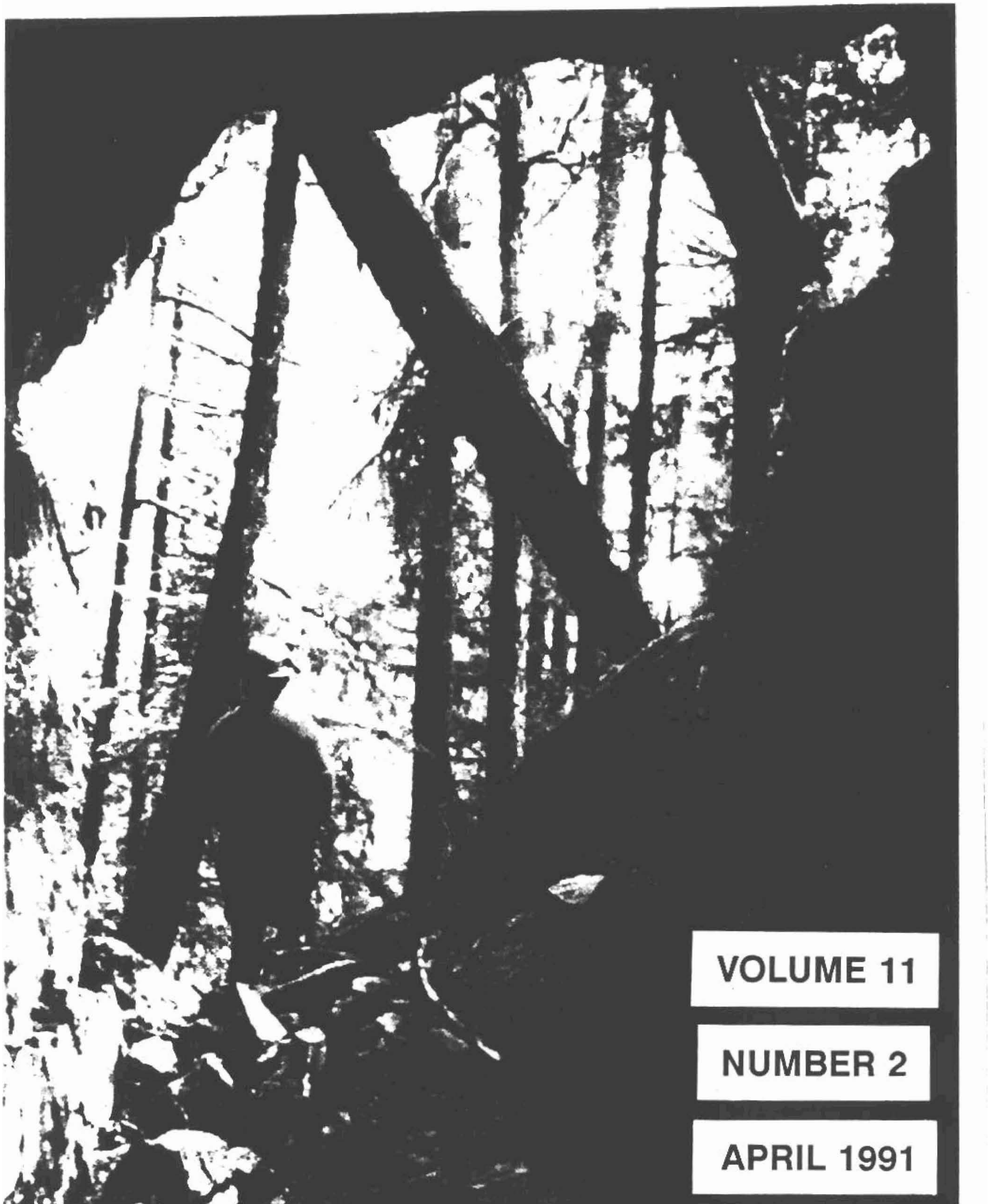
April 1991

Alaskan Caver, Volume 11, No. 2, April 1991

Curvin Metzler

The ALASKAN CAVER



VOLUME 11

NUMBER 2

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The Alaskan Caver (ISSN 0735-0481) is the intermittent publication of the Glacier Grotto of the National Speleological Society. Back issues are available from the President for $2 each. Send articles, letters, news items, announcements, trip reports, cave surveys, drawings, photographs, and so forth directly to the Editor. Opinions expressed within are not necessarily those of The Alaskan Caver, the Glacier Grotto, or the NSS.

Membership is open to all interested in Alaskan cave discovery, exploration, description, survey, mapping, photography, hydrology, morphology, biology, geology, history, speleogenesis and other spelaean processes, conservation, management, adventures, and the fellowship of Alaskan cavers. Annual dues are $15 for individual or $20 for family membership. Outside North America, dues are $23 (US) surface or $28 (US) airmail. Institutional subscriptions are $20 per volume (6 issues).

Dues are due on January 1 and are sent to the Treasurer (address below) with the application/renewal form. Those paying for the first time after October 1 will be considered paid up for the following year. The year through which each member is paid is indicated on the mailing label. Meetings are held in the Anchorage area at 7:30pm on the second Wednesday of each month. Anyone wanting to have a local or special meeting for any reason should notify the President or a regional Vice President.

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* Messages may be announced to Kevin daily via radio station KHNS at (907) 766-2020
† The area code for Dave Klinger in Leavenworth, Washington is (509) (both numbers)

Cover: Linda Morgan at entrance to El Capitan Cave. Photo by Norm Thompson.

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Calendar of Events

contact Curvin Metzler at 333-8766 for more details

date(s)	time	location/title	description/purpose/activity
Wed May 8	7:30pm	SCent Area Meeting	(see last page for details)
weekday May 9-15	1 day	Russian River	check limestone on the Kenai
weekday May 9-15	1 day	Wishbone (Sutton)	check for caves in conglomerate
Sat/Sun May 11-12	weekend	Gull Rock (Hope)	overnight hike to sea caves
between May 21-31	7-12 days	Sheep Mountain	check limestone way back in
Wed Jun 12	7:30pm	SCent Area Meeting	(see last page for details)
between Jun 13-21	8-9 days	White Mts (Frbnks)	check unglaciated limestone
between Jun 23-28	2-4 days	Chitina	check out some large holes
Wed Jul 10	7:30pm	SCent Area Meeting	(see last page for details)
Jul 15 thru Aug 15	(POWIE V)	Prince of Wales Is	(application package enclosed)
between Jul 22-31	10 days	Brooks Range	check caves along haul road
between Aug 19-30	12 days	Chitistone Mts	continue limestone explorations

President's Corner

Elections: The Nominating Committee's slate of candidates is:

President	Jay Rockwell, Jr.
VP: Northern	Mike Mauser
VP: Southcentral	Curvin Metzler
VP: Southeast	Kevin Allred
Secretary	Jack Massie
Treasurer	Harvey Bowers

All are NSS members except Jack Massie, and he has applied. Jack joined the Grotto early last fall and brings artistic and photographic skills. Contributions of the others are listed in The Alaskan Caver 10(6):10-21. Ballots will be included with the next issue; space will be available for write-ins.

Financial Crisis: It has come to my attention that the Grotto Treasury is exhausted. This is due to a combination of: 1) an increase in the frequency and size of The Alaskan Caver, 2) increases in costs of printing and mailing, and 3) an extended grace period before dropping delinquent members from mailings.

There is enough publishable material on hand for three 20-page issues, and by then we will have POWIE V behind us. No one contacted wished to delete material of the available quality. Accordingly, the Executive Committee decided to: 1) tighten up the format of The Alaskan Caver (the Editor has agreed to try this), 2) reduce publication costs (Dave Logan has volunteered to be Publisher--those with any cost-saving ideas please contact him), 3) Carl E. Clark will bill delinquent members who are off the roles and are not receiving The Alaskan Caver, and 4) raise the dues to $15 per year.

It costs about $12 to produce and mail six issues at the present size. Add to this other expenses such as postage and telephone calls, which have traditionally been contributed by the Officers, and everyone's share is easily $15. Details of the new dues structure appear on the inside of the front cover of this issue.

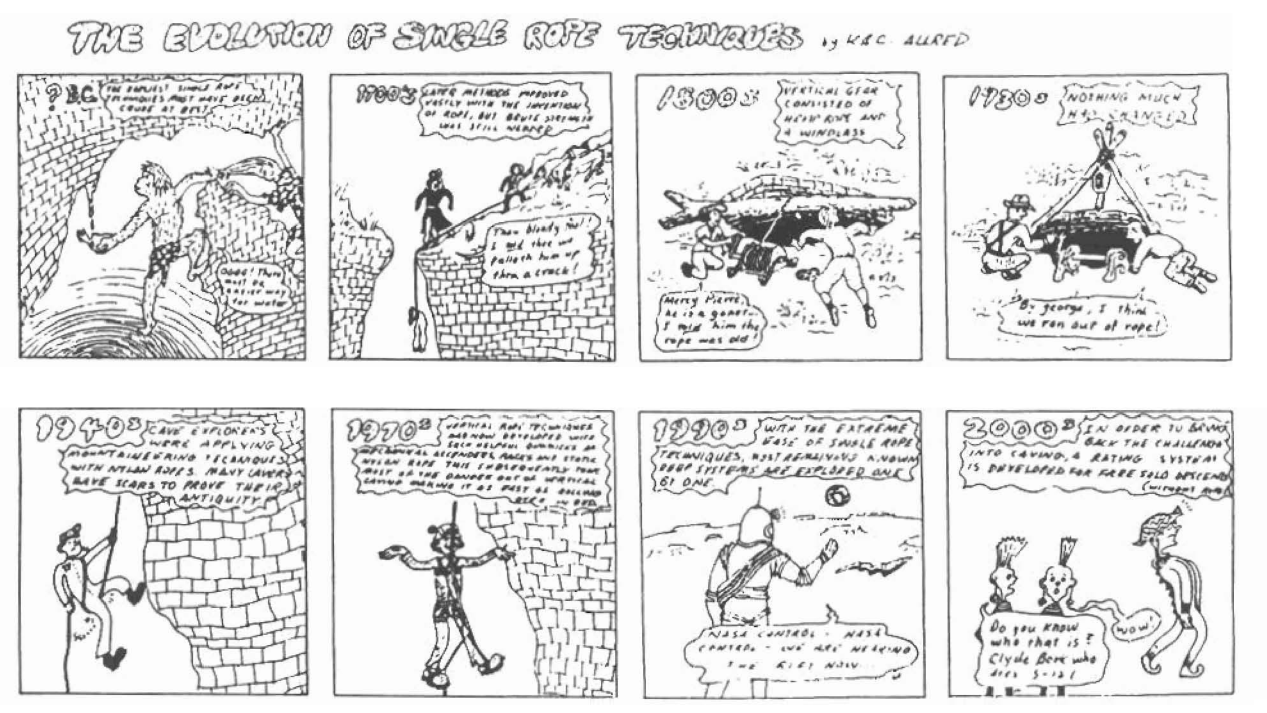
The new rates are not retroactive to the first of the year; those who have already paid their 1991 dues will not be rebilled. The deadline will be the distribution date of this issue. Henceforth, only the first issue of the new year will be sent to overdue members. Fund-raising attempts, such as the sale of patches, the sale of back issues, auctions, and other efforts will be continued to clear up the deficit. In the longer term, non-profit status

should reduce postage costs and make it easier to receive grants and gifts to further our work; it would also require stricter accountability.

By-law change: Article V of the By-Laws specifies the annual dues; and a by-law change requires a two-thirds vote of the entire membership (see The Alaskan Caver 10(6):6-9). It is proposed to change Article V to read: "The dues for regular and institutional members shall be set by the Executive Committee at a level which will cover the cost of publication and distribution of The Alaskan Caver and other incidental expenses. The Executive Committee is thus required to raise and lower dues and subscription rates and to observe the dictates of prudent financial management. The time of implementation of this change will be retroactive to the distribution date of The Alaskan Caver 11(2)." The advantage of this change is that it relieves the Grotto of making a by-law change every time the dues need changed.

POWIE V Applications: Enclosed with this issue is the POWIE V application package. These were reproduced for us by the U.S. Forest Service. Included are: Application--Explanation, the Application, the Challenge Cost Share Agreement, and the 1991 Work Plan. As a maximum of 10 cavers can be there at any one time, you should apply as soon as possible, especially if you want to participate during a specific week. You should indicate your preferred time, an alternate time, and whether or not you are willing to be put on standby if your desired time is filled. Kevin may be leaving Haines early to work out of El Capitan Work Camp. His mail will be forwarded.

If you are driving and do not have ferry reservations, dial (800) 642-0066 immediately. (Go to Ketchikan from Bellingham, WA, Prince Rupert, BC, or Haines, AK; then go to Hollis (Prince of Wales Island) from Ketchikan.) Walk-ons are less of a problem; camping on the ferry is allowed, but no fires. Alaska Airlines stops at Ketchikan; take the mail plane from there. Further information may be found in The Alaskan Caver 10(5):18, 10(6):8, 23,24, and 11(1):19-21. Last-minute details, such as the POWIE V mailing address, the mail plane, and emergency telephone numbers, will appear in the June issue of The Alaskan Caver. ¤



1989 Speological Investigations on Heceta Island

Technical Preliminary Report #7
by Carlene Allred
February 23, 1991

There is an estimated 58 square miles of Silurian Heceta Limestone on Heceta Island, forming an extensive karstland which ranges from forested hilly low-lying areas to the alpine karst of 2775-foot Bald Mountain. Studies of aerial photographs reveal numerous dolines (sinks) and some pits that can be seen in the portions that have been clearcut. A polje containing scattered trees approximately one-half mile across lies on the central eastern portion of the island.

In 1949, Robert J. Hackman, while doing map work in the area for the U.S. Geological Survey, documented the following observations and information concerning Heceta Island, which was reported in the NSS Bulletin (Hackman, 1949):

> "HECETA ISLAND. This island is mostly of limestone and has a considerable number of sinkholes on it, some of them filled with water and forming picturesque lakes. There is a large cave entrance in a sinkhole about half-a-mile inland from the east side of Port Alice. The cave has an underground stream in it and is believed to drain a sinkhole lake farther up the way. And just offshore, seen at low tide, a large spring gushes out of the ground and is about eighteen inches across. It is believed to be part of the same drainage system. The author talked with some geologists who were working on the island and they said they had seen some cave entrances but had not investigated them any further."

In 1975, Bruce Rogers, employed also by the U.S. Geological Survey, recorded the following in The Alaskan Caver (Rogers, 1975):

> "To the west of Twin Mountain lies Heceta Island, the type locality for the Heceta Limestone. Indeed, most of the porkchop-shaped island is limestone. And in the limestone are several caves. In the area that I mapped there were no obvious caves, although sinkhole alignments, karst corridores and such pointed to their presence. To the northwest of this area were two interesting lake groups: those about Chuck Lake and those about Mink Lake. In Chuck Lake itself was a large hole that water disappeared out the lake bottom. Several smaller lakes and ponds evidently drained underground into Chuck Lake itself. The smaller lakes about Mink Lake were comparable, but on a smaller scale. Both of these areas were looked over by Don Eberlien several years ago and several small entrances were noted."

During the first week of August, 1989, four members of the Glacier Grotto investigated Heceta Island for caves. Rumors were checked and clearcuts were scanned by wheeled vehicle for obvious entrances. Two small caves were located and explored, and are described in the text below. As of this writing there have not been enough caves studied for one to begin to understand or assess the speleological potential of the area. Much more work will be required. This report also includes descriptions of several more of the many potential leads which have yet to be checked.

Alice Cave (Mint Lake Cave)

Exploration and mapping were done on August 4, 1989, by Richard Bridges, Dave Modisette and Ann Strait. They were directed to the area by an aerial photo lead provided by Kevin Allred. He had noted that there was no outlet stream draining Mint Lake, and that downslope toward Port Alice was a prominent steephead where a stream and gully emerge abruptly from the mountainside. The description of the location also matches that of the cave reported by Robert Hackman above. His reported cave had been subsequently named Alice Cave by the National Speleological Society and listed in its files as such. Some prefer to call it Mint Lake Cave.

Located about one-half mile inland from the eastern shore of Port Alice, this cave captures the stream that flows out of Mint Lake. It is formed on or near the contact between the Heceta Limestone to the north and the Silurian conglomerate to the south. The cave, formed under phreatic conditions, has two entrances. The large northern entrance swallows the stream at present, and at high water the smaller southern entrance may also take in water. Both passages join inside the cave and continue as one. Unfortunately, the passage is plugged further with logs which were probably cut during logging operations and allowed to wash into the cave. The exploration team suggested a chain saw for removing this plug for further exploration. The cave may possibly resurge at the previously noted steephead one-fourth mile to the west. It may be part of a complex drainage system.

At present, 269 feet of passage has been surveyed. Air movement was noted.

Management Recommendations

There is no need to restrict the location of this cave. It is basically horizontal and there are no speleothems or other features that need to be protected. Sudden flooding during storms could possibly be a danger to visitors. Logs and debris from logging operations should be kept from entering the cave. If fish spawn up through the cave, their migrations may be affected by clogging. Other effects are unknown.

Deer Creek Sinks

This small cave formed in Heceta Limestone is located about one and a half miles east of Mint Lake. The entrance is in the bottom of a prominent shallow sink that has been clearcut recently. The cave contains roughly seventy feet of passage and was explored by Richard Bridges on August 5, 1989. Formed phreatically, it swallows a small surface stream and then splits underground. Both passages take the streams and head in a general northwest direction. They sump after a short distance.

Management Recommendations

There is no need to restrict the location of this insignificant cave. As in all karst areas containing caves, care should be taken when making roads.

Huckleberry Hole

This hole was seen from the road by Ann Strait, Richard Bridges, Dave Modisette and Carlene Allred while driving through the recent clearcuts. It is located in the bottom of a sink one-third mile east of Mink Lake. The pit descends a short ways before being partially clogged with silt and logs, but it may continue downward. There was no air movement noted. A rope will be needed for further investigation.

One-Hundred-Foot Hole

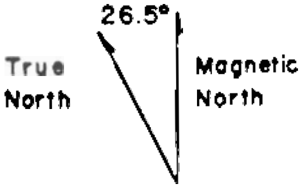
Locals reported a cave having an entrance which matched the description of a large hole estimated at one hundred feet in diameter noted on aerial photographs. An attempt was made to check this lead, but because of the nature of the overgrown clearcut around it our team cound not reach it. Perhaps a future attempt will be more successful. It is probably a collapsed doline.

MINT LAKE CAVE

HECETA ISLAND, ALASKA
TONGASS NATIONAL FOREST

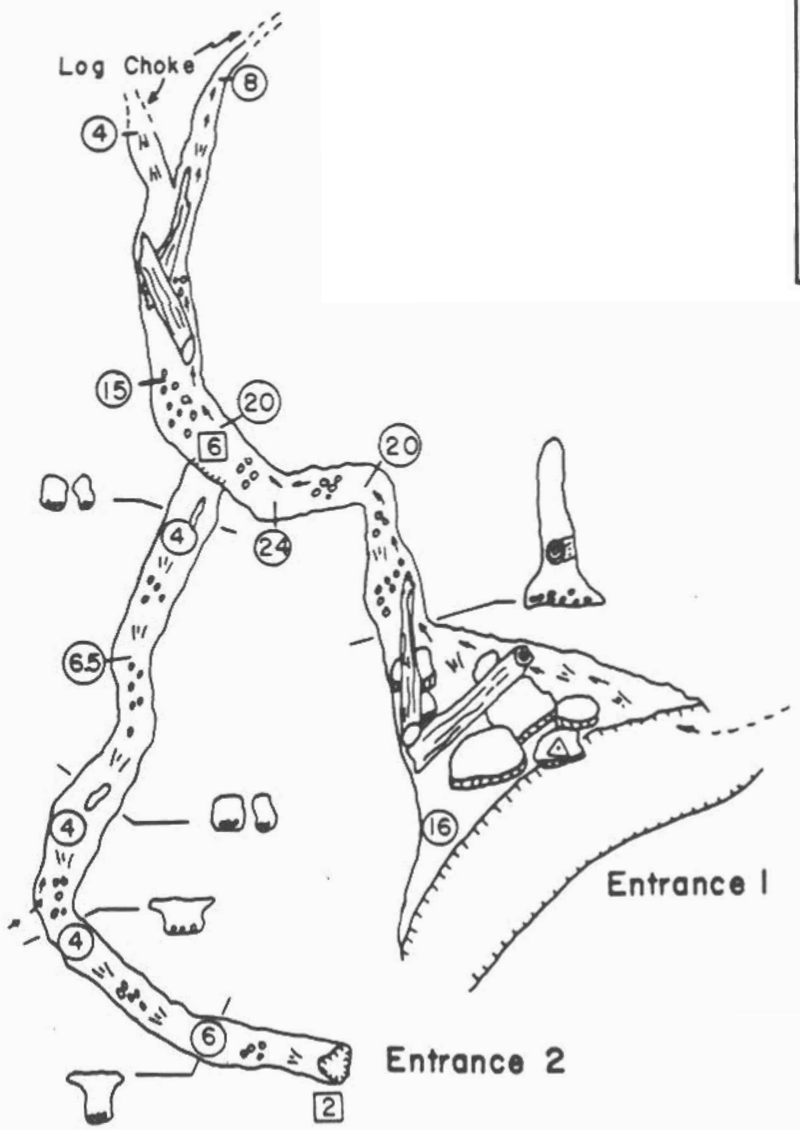
EXPLORED AND MAPPED 8-4-89
BY R.A. BRIDGES
D.R. MODISETTE
A.E. STRAIT

SKETCH, DATA REDUCTION, AND DRAFTING BY A.E. STRAIT



LEGEND

- Cobbles
- Logs
- Passage Height
- Breakdown
- Stream or Water Flow
- Drop Distance
- Slope



TOTAL SURVEYED PASSAGE
269 FT

0 10 20 30 40
FEET

Numerous pits to be investigated

The following description will take one into this area reported by Kim Redman. Follow the road south out of Port Alice to road #1425-100. Starting at the eight-mile marker and continuing on past the nine-mile marker there are various pits on either side of the road. This area is in virgin forest between two large clearcuts and is west of Warm Chuck Inlet. Most roadside pits were investigated and nothing significant found. The terrain in the surrounding forest should also be carefully checked for pits and caves.

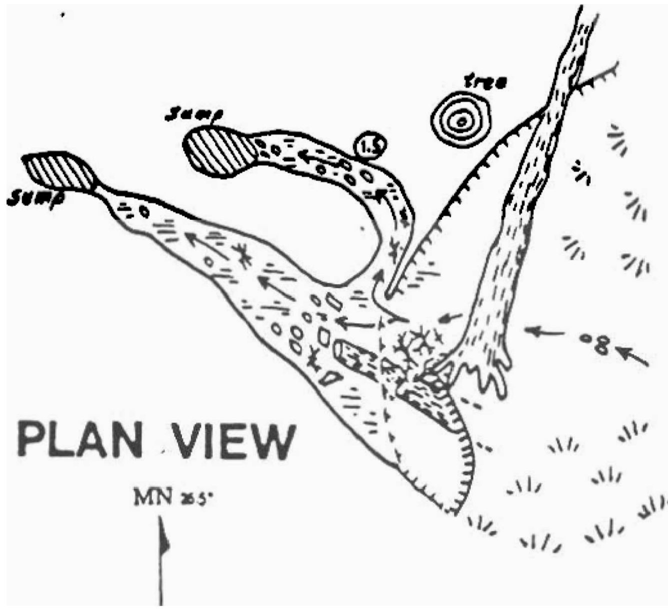
Bald Mountain

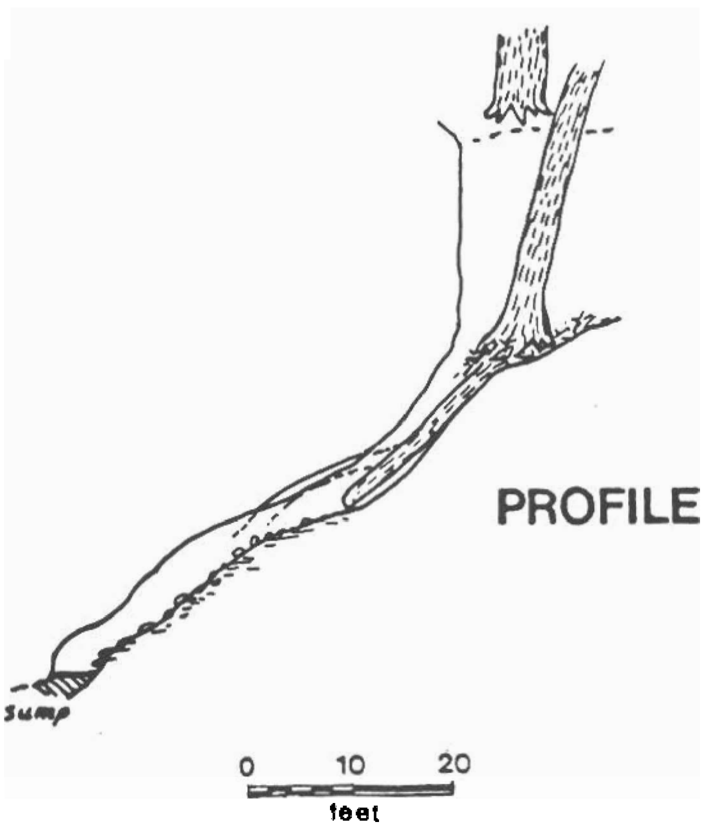
The summit and ridge northward contain innumerable pits and karst features which are typical of alpine terrain in Southeastern Alaska. There are probably some deep cave systems in this area. Mike Van Note, of Haines, Alaska, climbed to the sumit in 1979, but did not find any promising leads on top. In 1989, Richard Bridges, Ann Strait and others climbed up onto the ridge to the north and found some caves, but they did little exploring in them.

References

Hackman, Robert J. 1949. Speleology in Southeastern Alaska. NSS Buletin 11:16.

Rogers, Bruce W. 1975. This is it! The Alaskan Caver 4(2):3. ¤





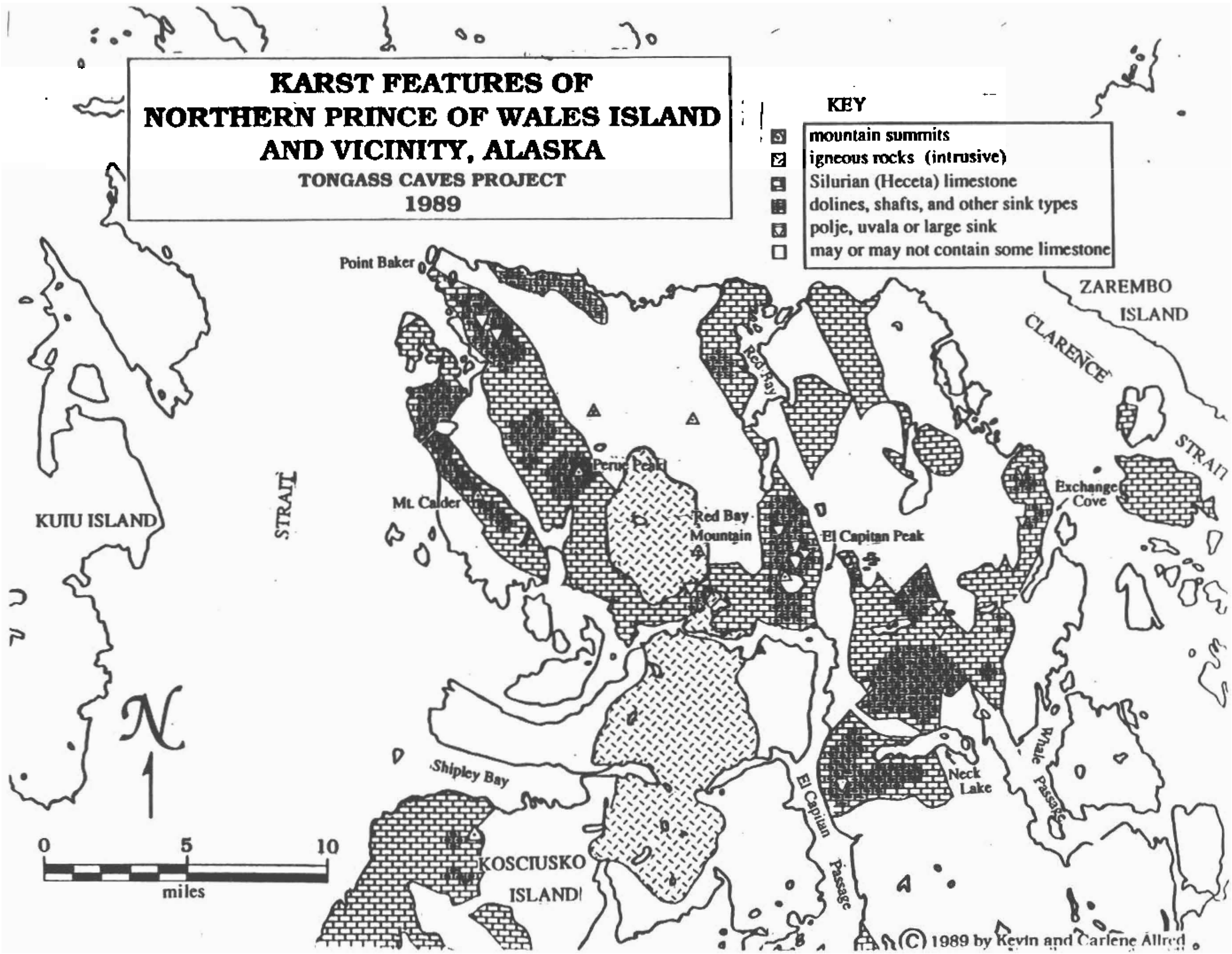
DEER CREEK SINKS

HECETA ISLAND

ALASKA

TONGASS CAVES PROJECT
1989

Sketch by R. Bridges


KARST FEATURES OF
NORTHERN PRINCE OF WALES ISLAND
AND VICINITY, ALASKA
TONGASS CAVES PROJECT
1989
KEY
mountain summits
igneous rocks (intrusive)
Silurian (Heceta) limestone
dolines, shafts, and other sink types
polje, uvala or large sink
may or may not contain some limestone
Point Baker
ZAREMBO
ISLAND
CLARENCE
STRAIT
Red Bay
Peril Peak
Mt. Calder
Red Bay
Mountain
El Capitan Peak
Exchange
Cove
KUIU ISLAND
STRAIT
N
Shipley Bay
Neck
Lake
Whale Passage
El Capitan
Passage
0
5
10
miles
KOSCIUSKO
ISLAND
© 1989 by Kevin and Carlene Allred

An Overview of Perue Peak Cave Potential
Technical Preliminary Report #17
by Kevin Allred
November 14, 1989

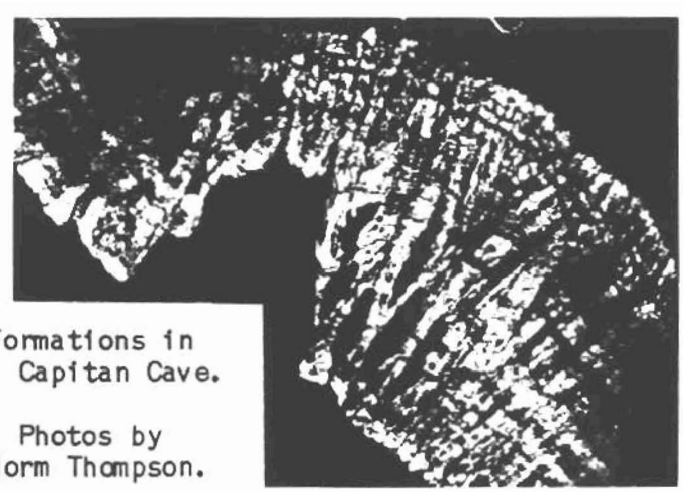
Judging from the study of aerial photographs, Perue Peak appears to hold the most promise on Prince of Wales Island for a very deep cave system. The entire mountain is Heceta Limestone, from sea level to over 3000 feet in elevation.

By studying the aerials, one can see brownish bands or veins of rock crisscrossing the mass of the Heceta. It is still not known exactly what this is, other than being noncarbonate. This material probably retards some cave development on Perue Peak by sealing off interstices. It appears to break down into a brown-colored silty residue. Interestingly, there was very little rillenkarren on the limestone, and the exposed surfaces had a much rougher granular appearance than found on El Capitan Peak, which is quite smooth and contains much rillenkarren.

A reconnaissance flight over Perue revealed that most of the shafts on the mountain were quite shallow, but subsequent field work by Curvin Metzler, Kevin Allred, and Steve Lewis on August 18 through 21, 1989, proved that some caves do exist. Two caves were entered and surveyed, namely Macho Peekaboo and Drip Drop. Access was on foot from the end of road 2087. Many more entrances were noted, even to the summit of the peak. Most shafts and pits were obviously sealed less than forty feet down and often contained snow, indicating cold traps. Others were deeper (seventy feet or more) and not investigated.

The limestone of Perue Peak extends to Flicker Ridge to the northwest. Somewhere below all this limestone must be large cave systems to carry off the tremendous amounts of snow melt and rainwater, as there are apparently few or no year-round surface streams. The stream between the Perue summit and Calder Bay was checked on August 4, 1989, by Harvey Bowers, Sandy Bowers, and Kevin Allred; it was quite low in flow near the bay. More field work should be done both on the peak and around its perimeter.

[A list of aerial photograph interpretations contained about 50 entries. Entries ranged from individual items, such as holes, pits, and sinks, to grouped items, such as clusters of pits and many sinks, and on to areas of given sizes (hundreds or thousands of feet across) which contain tens to hundreds of pits! Pinnacle karst was mentioned about five times, stream possibly going underground was mentioned a couple of times, and there was a plateau of 3500 by 2000 feet containing 230 holes!] ¤



Formations in El Capitan Cave.

Photos by Norm Thompson.

An Overview of Flicker Ridge Cave Potential

Technical Preliminary Report #18
by Kevin Allred
November 14, 1989

Flicker Ridge, located west of Flicker Creek, is composed mostly of Heceta Limestone, up to 2711 feet in elevation. The ridge can be reached from logging road 2087. Much of the terrain above 1400 or 1500 feet could be termed subalpine, where trees are sparse and grow very slowly. Logging has occurred to about 1800 feet or more, providing both access and unknown impacts to the karst and hydrology of this area.

No cave inventory field work has been done on or around Flicker Ridge other than driving and hiking through part of it on August 18, 19, and 21, 1989, on a Perue Peek reconnaissance. A sixty-foot-deep shaft, named Grabber Pit, was discovered on August 19 and investigated on August 21. It is unsurveyed and adjacent to, or on, a proposed continuation of road 2087.

Chances are that there are many more shafts and caves on Flicker Ridge. The unchecked alpine and subalpine areas appear to contain spectacular pits and shafts, judging from aerial photographs.

[Aerial photograph interpretations mention lightly and heavily karsted areas, a huge sink, lots of deep holes, a large sink with secondary sinkholes or pits, a pit, and a possible steephead. Additional leads include well-type shafts or pits, a couple of caves and holes, and a hole in a cliff.] ¤

An Overview of El Capitan Peak Cave Potential

Technical Preliminary Report #19
by Kevin Allred
November 14, 1989

Most of El Capitan Peak, which in this report extends to Red Lake, is Heceta Limestone, except for a large cap of polymictic conglomerate at the summit (2566 feet). Even with three years of brief expeditions into the region, and after study of aerial photographs and geologic maps, not much is known about the cave potential. It was hoped to utilize this karst area as a model to accurately determine the cave potential of other similar alpine terrain on Prince of Wales Island, but the limestone is somewhat different on two of the other sites visited in 1989.

Perue Peak and--even to a greater degree--Mount Calder were almost void of any rillenkarren, when compared to its common presence on El Capitan. Also, the texture of exposed limestone on Perue and Calder appeared much more granular and rough to the touch than the smooth and more aggressively karsted carbonates of El Capitan. The limestone of El Capitan Peak contains dikes and sills of basalt, which appear to control cave development to a certain degree, as in Blowing in the Wind Cave. But in at least one instance, El Capitan Pit, the basalt structures seem not to have affected the shaft development or direction at all.

El Capitan Cave, at the southern base of the mountain, has now been mapped to over 9000 feet in length, and continues. El Capitan Pit, atop the mountain, is now the deepest pit in the United States, at -598 feet deep. Snow Hole, also on the mountain, is the third deepest pit, at -448 feet. Another cave, Blowing in the Wind, is now 744 feet long and 312 feet deep, and also continues. Other

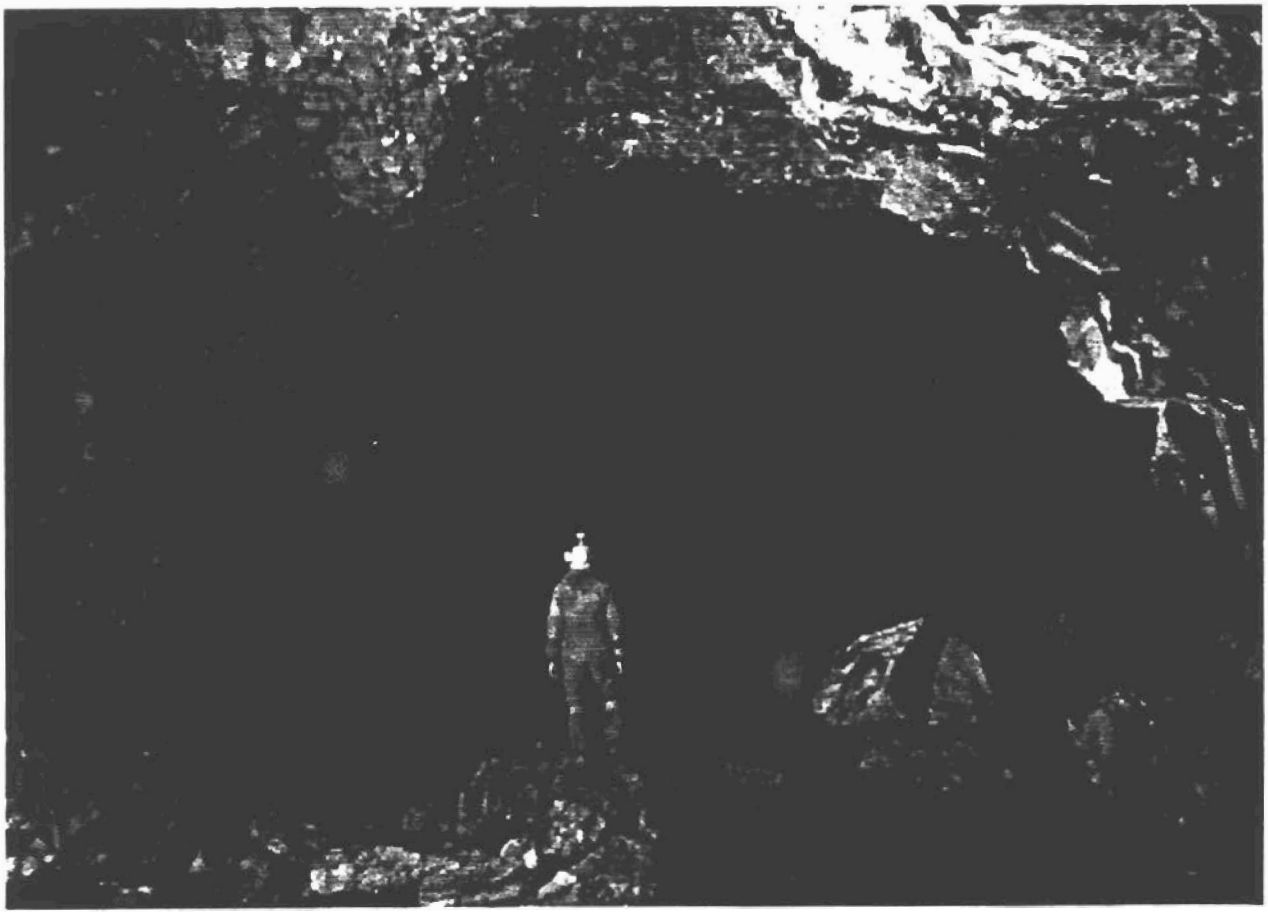
known caves of lesser size include Belittled Pit, Pit on the Cutting Edge, Kid Cave, Frost Pocket Cave, Almond Cave, and Salmon Fry Cave.

Both sides of the mountain have springs 1000 feet in elevation or lower, indicating base level for the karst water table in those areas. Nothing is known of the springs on the northern half of the mountain, but a large resurgence, at about eighty feet elevation to the south, was dye-traced from nearby El Capitan Cave in 1989 (see report #23).

The subalpine carbonate areas of El Capitan Peak are sculpted in a wide variety of karst forms, both large and small. Largest of all is a polje one-third mile wide and nearly one-half mile long. All drainage is underground, and it is nearly 200 feet deep. Another polje or uvala is three-fourth mile to the north; although not as large, it lies at almost the exact elevation, indicating a possible underground hydrological and cavernous connection. Blowing in the Wind, Snow Hole, and Window Well are between these two large depressions.

Other less spectacular closed depressions, such as uvalas, sinks, pits, and shafts, cover the karst areas to a density of over 3000 per square mile. This terrain is very rugged and dangerous. Karren (small solutional features) include rillenkarren, grikes, wall karren, solution flutes, heelprint karren, solution grooves, covered karren, and pinnacles.

As yet no main drainage systems of the mountain have been penetrated, other than the El Capitan Cave system. More detailed hydrological investigations were carried out in 1989 by



Looking into the Alaska Room from El Camino Real. Photo by Norm Thompson.

Winfield Wright, of the U.S. Geological Survey [report appears on pages 14-19].

Up until the 1989 season, it was not known if logging had a seriously negative impact on the caves and hydrology of the area. But with a recent landslide, which occurred above the Forest Service Work Camp of El Capitan sometime between the 1988 and 1989 expeditions, there is very strong evidence that this may have been caused by El Capitan Cave itself. The slide nearly reached the main road and the work camp itself. It is possible that, after the logging of the area in which the slide occurred, the root systems of the larger trees decomposed to the point where, when the yearly flooding of El Capitan Cave system occurred, part of the water seeped from the hillside between the cave and its resurgence on the other side of the camp. The ground was not able to remain stable, and a large portion of hillside sloughed downwards.

The logging of the watershed higher on the mountain may also have contributed to a higher than normal runoff into the cave. In view of what happened here, it is strongly recommended not to log the steep areas on the eastern side of El Capitan Peak, where small natural slides already occur. There are also several resurgences, which may contain cave systems, on this side of the mountain. In 1988, Jay Rockwell and Carlene Allred discovered Almond Cave, a small cave entrance at one of these springs. It was not investigated in the 1989 season. A road is apparently planned in this steep and unstable area. At the slope is Turn Creek, a salmon spawning stream.

[There are some emergence leads, a very large one with Almond Cave and another which blows air. Aerial photograph interpretations include sinks and poljes, pinnacle karst, a steephead, many pits, and many holes.] ¤

An Overview of Mount Calder Cave Potential

Technical Preliminary Report #20
by Kevin Allred
November 15, 1989

Mount Calder, 3370 feet high, lies in the center of a long band of Heceta Limestone, which runs from Hole in the Wall to Calder Bay. Judging from aerial photograph interpretations, there is much cave potential in Mount Calder. On bench areas between 2200 and 2500 feet elevations is extensive karst, consisting of sinks, fissures, and what appears to be shafts. The bench area to the south of and up to the summit was quickly checked for possible caves on August 9, 1989. Kevin Allred and Forest Service employees Boyd Benson and Malcom North approached the peak from logging road 2900-500. Kevin discovered an unnamed horizontal cave which lead some fifty feet to the edge of an unexplored pit of unknown depth. This was the major find of the day. No shafts over sixty or seventy feet were found on the heavily karsted bench, and nothing anywhere near the summit.

Interestingly, there was hardly any rillenkarren found on the mountain, and the limestone had a rough, granular texture--very unlike the smoother and more heavily karsted rock of El Capitan Peak. More work should be done in the cave inventory on Calder. The unexplored cave should be explored and surveyed. There are numerous holes visible in ledges and cliffs lower on the mountain; and the north bench remains to be checked, even if as briefly as the southern has been.

[Aerial photograph interpretations include caves, pits, holes, and sinks. The top of Mount Calder is karsted.] ¤

Preliminary Description of Karst Terranes of Northern Prince of Wales Island, El Capitan Peak Area, Southeastern Alaska, July-August, 1989

by Winfield G. Wright

Intoduction

The El Capitan Peak area is located in the northwestern part of Prince of Wales Island, southeastern Alaska. The study area is located on the Petersburg A-4 and Petersburg A-5 quadrangles. Altitudes range from sea level at El Capitan Passage to 2566 feet above sea level on El Capitan Peak. Because of the mountainous terrane and northern latitude of the area, this topography is called an alpine-karst terrane.

The exploration and hydrogeologic reconnaissance of the karst terranes of the El Capitan Peak area were undertaken as part of a cooperative effort between the U.S.F.S. Tongass National Forest and volunteer scientists from Alaska and the lower contiguous United States. Scientific information acquired during the reconnaissance are useful for documenting the natural resources (geologic, hydrologic, and biologic) of the alpine-karst terranes of southeastern Alaska.

Information regarding the hydrogeologic controls on karst development on northern Prince of Wales Island are needed to (1) help describe the origin of caves on Prince of Wales Island, Alaska, (2) to obtain a better understanding between surface features (such as sinkholes and poljes evident on aerial photographs) and hydrogeology, (3) provide this information to the U.S. Forest Service for their use in managing the timber resources of the parts of southeastern Alaska underlain by carbonate rocks, and (4) provide this information to the general scientific community for additional analogies of karst development in alpine-karst settings.

The western slope of Prince of Wales Island receives as much as 180 to 200 inches of rainfall annually. Temperatures remain moderate through the winter months because of the warm Pacific Ocean currents making climatic conditions of the area that of a temperate rainforest.

Purpose and Scope

This article presents a preliminary description of the karst terranes of northwestern Prince of Wales Island, southeastern Alaska, and identifies basic geologic and hydrologic controls on karst development of the study area. A description of the water-quality characteristics of springs and streams is presented and needs for further studies are identified.

Data were collected during July and August, 1989, from three springs and a creek in the El Capitan Peak area (Figure 1). The water samples were analyzed for major cations and anions and oxygen and deuterium isotopes. Temperature, pH, specific conductance, and alkalinity titrations were performed in the field.

Methods of Investigation

Water samples from three springs and a creek were collected for water-quality analyses. Filtration and preservation of the samples were performed in the field. Filtration included using a 0.25 µm filter for dissolved cation and anion species. Preservation of samples for cation analyes included addition of nitric acid lowering the pH of the sample to 2 in order to prevent precipitation of metal species in the sample bottle. Preservation of samples for stable isotopes included addition of mercuric chloride to the water sample. The samples were shipped to the laboratory in non-chilled containers.

Limited dye-tracing tests were performed to determine the hydrologic relations between the caves and springs. Activated charcoal traps were placed in springs and streams in the El Capitan Peak area. Dyes were injected into underground cave streams and traced to springs to determine general patterns of groundwater movement and approximate travel times of groundwater flow.

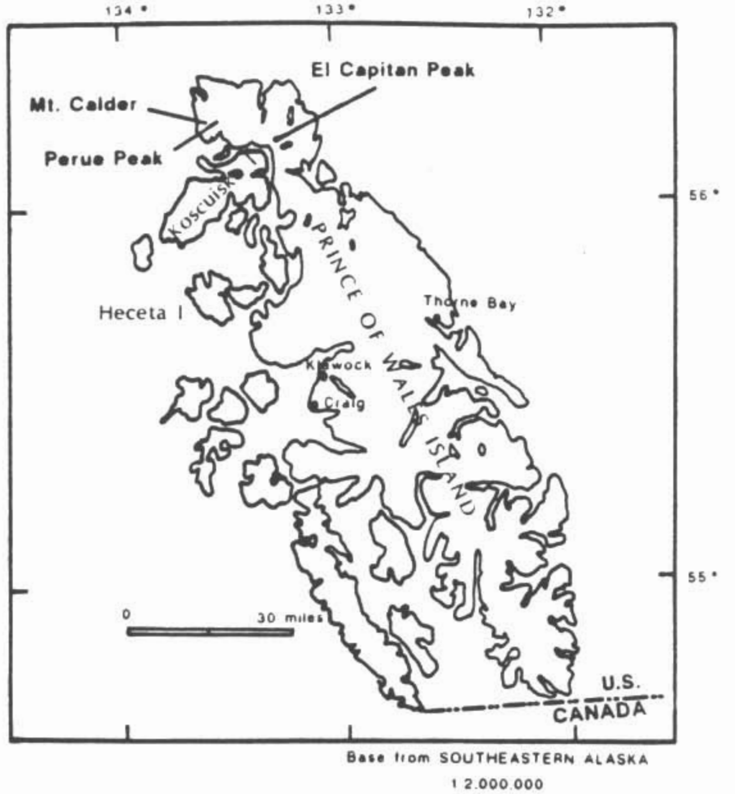


Figure 1.--Prince of Wales Island and location of karst areas in the northwestern part of the island.

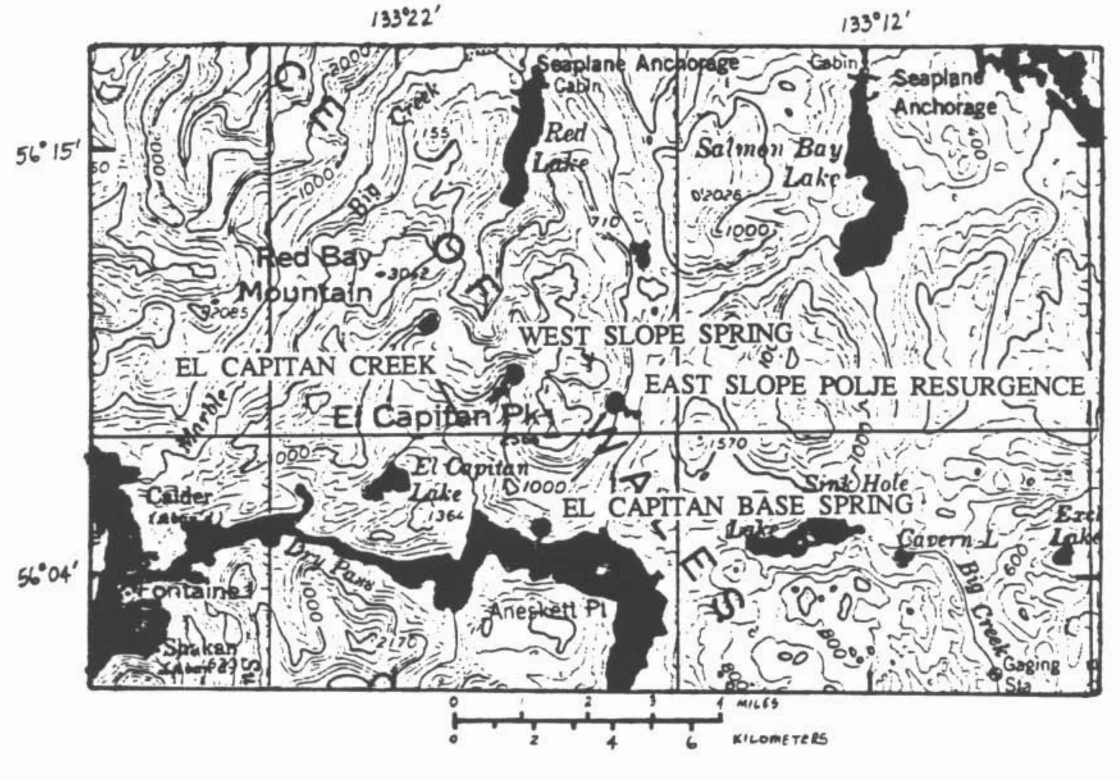


Figure 2.--Location of springs and creek sites sampled in the El Capitan Peak area, Prince of Wales Island, southeastern Alaska.

Geologic Setting

The geologic formations of the area are part of the Alexander Belt, which is one of the largest accretionary fragments in the northeastern Pacific region. It is characterized by an early complete record of Paleozoic and early Mesozoic deposits. The origin of these deposits within an island arc environment is indicated by the abundance of volcaniclastic, quartz-free lithologies, and fossiliferous marine limestones (Eberlein and Churkin, 1970; Soja, 1990). More than 9000 meters of well-preserved limestone and siliciclastic rocks are exposed near Prince of Wales Island.

The karst formations of northwestern Prince of Wales Island are mostly developed in the Heceta Limestone of Silurian age. This limestone is fossiliferous and massive (for instance, bedding is not discernible in bedrock exposures), fine grained, and has a high percentage of calcium carbonate. The rocks are extensively fractured; the fractures are frequently filled with calcite and rarely with dolomite (Eberlein and Churkin, 1970, p. 16). Thickness of the limestone ranges from 3000 to 4000 meters (Eberlein and Curkin, 1970, p. 18; Brew and others, 1984, p.16; Soja, 1990, p. 237). Limestone breccias and conglomerates are interbedded within the Heceta Limestone. The breccia clasts are mixed-angular and rounded, and the breccia cement is composed mostly of limestone. The origin of the intraformational limestone breccias and conglomerates is probably sourced in debris flows on platform slopes of organic buildups during the Silurian time.

Igneous dikes and sills of Cretaceous age intrude much of the Heceta Limestone in the area. These intrusive dikes, speculated from descriptions provided by Brew and others (1984), Eberlein and Churkin (1970), and K. Allred (Glacier Grotto of the National Speleological Society, written common., 1989), are probably comprised of "andesite with phenocrysts of amphibole". These rocks are a grayish-green color when freshly broken, but appear brownish-green in weathered exposures on cave walls and on the surface.

Soil cover is thin to absent in most places near the tops of the peaks and on the hillslopes where caves are most evident. Soils that have collected in swales and valleys are generally saturated with water and rich in organic matter forming muskeg-like areas. Even at great altitudes, small ponds occur in these muskeg areas.

Geologic and Hydrologic Controls on Karst Development

The dominant controls on karst development in the alpine-karst terranes of northern Prince of Wales Island include (1) occurrence of intrusive-igneous dikes, (2) occurrence of deep fissures, and (3) the steep terrane. Deep caves have developed along fissures, many of which are probably related to igneous dikes. El Capitan Pit, just one of these deep fissures, was discovered in 1988, and in 1989 was surveyed to have a total depth of 598 feet below land surface--straight down--with few explorable cave passages at the bottom. Many of these deep fissures exist in the Heceta Limestone on El Capitan Peak, Perue Peak, and Mount Calder, but few of them have been explored; in addition, the limestone areas of the island are riddled with shallower fissures forming a "grike and fissure" type of karst terrane. This type of terrane is extremely difficult to negotiate on foot.

There are several possible explanations for the occurrences of the deep fissures:

1. Groundwater percolates along fractures next to the dikes, or the dikes divert groundwater flow; cave development takes place in limestone next to the dikes;

2. The fissures were enlarged by melt-water drainage from glaciers that once covered the region;

3. The fissures were at one time filled with the igneous-intrusive rock--the igneous rock has weathered away to leave an open fissure;

4. The fissures were enlarged partly by stress relief during and after glacial unloading and then later were enlarged by limestone dissolution; and/or

5. Repeated and continued thrusting and uplifting of the islands of the Alexander Belt may be cause for fracturing of the rocks, which are preferential paths of groundwater movement.

Deep fissure-cave development also occurs when tectonic uplift causes sudden lowering of the potentiometric surface (or water table) causing rapid downcutting of the karst terrane. Most of the above processes are unique to alpine karst.

Caves of great horizontal extent also occur on northern Prince of Wales Island, El Capitan Peak area. El Capitan Cave (located near El Capitan Base Spring, see Figure 1) has been surveyed to over 1.5 miles in extent, and most of the cave passages are horizontal in nature. This cave is different in character from the deep fissure caves on the mountaintops. The development of El Capitan Cave may be related to the waters that percolated downward from the once-heavily-forested area overlying the recharge area for the cave system.

Water Quality and Karst Development

Preliminary water-quality data were collected from three springs and a creek in the El Capitan Peak area during July, 1989 (Table 1). Geochemical speciation of dissolved minerals was identified by applying the data to the geochemical-equilibrium model WATEQF (Plummer and others, 1967); these results are shown in Table 2.

Water from the springs on the eastern slope of El Capitan Peak are saturated with respect to calcite and supersaturated with respect to aqueous-iron complexes. Water from the spring and creek on the western slope of El Capitan Peak are undersaturated with respect to calcite and supersaturated with respect to aqueous-iron complexes. Water from the springs and creek are undersaturated with respect to all other mineral types including dolomite and gypsum. Water from all the sites are a calcium-bicarbonate type and generally have weak ionic strength.

Oxygen/deuterium isotope analyses indicate that the waters are definitely meteoric, ruling out the contribution of connate water or geothermally-altered groundwater (indicating a deep source) to the flow system.

Limestone dissolution typically occurs because of the enrichment of percolating ground waters with carbon dioxide derived from the soil zone and the generation of carbonic acid. Dissolved carbon dioxide is probably abundant in the saturated, organic-rich muskeg areas; these waters probably contribute significanly to karst development (field measurements of water from a high-altitude muskeg pond indicated a pH of 5.6). A small percentage of the carbon dioxide needed to drive the carbonic-acid dissolution of the limestone may be from atmospheric gases circulating through the fractured limestone mountains; dissolution features on the walls of caves (cave karren) have been documented in El Capitan Peak area caves indicating corrosion of the limestone by CO_2-rich condensation.

Where the soil cover is thin to absent on mountainous peaks of the El Capitan Peak area, other geochemical mechanisms may be occurring that dissolve limestone and enlarge the vertical fissures. For instance, acid generation may be related to the occurrence of igneous dikes. Hydrolysis reactions of metal ions (such as ferrous and ferric iron) produce acidity, and the oxidation of ferrous to ferric iron by dissolved oxygen also may produce acidity (Hem, 1985, p. 111). Precipitation of iron species from the spring waters

Table 1.--Water-quality data for selected springs in the El Capitan Peak area, Prince of Wales Island, southeastern Alaska

["Field" headings are measurements performed immediately after collection; "--" indicates data were not collected; µS/cm indicates microsiemens per centimeter at 25 °C; mg/L indicates milligrams per liter µg/L indicates micrograms per liter]

Site name	Sample date	Approximate discharge, gal/min	Field water temperature (°C)	Field specific conductance (µS/cm)	Field pH	Field alkalinity, mg/L as calcium carbonate	Nitrate, mg/L as NO_3
El Capitan Base Spring	07-24-1989	500	6.0	20	8.1	115	0.9
East Slope Polje Resurgence	07-24-1989	200	5.	82	8.3	115	.5
El Capitan Creek (west slope)	07-24-1989	1,000	10.	40	7.4	107	.2
West Slope Spring	07-24-1989	300	3.5	--	7.3	104	.2

Site name	Calcium, mg/L	Strontium, mg/L	Magnesium, mg/L	Sodium, mg/L	Potassium, mg/L	Chloride, mg/L	Sulfate, mg/L	Bicarbonate, mg/L	Iron, µg/L	$\delta^{18}O$, ‰	δD, ‰
El Capitan Base Spring	35.9	.05	.8	3.	.2	2.8	2.2	140	90	-11.6	-80.
East Slope Polje Resurgence	31.3	.05	.9	3.	.2	2.2	.5	140	80	-11.6	-79.
El Capitan Creek (west slope)	44.8	.05	.9	3.1	.6	2.9	1.6	130	500	-12.0	-83.5
West Slope Spring	25.2	.03	.5	2.5	.1	2.9	1.2	128	80	-12.2	-85.5

Table 2.--Results of thermodynamic speciation calculations

[Results obtained from theoretical calculations performed by the WATEQF geochemical-equilibrium model (Plummer and others, 1976); saturation indices less than zero and greater than zero indicate undersaturation and supersaturation, respectively]

Site name	Log P_{CO_2}	Saturation indices								
		Calcite	Aragonite	Dolomite	Gypsum	Anhydrite	Strontianite	$Fe(OH)_3$	Goethite	Hematite
El Capitan Base Spring	-3.06	0.124	-.035	-1.36	-3.31	-3.77	-2.16	1.95	8.25	16.14
East Slope Polje Resurgence	-3.30	.286	.127	-.945	-3.42	-3.89	-1.93	1.78	8.03	15.72
El Capitan Creek (west slope)	-2.37	-.447	-3.78	-2.47	-3.38	-3.78	-2.86	2.60	9.09	17.78
West Slope Spring	-2.35	-.837	-.998	-3.38	-3.68	-4.18	-3.17	1.59	7.76	15.21

is evident from the brown and black colorations downstream from the spring resurgences.

Dye-Tracing Results

Dye placed in a stream in El Capitan Cave during the July, 1989, expedition resurged in about six hours at El Capitan Base Spring, where the water is withdrawn for use by the U.S. Forest Service's El Capitan Work Camp. Dye placed in Blowing in the Wind Cave (located northeast of El Capitan Peak at altitude 2410 feet above sea level) was detected in small concentrations in a charcoal dye-detection trap which was placed at the Turn Creek bridge east of El Capitan Work Camp. Travel times of the dye from Blowing in the Wind Cave to Turn Creek are not known. These dye traces were performed during the dry season when retention times of underground streams would be slower than during the rainy season.

Summary and Conclusions

The igneous dikes within the Heceta Limestone seem to play a major role in the development of the alpine-karst terrane of northwestern Prince of Wales Island, southeastern Alaska. This has also been noted by the author for the caves of northwestern Vancouver Island, British Columbia, Canada. The dikes play a geochemical role in limestone dissolution and play a physical role by diverting percolating ground waters along the dikes. However, considerable amount of additional data are needed to describe the hydrogeologic framework of the alpine-karst systems of northern Prince of Wales Island. Suggestions for further studies include definition of recharge areas to karst springs in the area, description of the depths of fresh groundwater circulation below sea level and definition of the saltwater/freshwater boundary (for withdrawal of groundwater by wells), role of geologic structure on groundwater-flow patterns, and extensive water-quality and biologic-quality sampling of spring and ground waters of the island. Dye-tracing tests from sinkholes to springs are needed to define travel times of potential surface contaminants entering the groundwater system through sinkholes.

Acknowledgments

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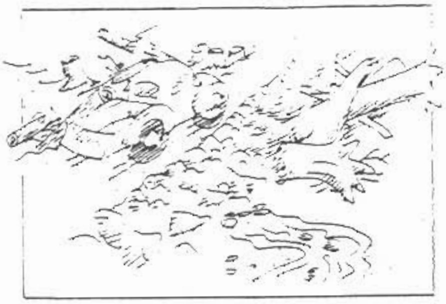

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