or will undergo ecological changes due to the presence of the nearby road in what previously was densely forested country.

NIELSEN'S CAVE (62)

Sec. 8, T. 5 N., R. 9 E., Willard quadrangle. Elevation about 3,200 feet.

As now known, this cave consists of lava talus at the end of a shallow branch lava trench that is a tributary of the southern end of the Big Cave trench. Its small entrance was discovered by Carl Nielsen while scouting near Big Cave, and was forced by the Survey in November 1959. However, it has not been possible to reach an identifiable segment of lava tube beyond the talus. Crawlways through the talus can be followed in several directions for about 50 feet, and there are several small chambers. The cave supports an extensive biota, and is recorded for that reason.

NIELSEN'S BIG CAVE (See Big Cave.)

OLE'S CAVE (63) (Mount St. Helens Cave, Lava Cave)

Secs. 19 and 20, T. 7 N., R. 5 E., Mount St. Helens quadrangle.
Elevation of main entrance about 1,350 feet.

Ole's Cave (pl. 9) is the second longest cave in the Mount St. Helens group, with a slope length of about 5,800 feet of mapped passages, and a 5,400-foot main passage. With the exception of the bifid 400 feet immediately south of the lowest, or main, entrance (fig. 79) and of a few short lava springs and segments of additional upper levels, the cave has the form of a unitary, locally sinuous lava tube. At first, the cave trends south from its upper end, only a few miles from the lower slopes of Mount St. Helens, but its passage gradually trends more and more toward the west. As in most known lava tubes of the Northwest, the slope is gentle, with a perceptible grade only in one short segment about 500 feet

Figure 79.—Main entrance of Ole's Cave, near Mount St. Helens. Note the bulge over the course of the tube. Photo copyright 1959; used courtesy of Harper and Bros.

nental United States, perhaps originating concomitantly with the 1842 or 1854 eruptions of Mount St. Helens (Verhoogen, 1937). Despite the heavy rainfall of this area, casts of delicate tree parts are visible in tree molds on the surface of the flow, and the trees growing on the surface of the flow are strikingly younger than those bordering it.

Rockfall is prominent in many sections of the cave, and has caused the formation of five entrances. The rockfall appears to be segmental rather than general, however, and the floor of much of the cave has the appearance of fresh lava. In many places, fragments fallen from the ceiling into still-molten lava have left congealed splash rings in the floor. Some of these rings are several feet in diameter.

The cave was discovered in 1895 by Ole Peterson (fig. 80), who owned a farm near the Lewis River below the cave (Forsyth, 1910). For several years, Peterson conducted parties through the cave, so Ole's Cave (Mount St. Helens Cave) was Washington's first commercial cave.

south of the second entrance. The overall slope of the flow is about 300 feet per mile in the region of the cave.

The interior of the cave varies considerably in size and cross section. Below the lowest, or main, entrance, it tends to be broader than anywhere else in the cave except perhaps below the northernmost entrance, near the pillar. Much of the cave is about 10 feet high and 15 feet wide, but there are long sections that are high and narrow, and near the second entrance the passage is only about 3 feet in diameter.

This cave is in what may be the most recent pahoehoe lava flow in the conti-

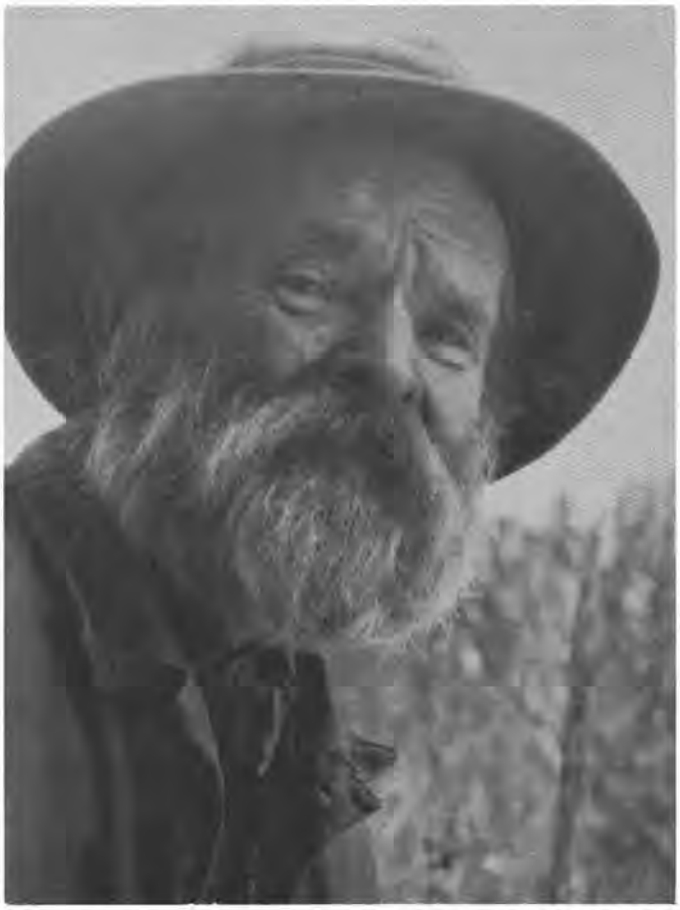


Figure 80.—Ole Peterson, discoverer and proprietor of Ole's Cave, Washington's first commercial cave. Photo by Harry Reese.

Ole's Cave is of biologic interest. The Oregon salamander, Ensatina escholtzii oregonensis, has been found in the cave beneath the second entrance. Ferns growing in the upper entrances show a phototropic response consisting of vertical, rather than horizontal leaf alignment.

The cave is divided into five sections by collapse sinks that serve as entrances. The northwesternmost section is the shortest — about 200 feet in length. About 50 feet from the end of the cave, a large collapse sink opens into the north wall of this passage. The section northwest of this opening is of especial interest, because its floor shows a slope that is the reverse of that elsewhere in the cave. This appears to be due to subsidence of lava into a vent. Glazing of the walls is very marked in this area. A fine pillar about 10 feet in diameter divides the passage at a point about midway between the two northernmost entrances.

As the usual approach to the cave is from the south, the entrances are numbered in reverse order to the slope. The area upslope from the fourth entrance has been described. A short upper level at this entrance partly masks the main passage below, which must be entered through a small hole in breakdown. Aside from the plant growth mentioned above, the short section of cave between the fourth and third entrances is not remarkable.

There is a distance of about 1,500 feet between the third and second entrances. Neither is a safe or practical point of entry into the cave, and the second entrance is little more than a skylight. In this section, the cave is locally more sinuous than in the upper sections. The lava floor is largely a granularly surfaced pahoehoe with well-marked flow ripples and splash rings. About 200 feet north of the second entrance, a short length of secondary lava tube is formed in the pahoehoe flow that is the present floor of the cave. Just north of this entrance is the only part of the cave where crawling is necessary in the main passage.

The section downslope and southwest of the second entrance is the longest unbroken length of tube in the cave, measuring about 3,700 feet in length. Its upper end is particularly interesting, including another length of tube-in-tube, the cave's finest flow ledges and contraction fissures, and one of its best lava springs. There are several short lengths of upper level, which are not all aligned parallel to the main passage. One of them is domed, and contains several tiny white calcareous tubular stalactites as well as two similar red speleothems of an unidentified nature. Several of the moderately developed cupolas of the cave are found in this section, as is the unique and unexplained speleogen projecting from the bedrock and resembling, in profile, the face of George Washington (fig. 83). Near the lower end of this section, rockfall is heavier than elsewhere in the cave. In the rockfall along the northwest side of the tube, near the main entrance, is the entrance of the parallel passage that rejoins the main passage about 400 feet farther southwest in the cave.

The lowest section of the cave is about 800 feet long. It contains many small spatter deposits (fig. 84) and some drip stalactites as much as 6 inches in length. A few have the form of pipestem lava stalactites with segmental flattenings, giving the stalactite the shape of a sequence of pipe stems.

Figure 81.—Typical lava tube (Ole's Cave) without breakdown. Note lateral groovings on lower portion of walls, the granular floor, and the slumped bubble area on wall. Photo copyright 1959; used courtesy of Harper and Bros.

Figure 83.—George Washington's Face —a curious feature of Ole's Cave. Photo copyright 1959; used courtesy of Harper and Bros.

Figure 82.—Lateral ridges in Ole's Cave left by two (perhaps three) flows of different sizes.

Figure 84.—Closeup of a lava stalagmite, Ole's Cave.

About 400 feet southwest of the main entrance is the junction of the main passage with the parallel passage that enters from the northwest. It is smaller than the main passage, but contains one chamber into which a lava spring entered from above and southeast.

The cave ends at a cupola, beyond which a 30-foot crawlway can be entered through a small hole that has been opened by blasting, apparently because someone felt a strong breeze entering a small crevice. The crawlway beyond the cupola is in dangerously unstable rock. The only feature in it of interest is an old flow mark that slants upward a few feet beyond the cupola.

Ole's Cave has features of particular interest to persons interested in the unexplained details of lava-tube speleogenesis. In few other caves can a tube be traced from an upper vent to a terminal cupola.

There are many other openings in the surface of the flows near Ole's Cave. Although none of the openings has been found to lead to a tube more than a few feet long, other tubes may be found here in the future.

PANTHER CREEK CAVE (See Falls Creek Cave.)

PETERSON PRAIRIE CAVE SYSTEM

Sec. 27, T. 6 N., R. 9 E., Willard quadrangle. Elevation about 3,000 feet.

This extensive but largely collapsed lava tube system (fig. 85) is between Peterson Prairie and Dry Creek. Slope length of the main route is 3,915 feet, but re-entrants and confluent and effluent passages and trenches bring the slope length to a total of 6,900 to 7,000 feet, and it is probable that considerable additional lengths of the tube system have not been traced. With the exception of a confluent passage 1,336 feet long, no sizable cavernous section remains, although a number of short, locally complex segments still persist. "Skylights" of collapse origin are present in several places. Breakdown is massive in most areas, and the original tube floor is rarely seen. Where visible, it is usually a rather smooth but granular pahoehoe. Glaze is prominent where not obscured by breakdown, and in a few areas, complex dripstone agglomerations occur, as well as small lava stalactites and stalagmites of more typical form. Multilevel development has taken place in at least two short sections. One cavernous part contained ice deposits in August 1962.

A rather extensive biota is sheltered in the cave. Locally, small plants display a marked phototropism.

The complexity of this system and its possible relationship to schollendoms in two areas makes it of especial interest despite the degree of collapse. An additional shallow sink is about 500 feet southeast of the lower end of the system as presently known.

PETERSON RIDGE ROAD CAVE

Sec. 35, T. 6 N., R. 9 E., Willard quadrangle. Elevation about 2,900 feet.

This small segment of lava tube (fig. 86) was discovered in August 1962 by a Washington Speleological Survey party. Its slope length along traverse lines is 241 feet; the entrance sink is only 194

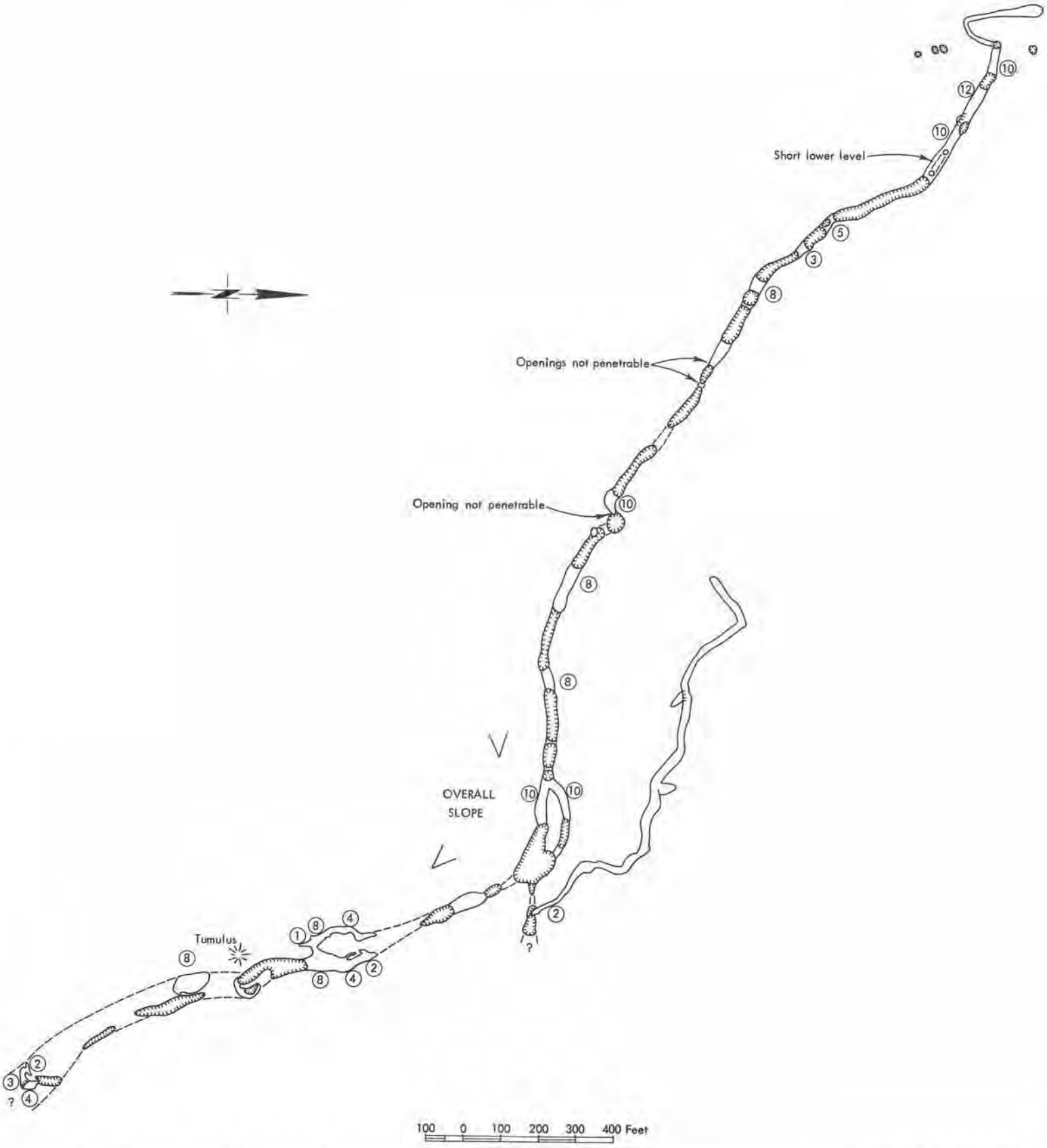


Figure 85.—Peterson Prairie Cave System, Skamania County. Compass and tape survey (uncorrected) by Cascade Grotto, National Speleological Society, August 18, 1962.

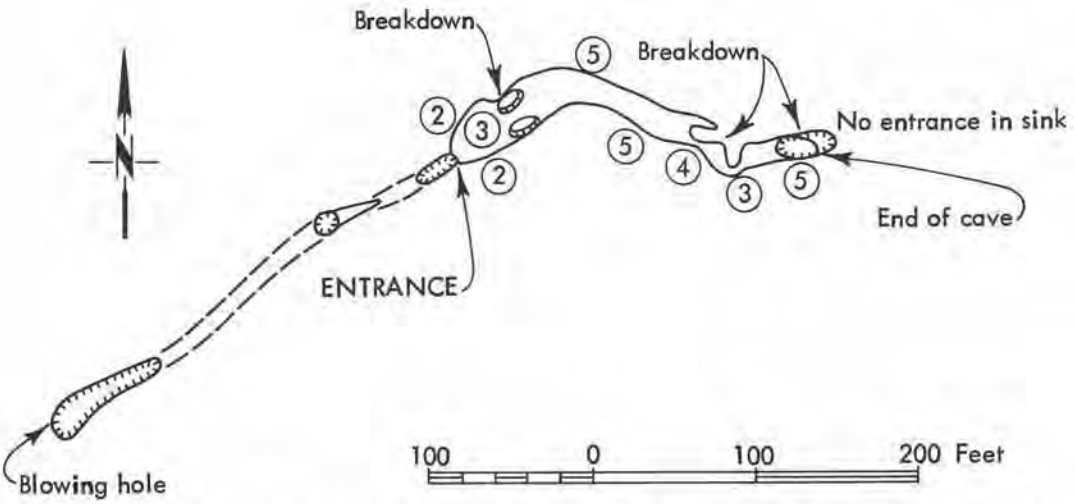


Figure 86.—Peterson Ridge Road Cave, Skamania County. Compass and tape survey by Cascade Grotto, National Speleological Society, August 19, 1962.

feet from an impenetrable sink alongside Peterson Ridge road that corresponds to the farthest penetrable part of the cave. Much breakdown and inwash lie in most of the cave, but a rippled floor of granular lava is visible locally. The cave tends to be wide but low, and much crawling is required. Considerable glaze is present. Terraced mud "flowstone" occurs locally. Some insects inhabit the cave.

The entrance sink is 24 feet long and has the cave entrance at its east end. Another sink is 88 feet farther west, with a crawlway leading about 30 feet eastward. At the west end of still another sink, 110 feet farther southwest, is an impenetrable opening that was emitting large quantities of cold air on August 19, 1962.

Possibly additional study may show that this small system is part of the Peterson Prairie Cave System or of New Cave, or even a connection between the two systems. Preliminary data suggest that it is only about 500 feet from the upper end of New Cave, and about 3,000 feet from the lower end of the Peterson Prairie system.

SLIME CAVE (64)

SW. cor. sec. 3, T. 6 N., R. 9 E., Steamboat Mountain quadrangle.
Elevation about 3,600 feet.

Slime Cave (fig. 87) is a unitary lava-tube cavern about 775 feet long, with a slightly sinuous course trending almost exactly from south to north. Its entrance is in a collapse sink about 100 yards east of the main Forest Service road leading north from Peterson Prairie Guard Station, at a point about half a mile south of Smoky Creek Campground. An abandoned side road closely parallels the upper part of the cave and runs alongside the entrance sink.

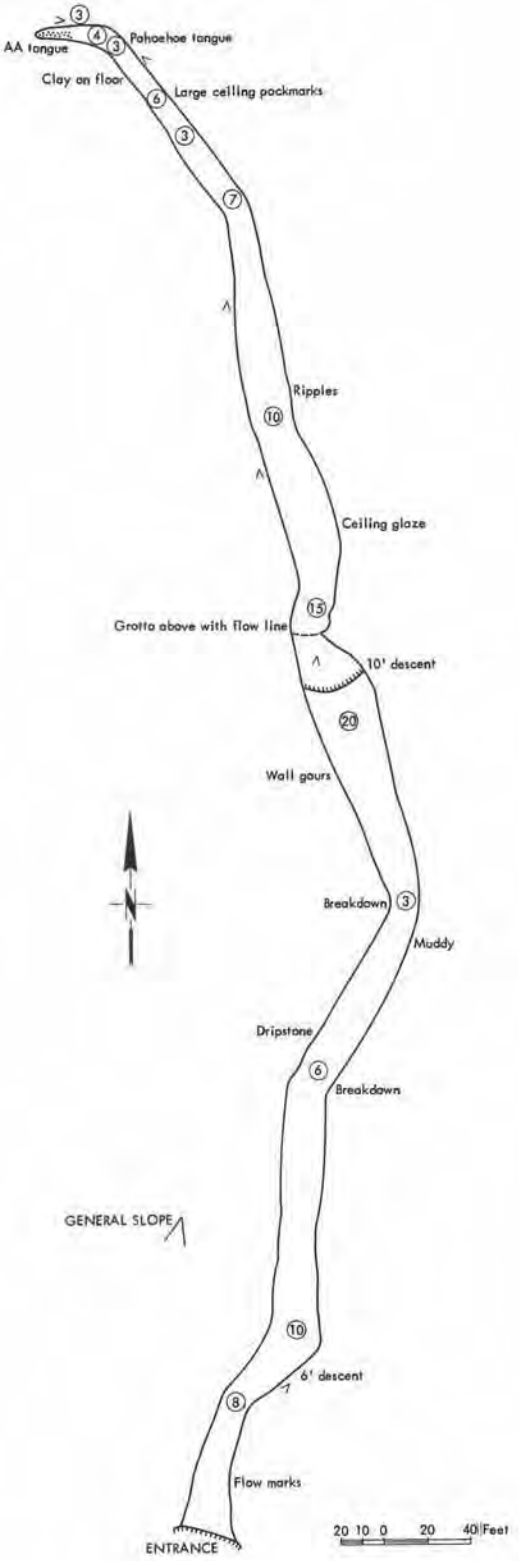


Figure 87.—Slime Cave, Skamania County. Survey by Washington Speleological Survey, 1960.

Also alongside this road, between Slime Cave and the highway, is another collapse sink, which is connected to the entrance sink by a short length of lava tube. This small cave is 3 to 6 feet high, about 25 feet wide, and 54 feet long as measured to a point where breakdown occludes most of the passage. A crawlway about 10 feet long continues to the south end of the Slime Cave entrance sink. This small cave trends N. 40° W. from its entrance. The cave has little total darkness and is rather warm and dry. A plentiful biota was noted August 8, 1959.

Figure 88.—Unexplained lava wall gours or melt cups, Slime Cave, Skamania County.

Slime Cave is named for an unidentified algaelike material that is present on the ceiling and walls in many of the moist parts of the cave. Thinner deposits of similar material have been found in many lava tubes of the Northwest, but in Slime Cave it reaches a thickness of more than 1 cm. Other features of the cave include small amounts of white calcareous dripstone and flowstone, together with local patches of red and black flowstone. Terraced flowstone or flowstone-coated melt cups (fig. 88) are present in a few areas. There is a small amount of reddish lava. Biota is scanty except in the twilight zone, which contains a considerable amount of rodent debris.

The entrance of the cave is about 25 feet wide and 6 feet high. Flow marks are prominent in the first part of the cave, which gradually increases in height and narrows somewhat as it slopes gently northward. At a point 66 feet from the entrance, the cave descends 6 feet rather abruptly to a second flow level (fig. 89), at an offset to the east.

Below this lavafall, daylight is no longer visible, and the cave is cooler, moister, and wider. It maintains a width of 15 to 25 feet for about 400 feet. Breakdown is present, and the cave is low, wet, and somewhat muddy beyond it. In several areas, long rootlets hang from cracks in the ceiling.

At a point about 400 feet from the entrance of the cave, a second steep descent, about 10 feet in height, leads to a third flow level. However, the ceiling does not follow the same slope as the floor. In fact, the general appearance is that of a hole punched downward diagonally from the lower part of the old termination of a tube. A small grotto is present, recessed behind (north of) the opening to the lower flow level. A flow line in this grotto is at the same level as that in the main portion of the cave.

Below the second lavafall the passageway is lofty and contains particularly well developed flow patterns. Lateral grooves are evident as high as 6 feet above the present floor. A lava tongue occupies the center of the passage but does not extend quite to the walls. A short distance onward, the center of the flow consists of beautifully roped pahoehoe, and the flow is bounded with aa. The ceiling glaze

Figure 89.—Second level, Slime Cave. Photo by Ed Wyman.

is prominent, and there are some small tubular stalactites. Locally, the glaze peeled off in small patches while still molten.

About 100 feet from the northern end of the cave, large semirectangular ceiling pockets are present. A thin clay layer obscures some floor details. Beyond this point the smooth, ropy pahoehoe flow is jumbled, and at a point 30 feet from the end of the cave, a darker aa flow billows down from the end of the cave to the pahoehoe jumble. Whether this mass of aa was intruded from the north through a separate vent or was forced southward along the tube into its present position by a later flow of pahoehoe is not clear. At first glimpse, the former appears to be the case.

Slime Cave presents no unusual problems of speleogenesis except for the aa lava at the north end. It is a unitary lava-tube cave with three flow levels and with relatively minor subsequent flow. The sharply demarcated flow levels may represent descents of the tube-forming flow over the lower ends of earlier flow units, or of invasion of underlying tubes.

SPEAR POINT CAVE

Sec. 33, T. 6 N., R. 9 E., Willard quadrangle. Elevation about 3,200 feet.

This small, somewhat complex lava-tube cavern (fig. 90) is the only lava-tube cave in Washington in which Indian artifacts are known to have been found. A flint spear point was found half embedded in mud during the mapping of the lower section of this cave in August 1962. The cave consists of 568 feet of low crawlways on granular lava, breakdown, or inwash, although locally the cave contains areas with widths as much as 40 feet. The upslope section is 145 feet long, with one 35-foot confluent; the downslope section is 353 feet long, with one 35-foot effluent passage. Flow ridges are well developed in the section upslope from the entrance; floor ripples, in the downslope section.

Lava tube slime is present in moderate quantities, and indications of a moderate biota were observed.

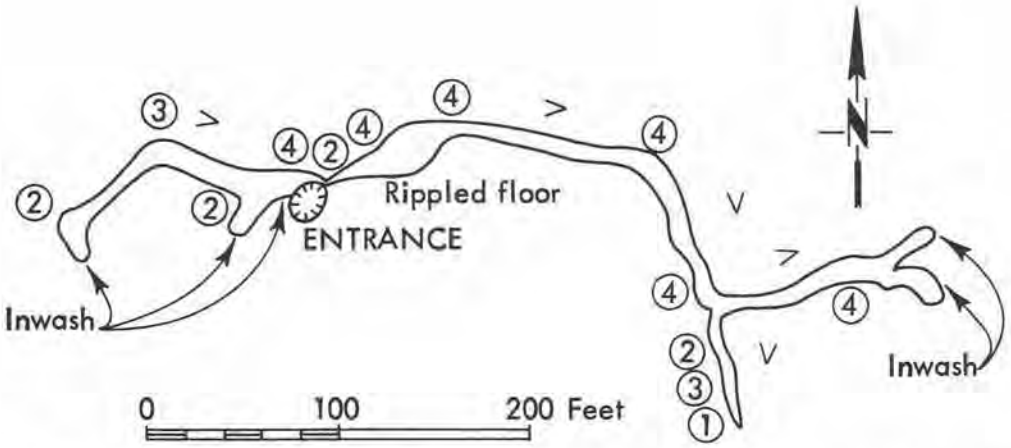


Figure 90.—Spear Point Cave, Skamania County. Compass and tape survey by Cascade Grotto, National Speleological Society, August 19, 1962.

TROUT LAKE ICE CAVE (See Ice Cave, Skamania County.)

OTHER CAVES

Homer Spencer (oral communication) reports that old-timers spoke of a large glaciere south or southwest of Steamboat Mountain. It apparently is not known today. There are said to be at least two lava-tube caves in the northwestern corner of sec. 16, T. 6 N., R. 9 E., and in the forested area southwest of Peterson Prairie. A large compound sink, shown on some Forest Service maps, was found in the latter area by the Survey, but none of these reported caves could be located.

SNOHOMISH COUNTY

Although there are a number of limestone outcrops in Snohomish County that possess karstic characteristics, no limestone cave has been confirmed there. A small cave is said to have been encountered in quarrying a limestone lens near Arlington, but it was soon quarried away. A photograph illustrating a University of Washington thesis (Norum, 1910) shows the apparent entrance of a cave in another limestone quarry east of Granite Falls. When the quarry was found, two small grottos there were found to have phreatic characteristics, but neither was large enough to qualify as a cavern (Gibson, 1953). Also, there is rumored to be a cave in one of the small limestone pods along the west side of Proctor Creek southeast of Gold Bar, but none was found in the field study for this report. The origin of the report may have been one of the mines in that area. There are also some small karstic features in a creek bed on the hillside high above Wallace River, and on the ridge crest east of Crystal Creek northeast of Wallace Falls (W. R. Danner, oral communication).

BEAR CAVE

Sec. 13, T. 28 N., R. 9 E., Index quadrangle.

Bear Cave is a rockshelter in quartz diorite, extending into the cliff about 30 feet. It is of some geologic interest, and may have been enlarged by prospectors (Carithers and Guard, 1945).

BIG FOUR ICE CAVE

Although this name apparently is also applied locally to a mine containing ice, in the same general area, Big Four Ice Cave is a large glacier cave or snow cave southeast of the site of the former Big Four Inn between Silverton and Monte Cristo. Its entrance is visible from the Barlow Pass road.

ICY WIND CAVE

It is said locally that formerly a sign on the road to the Boy Scout Camp near Silverton indicated the entrance of a cave by this name. Field work and local inquiry in 1951 strongly suggested that the cave, if one existed, was filled during logging operations. This is not a limestone area.

SPOKANE COUNTY

No limestone or pahoehoe lava is known within Spokane County, and only a few rockshelters and talus caves have been reported.

ICE CAVE (Spokane Ice Cave)

Sec. 12, T. 26 N., R. 42 E., Deer Park quadrangle. Elevation about 1,900 feet.

This small rockshelter is only about 8 feet long but is of some note because of the artifacts found in it (Bischoff, 1942). The Washington Division of Mines and Geology (written communication, 1959) reports that the name is due to confusion with a nearby shaft in cold-trapping talus.

SPOKANE ICE CAVE (See Ice Cave.)

OTHER CAVES

There was a small rockshelter in granite on the south side of Minnehaha Hill in Spokane until blasted shut by local authorities (Washington Division of Mines and Geology, written communication, 1962). Also, there is said to be a cave of undetermined type about a mile west of Dartford. It was not found during field work for this report.

STEVENS COUNTY

Extensive but scattered deposits of limestone, marble, and dolomite occur in Stevens County, but no caves have been reported there, with the exception of a block-creep cavern in basalt at the top of a cliff in sec. 12, T. 28 N., R. 39 E., (Washington Division of Mines and Geology, written communication, 1959). On the saddle of Rabbit Mountain, shown in sec. 23, T. 37 N., R. 40 E., on the Aladdin quadrangle map, there are said to be several sinks, one being about 30 feet deep.

THURSTON COUNTY

No caves have been reported in Thurston County.

WAHKIAKUM COUNTY

No caves have been reported in Wahkiakum County.

WALLA WALLA COUNTY

No true caves are known in Walla Walla County. Ash Cave is a large rockshelter in basalt, about 17 miles north of Eureka (Butler, 1958).

WHATCOM COUNTY

Karst topography is a feature of several limestone deposits in Whatcom County, and some small caverns have been found in the Red Mountain deposits. Collapse sinks and ponors also occur in two limestone outcrops on the north side of Black Mountain, northeast of Maple Falls. Other types of caves are also present in Whatcom County, including sandstone rockshelters reported near North Pass, southeast of Sumas.

BIG SINKHOLE GROTTO

Sec. 14, T. 40 N., R. 5 E., Van Zandt quadrangle. Elevation about 1,900 feet.

This impressive karstic feature is some 50 to 100 yards east of the 1960 rim road of the Permanente quarry, fairly close to its south end. From the hillside, the grotto has the appearance of an overhung collapse sink about 40 feet in diameter and 70 feet deep at the uphill side and 50 feet deep at the southern, downhill side. It is half filled (largely on the uphill side) by debris. At the bottom is an impenetrable ponor in an impure limestone of Early Pennsylvanian age (W. R. Danner, oral communication).

Looking outward from this point, the viewer obtains a thoroughly cavernous impression. Aside from a single small chimney, significant speleothems and speleogens are absent.

LARRABEE STATE PARK CAVE

On the north shore of the small cove immediately north of the main beach at Larrabee State Park is a tunnel about 25 feet long, 3 feet wide, and 4 feet high. As the tunnel is aligned along a small vein of vertically bedded coal, it is unclear whether this opening is an abandoned excavation or a littoral cavern. This may or may not be the rum-runners' cave rumored in this vicinity.

SINKHOLE CAVE (65)

Sec. 14, T. 40 N., R. 5 E., Van Zandt quadrangle. Elevation about 1,900 feet.

This small cave (fig. 91) is about 200 yards south-southeast of the parking area at the point where the quarry rim road of the Permanente Red Mountain limestone quarry reaches the level of the rim. The cave entrance is at the south end of an irregularly shaped sink between the quarry rim road and a recent (1960) logging road. Also at the southern end of this sink are several other, impenetrable horizontal and vertical openings. The cave entrance is several feet above the low point of the sink. In July 1960, after a rainless month, a small rivulet from a pond in the northeastern part of the sink was observed entering rubble a few feet below and northeast of the cave entrance. There is evidence that at high water a small rivulet flows into the entrance of the cave and runs most of its length before vanishing into a small ponor. However, flood debris at ceiling level indicates that the cave occasionally floods completely.

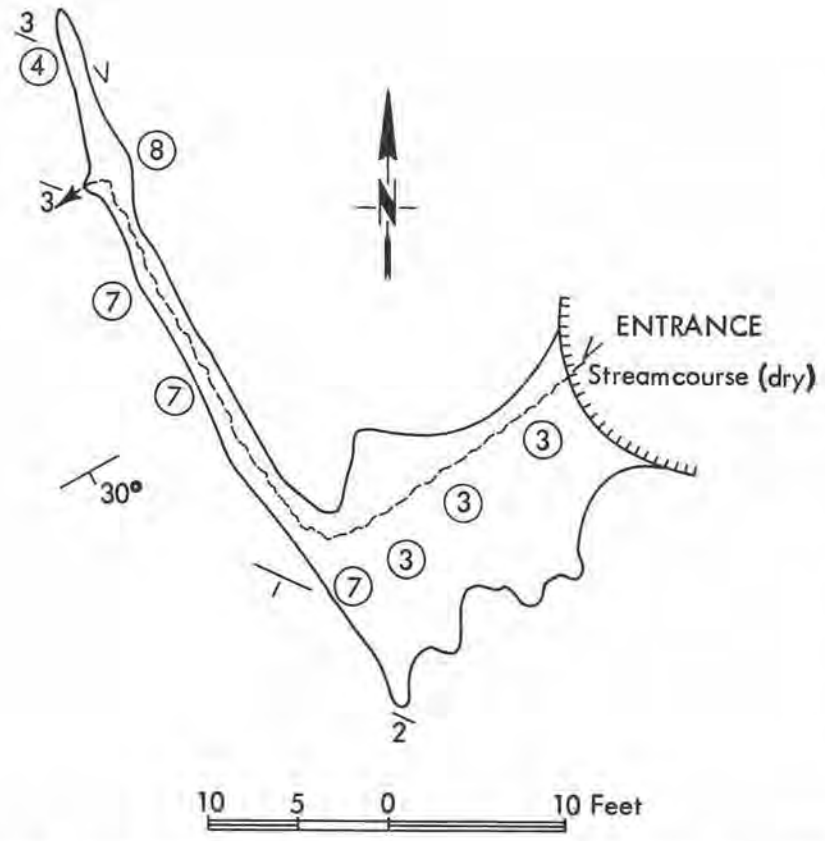


Figure 91.—Sinkhole Cave, Whatcom County. Survey by Wm. R. Halliday and Fleming.

The low entrance to the cave is about 3 feet high and 8 feet wide. Immediately inside is a low antechamber with irregular enlargements along dip joint planes. The distance to the rear wall is 17 feet.

To the northwest, a narrow passage averaging 7 feet in height and 1½ to 2 feet in width extends 37 feet along a dip joint. A small amount of flowstone and some small, muddy-appearing draperies are present. Also, there are coralloids near the entrance. Eleven feet from the end of the cave, an impenetrable ponor on the southwest side of the passage "swallows" the cave stream, the course of which is evident in the alluvium on the cave floor.

Sinkhole Cave is in typical cutover Northwest lowland hillside forest. It appears to be the only penetrable part of a largely filled network of small phreatic passages of considerable extent, which probably developed in relation to the erosion surface of which the gentle slopes of the mountaintop are a remnant. Besides the other openings in the same sink, there are at least two other sinkholes between this cave and Big Sinkhole Grotto, and another just east of the parking area mentioned above. Quarry employees report that a small cave about 20 feet long was recently encountered, then destroyed during quarry operations. As the quarry is extended eastward, additional caves may well be encountered.

SUMAS MOUNTAIN CAVE (66)

Sec. 21, T. 40 N., R. 5 E., Van Zandt quadrangle. Elevation about 1,500 feet.

This complex little cave (fig. 92) has about 250 feet of narrow passages and small chambers, and is the only known sizable limestone cave of western Washington outside of the Snoqualmie Pass group. Its low entrance is at the base of a low limestone face that forms the west wall of a shallow sink, which is on a small flat section of the steep eastern slope of Sumas Mountain. About 100 yards southeast of the

cave is a large sink about 60 feet long and 25 feet wide, and the presence of numerous small sinks in the deeply mantled and densely vegetated slopes and flats of this part of the mountain indicates the existence of more extensive local karst development. The bedrock is limestone of varying purity and interbedding. However, several highly fossiliferous horizons are exposed in the cave, in which Late Devonian plagioporan corals (W. R. Danner, oral communication) have been found. The dip and strike vary considerably within the cave, but the dip averages about 45° SW.

Sumas Mountain Cave shows phreatic development along dip and strike joints, oblique joints, and bedding planes. The bedding has greatly influenced the speleogenesis of the western part of the cave, where the limestone is more markedly interbedded and less pure. Although some small stream channels have been incised atop fills, little or no vadose modification of the bedrock is apparent. In two locations there are small flat areas on the ceiling, but they are not well enough defined to be classified with certainty as water-table horizons. In the narrow entrance passage are some indistinct transversely elongated flutings that might indicate solution by turbulent water. The rest of the speleogens of the cave, which include many rounded joint pockets, natural bridges, spans, and the like, appear to be typical of quiet phreatic solution. Some spongework is present, particularly in the fossiliferous horizons. Although the vertical extent of the cave is less than 20 feet, the multilevel development of the small passages and the massive fills of the cave suggest that the cave extends to greater depth as a small three-dimensional network of deep phreatic origin, rather than one developed in the shallow phreatic zone.

Because of the complexity of the cave, its pattern is better described by the accompanying map than by text. Detailed study of bedrock features exposed in the cave is desirable. The fauna of the cave is moderately large. Mosquitolike insects and harvestmen were noted in total darkness in the survey for this report, and rodent (cony?) droppings were present. A large white slug was collected in total darkness, and in the dim twilight zone of the entrance passage, spiders and two large white slugs with irregular large black spots were noted.

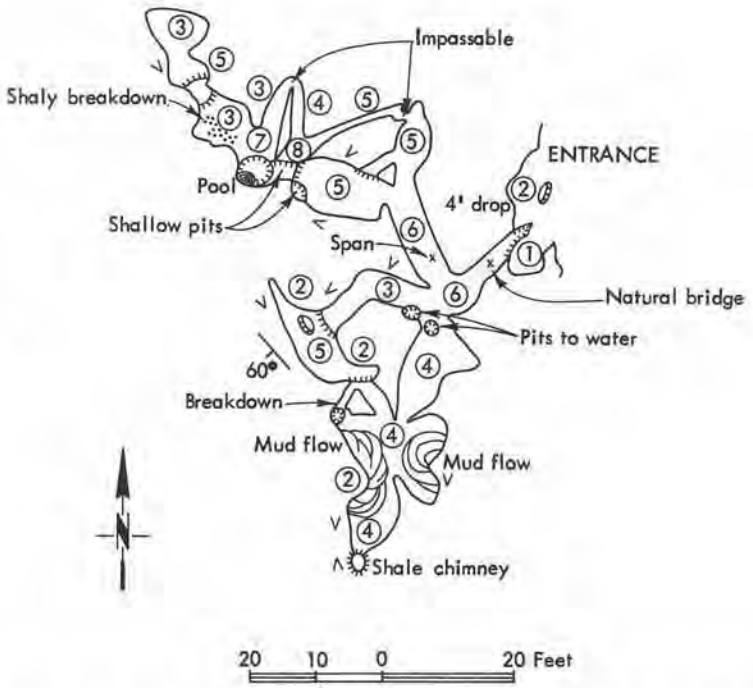


Figure 92.—Sumas Mountain Cave, Whatcom County. Survey by Washington Speleological Survey. October 1960.

OTHER CAVES

There is rumored to be a large cave entrance near the mouth of Sulfide Creek, in the cliffs east of the Baker River about 3 miles north of the Baker Lake Bridge. Although there is a little limestone in this general area, only rock overhangs were observed by the Survey.

WHITMAN COUNTY

The only caves reported in Whitman County are small rockshelters near Ewan, in the cliffs north and west of Rock Lake (United States W. P. A. Federal Writers' Project, 1941).

YAKIMA COUNTY

The northeastern part of the Mount Adams lava tube area extends into Yakima County, and there are local reports of one or two small lava tubes south of Bird Creek near Smith Butte. Their existence has not been confirmed.

BOULDER CAVE (See Boulder Creek Cave.)

BOULDER CREEK CAVE (67) (Boulder Cave)

Sec. 21, T. 17 N., R. 14 E., Mount Aix quadrangle. Elevation about 2,800 feet.

This impressive 400-foot cavern was cut by Boulder Creek after a slide dammed its canyon. The imposing upper entrance is almost 200 feet wide and about 50 feet high. The lower entrance is a narrow opening between the compacted slide and the canyon wall. The cave follows a curved path, and is actually a huge closed stream meander niche. Much of its length is in total darkness despite the immensity of the entrance. It has been known since 1901 (Anonymous, 1901), and is much visited by campers at the nearby Forest Campground across and a short distance up the Naches River from Cliffdell.

CRYSTAL CAVES

It is locally said that there are rockshelters near Priest Rapids on the Columbia River that have been given this name.

INDIAN OCHER CAVE

There is said to be a small rockshelter near Satus Creek from which local Indians formerly obtained ocher. Its existence has not been verified.

OTHER CAVES

A legendary Dead Man's Cave (Lynch, 1961) is locally believed by some to be on Hell Roaring Ridge on the lower slopes of Mount Adams (Anonymous, 1961).

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GLOSSARY

Aa, the rough, clinkery type of basalt flow in which lava tubes do not form.

Block creep cavern, a specific type of fissure cave, formed by a fracture parallel to the face of a cliff with subsequent "creep" of the smaller fragment away from the main block.

Blowout, an opening from a lava tube to the surface, resulting from an explosion of the gases within the tube during its thermal phase.

Boxwork, a petromorph of intersecting mineral blades projecting from the walls or ceiling of a limestone cavern. A vaguely similar speleogen has been recorded in a Washington lava tube.

Breakdown, accumulation of rock, resulting from flaking off from or collapse of the walls or ceiling of a cave.

Breakdown dome, a high, arched chamber or passage section in either a limestone cavern or a lava tube, resulting from partial, usually intermittent, collapse of the ceiling.

Cave, a natural subterranean opening large enough to enter, with some part in total darkness. The term is applied loosely to a variety of other natural underground cavities.

Cavern, essentially the same as cave.

Ceiling channel, a distinct channel dissolved upward into the ceiling of a pre-existing limestone cave, or gouged into the ceiling of a lava tube.

Ceiling grooves, longitudinal scratch marks in the ceiling of a lava tube.

Ceiling pendant, a downward projection of limestone, various modifications of which are indicative of speleogenetic factors.

Ceiling tube, a ceiling channel with a particularly tubular appearance.

Chockstone, a fragment of breakdown that has become wedged in a narrow passage instead of falling to its floor.

Column, a gravitomorphic speleothem attached at both ends, usually as the result of fusion of a stalactite and a stalagmite.

Concentric, in lava tubes, a "bull's-eye" pattern on the floor, usually resulting from rockfall into a partially crusted flow ("splash concentric" or "splash ring"), but rarely by deposition of successive lateral ridges around a small obstruction.

Contraction fissures, cracks found in the flows on the floors of lava tubes, presumably as a result of contraction during cooling.

Coralloid, a speleothem resembling branched globular corals or massed popcorn. Coralloids vary widely in size, and both the calcareous and lava types probably originate in several ways.

Cupola, a smooth, domed upward expansion in a lava tube, resembling the inside of a huge gas bubble. At times, this term has been applied to the opening of an upper-level tube into a lower-level tube as seen from below, but this usage probably should be discouraged.

Dome pit, a specific vadose speleogen consisting of a shaft several feet in diameter with sheer, slightly grooved walls and roughly circular cross section.

Dripstone, a popular or semitechnical group term including stalactites, stalagmites, columns, and similar projecting speleothems, deposited from dripping water.

Duck-under, a short, low section between two more spacious areas of a cave.

False floor, in limestone caves, a thin deposit of flowstone over a fill that has subsequently compacted or been washed away, leaving a space beneath an apparently solid floor. A similar phenomenon occurs less commonly in lava tubes, due to crusting.

Flow grooves, longitudinal grooves in the walls of lava tubes, seemingly incised by gouging during flow through the tube.

Flow ledge, a large or small ledge on the wall of a lava tube, extending longitudinally as though deposited at the upper margin of a flow through the tube.

Flow line, an imprecise term applicable to indistinct flow grooves or ledges.

Flow mark, any longitudinal deposit or site of removal of material in a lava tube seemingly a result of subsequent flow through the tube.

Flow shelf, a broad flow ledge.

Flowstone, a mineral deposit in a cave, resulting from deposition from water that trickles over a surface, without dripping.

Glacier cave, a cave developed by melting in or beneath a glacier.

Glaciere, a cave or other subterranean site in which ice forms and persists for considerable periods of time (see also ice cave).

Gour, a calcite-walled pool or the space that a now-dry pool of this type once occupied.

Grotto, (1) a small side chamber of a cavern.
(2) a cavernous opening that extends only into the twilight zone.
(3) a local unit of the National Speleological Society.

Helictite, a specific nongravitomorphic axial speleothem. Most helictites are curved throughout, or at some point in their length. Many lava helictites are not truly axial.

Horizon, a specific level of speleogenetic flow manifested in the cave walls.

Ice cave, a cave in which ice forms and persists for a considerable period (see also glaciere).

Joint pocket, a specific phreatic speleogen consisting of a rounded enlargement of a cavern space along a joint.

Karst, a specific type of topography resulting from the solution of limestone bedrock and characterized by the features of development of underground drainage at the expense of surface drainage.

Lapies, a low, narrow limestone ridge, usually representing the exposure of the strike of the beds in karst topography.

Lateral ridge, a longitudinal floor deposit of a lava tube, apparently deposited at the margins of a flow through the tube.

Lava dams, structures of some lava tubes that roughly resemble gours several feet high. They may prove to be the snouts of flows, the still-molten core of which has drained to lower levels after the dam has solidified.

Lavafall, a solidified cascade of lava.

Lava pillar, a short section of wall dividing a lava tube passage.

Lava puddle, a deposit of smooth nonvesicular pahoehoe lava at the base of a lava speleothem or at the outlet of a lava spring, without flow features.

Lava seal, a point where a smooth lava floor meets the ceiling of a lava tube.

Lava spring, a recess in the wall of a lava tube from which lava has flowed into the tube.

Lava tongue, a raised section of a flow within a lava tube.

Lava trench, an elongated depression of considerable length resulting from collapse of a section of lava tube.

Lava tube, a long, near-surface, somewhat tubular cavern found in certain flows of pahoehoe lava. Ingressive or egressive branches are not uncommon, and considerable complexity is present in some caverns.

Lava tube crust, a deposit lining lava tubes, of which lava tube glaze is a specific subtype.

Lava tube glaze, a thin smooth shiny nonvesicular form of lining of many lava tubes.

Lava tube slime, a curious and little-studied material found on the walls and ceiling of many lava tubes, consisting of an amorphous, jellylike film. It may consist of a silica gel and (or) micro-organisms.

Littoral, pertaining to the zone of wave action.

Meander niche, a speleogen showing the characteristics of solution of the wall of a limestone cave by the curve of a stream.

Melt cup, a lava speleothem resembling vertical terraced flowstone, seemingly formed in the molten phase, but not yet subjected to microscopic, petrographic, or mineralogical study.

Moonmilk, a white, puttylike form of flowstone, formed of calcite, hydromagnesite, or dolomite.

Pahoehoe, a type of basalt flow characterized by marked fluidity, and subsequent smoothness.

Petromorph, a deposit formed within bedrock and subsequently exposed in the wall of a cave.

Phreatic, pertaining to the zone of water beneath a water table.

Pisolith, a rounded concretion of calcium carbonate.

Ponor, a point of piracy of a large or small stream by underground drainage.

Resurgence, the point of emergence of a subterranean stream to the surface.

Rockshelter, a cavernous natural rock overhang.

Schollendom, the German term for tumulus, a low domelike protrusion in congealed lava flows.

Slime flowstone, a terraced flowstone, seemingly resulting from the action of, or coincidental with, lava tube slime.

Slump ripple, a specific pattern of lava tube crust resulting from its irregular partial slumping.

Speleogen, a feature of the bedrock of a cave, resulting from removal of material therefrom.

Speleogenesis, the process of origin and development of caves.

Speleoliferous, containing caves.

Speleology, the study of caves and their contents.

Speleothem, a feature of a cave resulting from mineral deposition.

Splash concentric, "congealed ripples" resulting from the fall of an object into congealing lava. (See concentric.)

Stalactite, an axial, gravitomorphic speleothem directed downward.

Stalactite, tapered, a stalactite with a base larger than its lower end.

Stalactite, tubular, a thin-walled, hollow stalactite with a uniform diameter.

Stalagmite, an axial, gravitomorphic speleothem directed upward.

Stream flute, an elongated, cupped speleogen resulting from turbulent flow of water.

Swallet, same as ponor, but usually applied to streams or rivulets of some size.

Terraced flowstone, a specific form of flowstone on which small gours have developed.

Tree cast, a tubular (horizontal or vertical) imprint in lava of a tree trunk engulfed by the lava.

Tube-in-tube, a rudimentary lava tube inside a lava flow which itself is within a larger lava tube.

Tumulus, a low domelike protrusion in congealed lava flows.

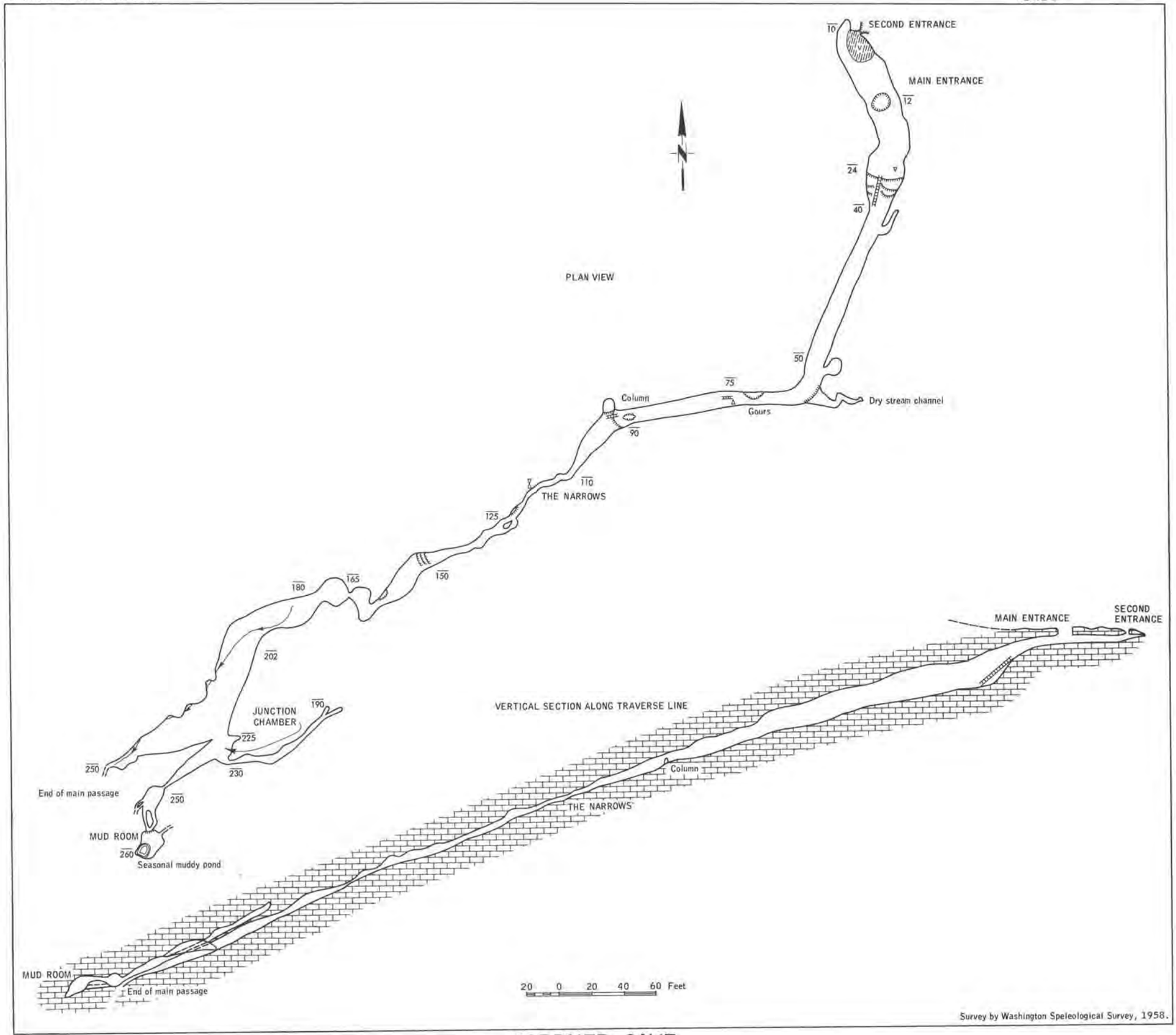
Vadose, pertaining to the zone above a water table.

Vadose grooving, a specific speleogen consisting of fairly regular vertical grooving of limestone walls by solution of descending films of water. In Washington, it is seen predominantly in high-elevation caves.

Wall ridge, a longitudinal deposit on a lava tube wall, apparently deposited at the margin of a flow through the tube. Probably should be superseded by the term "flow ledge."

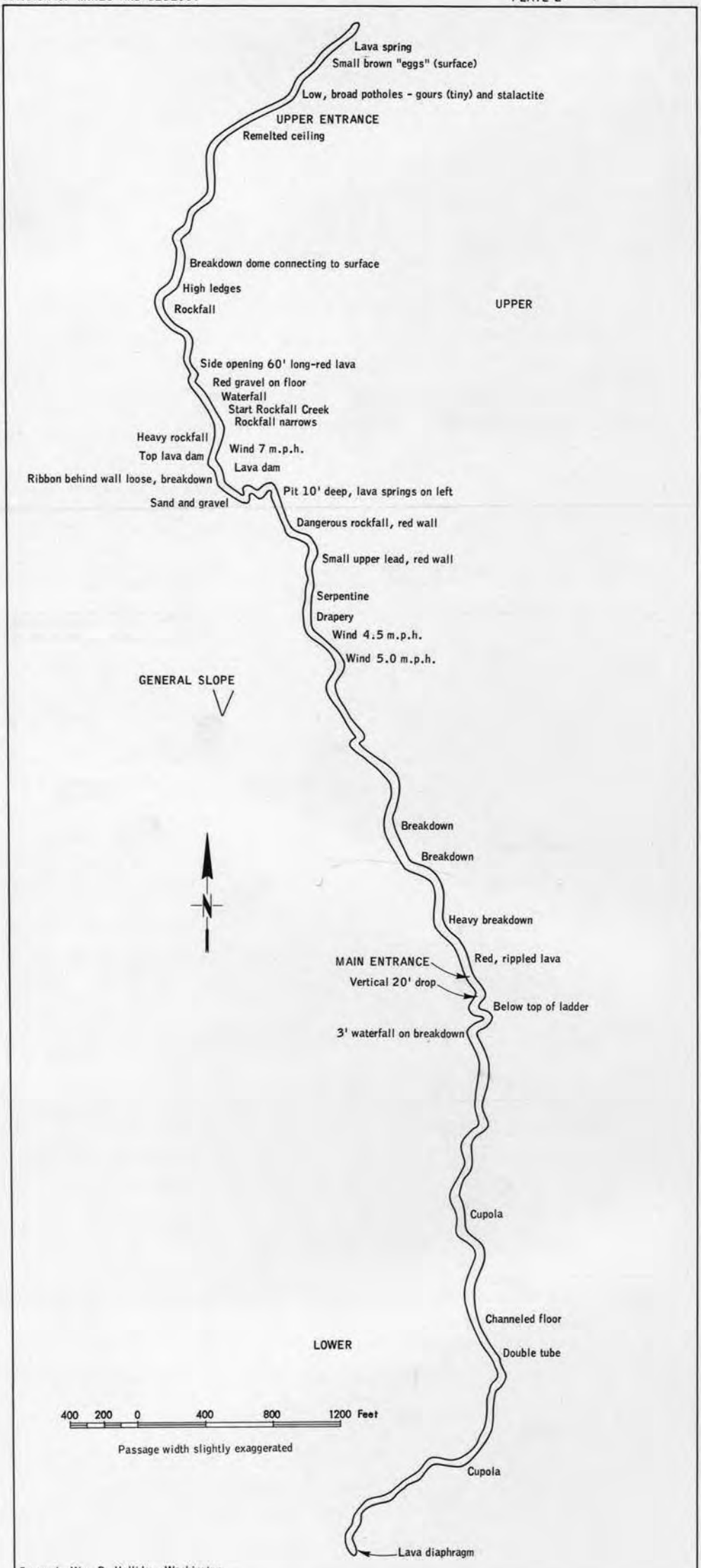
Waterfall slot, an accentuated and regular form of vadose grooving limited to a small area as a result of local concentration of descending water.

INDEX OF CAVES



Survey by Washington Speleological Survey, 1958.

GARDNER CAVE



Survey by Wm. R. Halliday, Washington Speleological Survey, December 1958.

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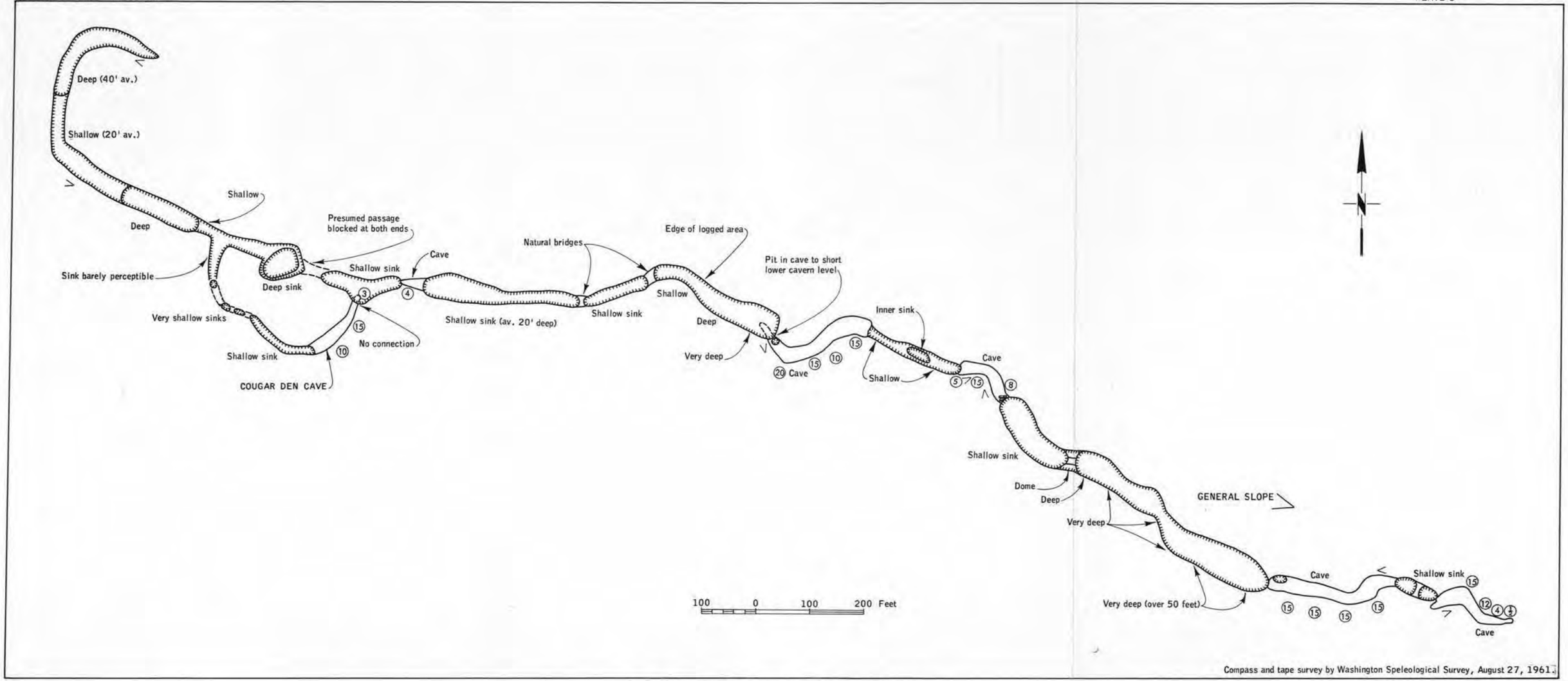
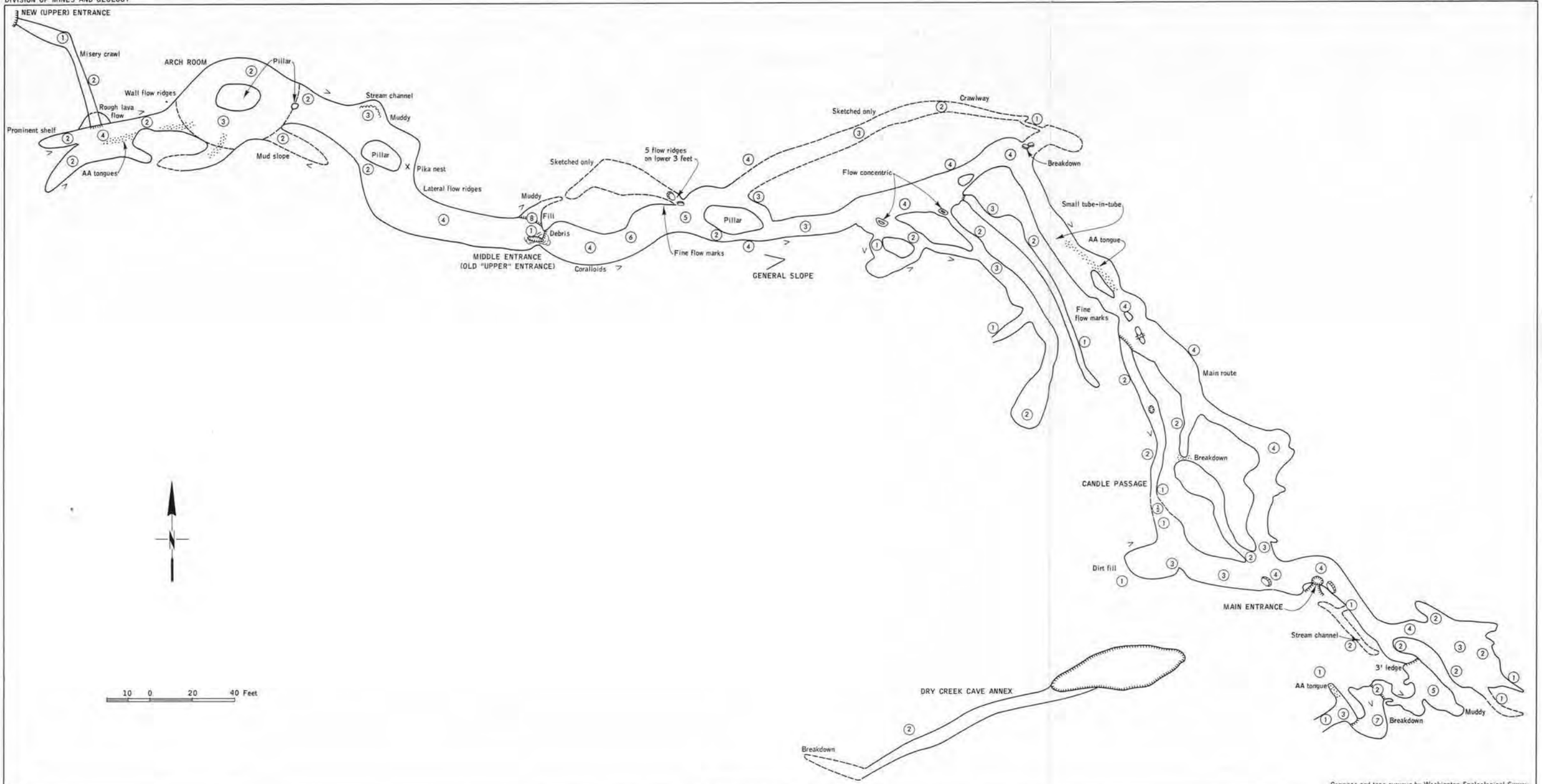


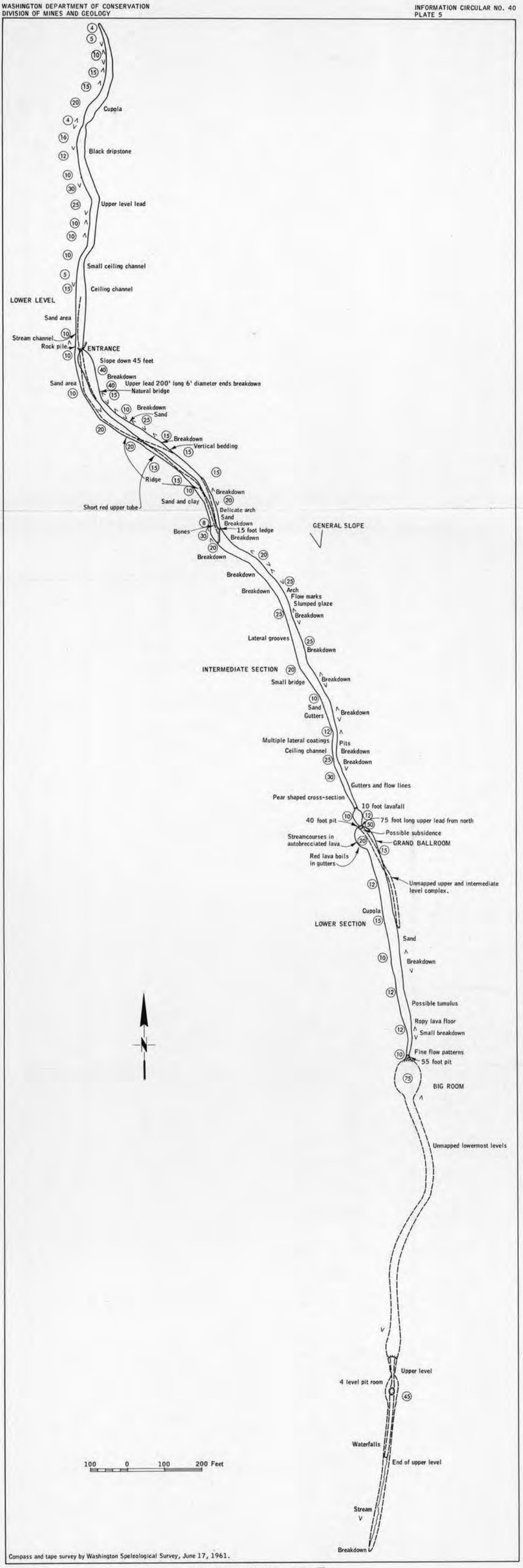
Compass and tape survey by Washington Speleological Survey, August 27, 1961.

BIG TRENCH CAVE SYSTEM



Compass and tape surveys by Washington Speleological Survey.

DRY CREEK CAVE



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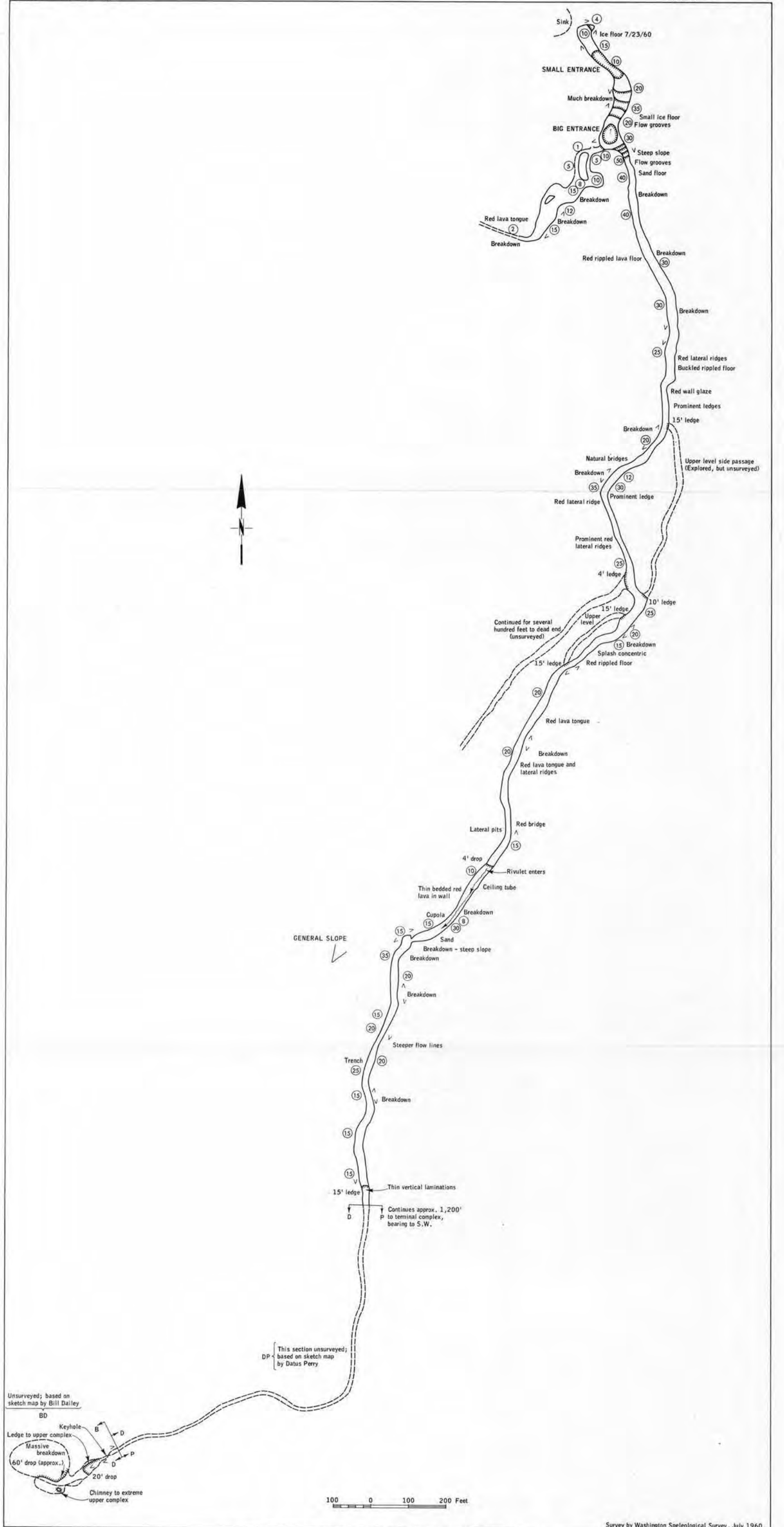
DYNAMITED CAVE



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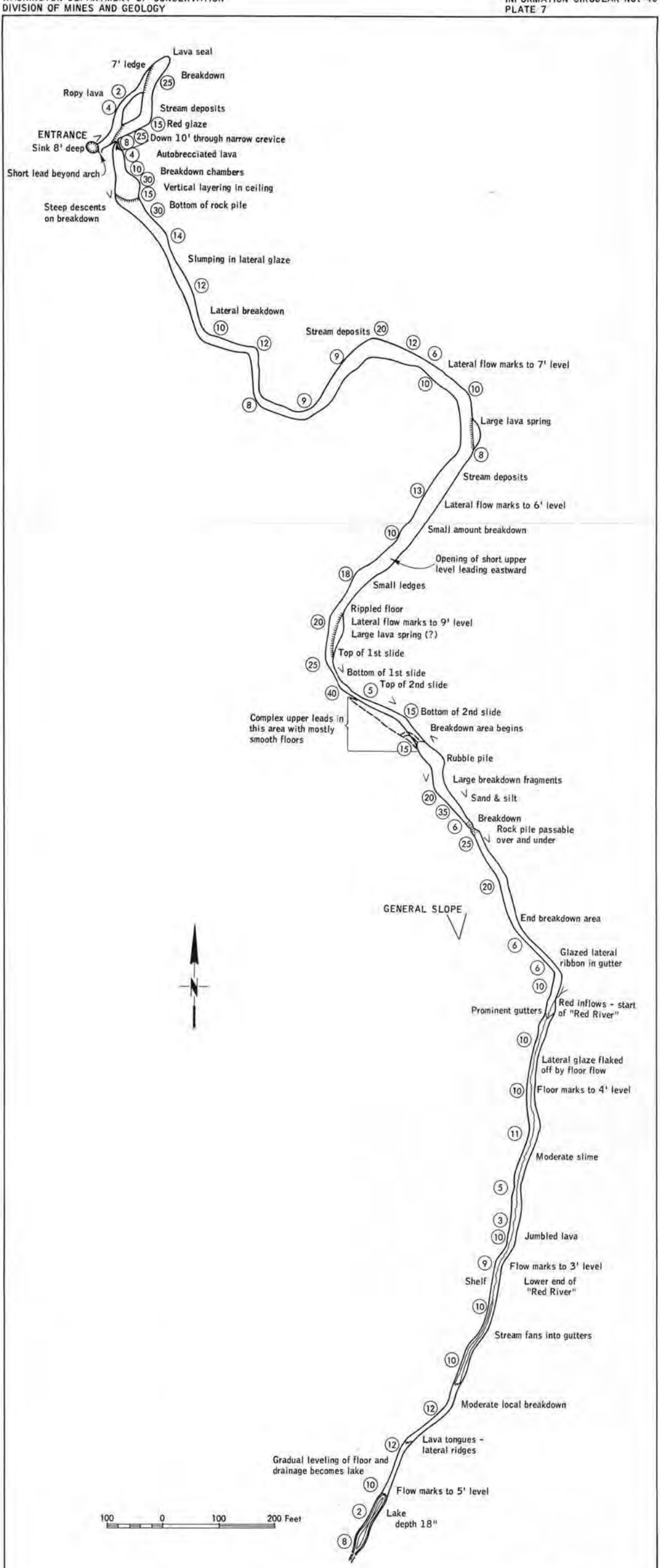
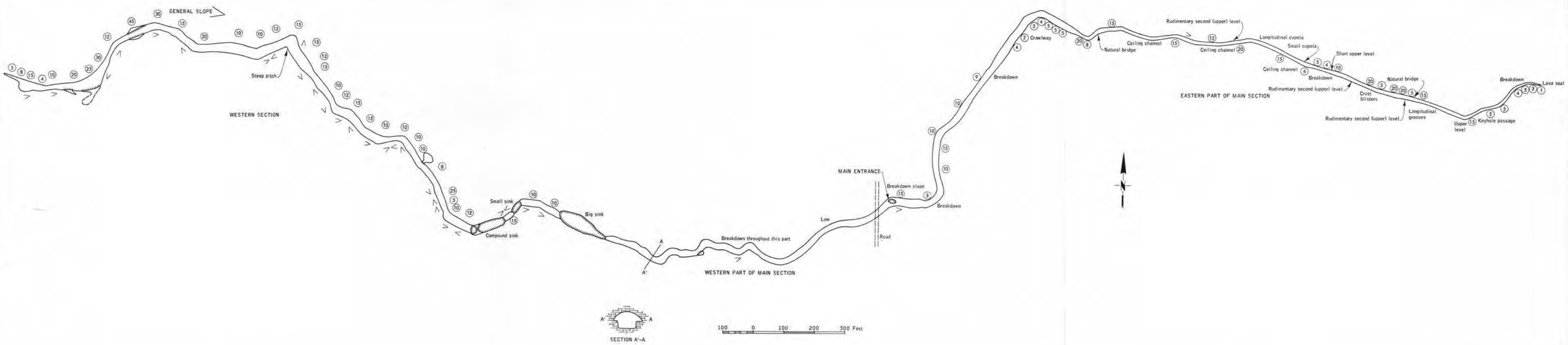
FALLS CREEK CAVE (PANTHER CREEK CAVE)



Survey by Washington Speleological Survey, November, 1960.

LITTLE RED RIVER CAVE



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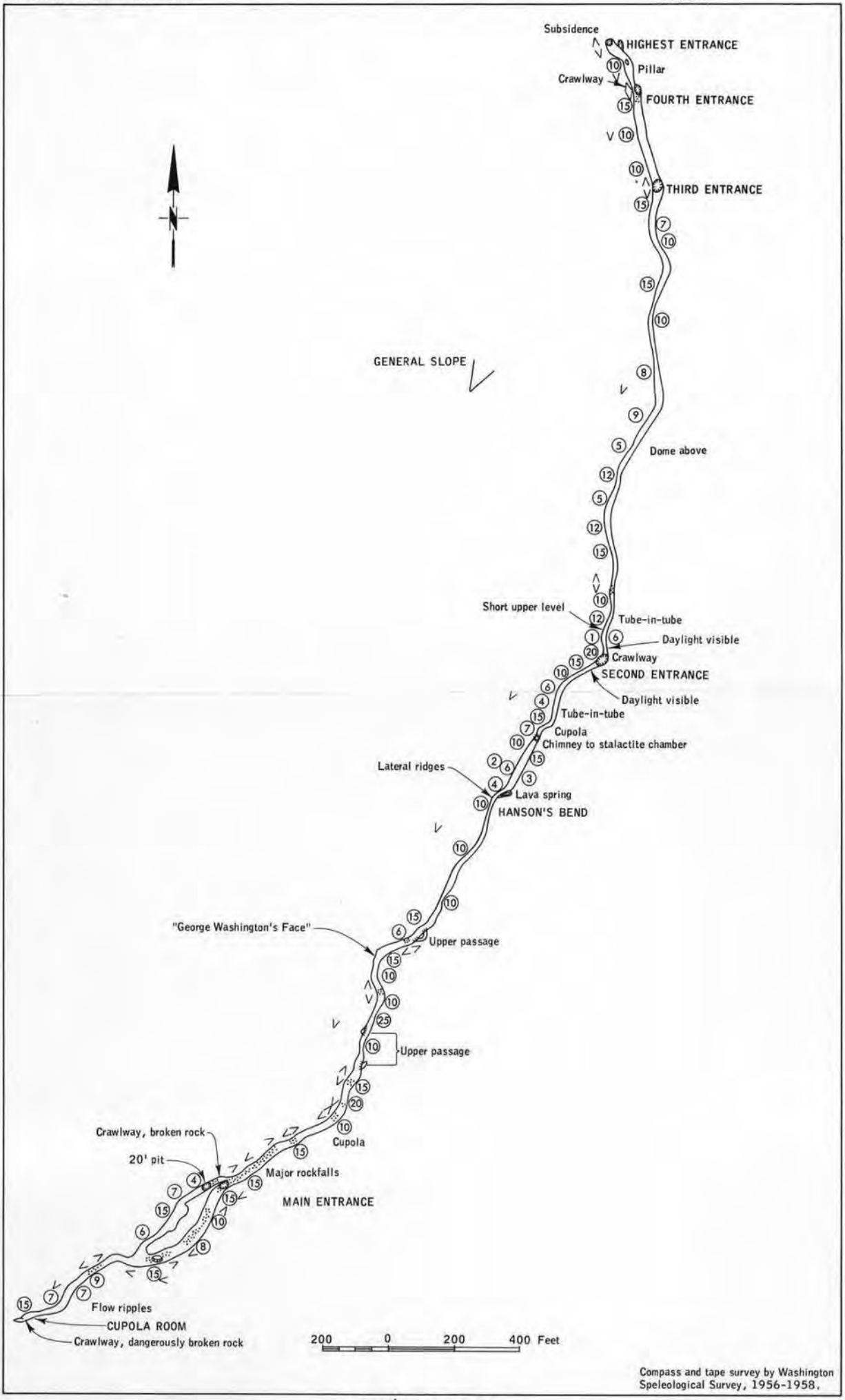
NEW CAVE



Compass and tape survey by Washington Speleological Survey, 1956-1958.

OLE'S CAVE